Development by Design: opportunities in northern Australia and the potential role of Indigenous people, with particular emphasis on the Northern Territory

A scoping study for The Nature Conservancy

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NAILSMA

NORTH AUSTRALIAN INDIGENOUS LAND AND SEA MANAGEMENT ALLIANCE

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1 SUMMARY

North Australia's savanna landscapes have suffered little overt structural modification through development, but their conservation and cultural values are nonetheless substantially degraded. Land management capability and financial resources to support land and heritage management are inadequate to meet demonstrated need. Incremental deterioration will continue until greater resources and commitment to improvement are found.

Rhetoric about obligations to develop the north as a nation building task is entrenched in public discourse about the region's future. A Parliamentary Inquiry has fed that interest with recommendations to: establish a Department of Northern Development; accelerate infrastructure programs in road, rail, ports and airports and water development; offer incentives for graduates to work in northern Australia; support Indigenous employment programs; frame a 20-year agriculture development strategy addressing regulatory constraints; improve access to land, including Indigenous land; and "harmonise" environmental regulation.

As in the past, realising ambitions for northern development will be slowed by the realities of harsh climate, poor soils, a weak infrastructure base and sparse human and financial capital. Nonetheless, coincidence of this push with new opportunities: in unconventional gas; threshold levels of activity sufficient to justify private investments in major processing facilities for beef and other agricultural products; determination of Indigenous interests to connect to the mainstream economy; and the prospect of greater Asian investment are likely to drive some acceleration in rates of change.

The most comprehensive and coherent statement (Woinarski et al. 2007) of the conservation challenges facing north Australia proposes a model for following a pathway emphasising:

- regional planning that identifies capacity of regions to absorb human-induced changes to the landscape;
- core areas to be managed primarily for conservation;
- constraints on activities that are directly or indirectly destructive of natural values and ecological processes;
- promotion of economic activities that are, or can be, compatible with those values and processes;
- promotion of management compatible with conservation across all land tenures;
- fostering collaborative approaches to conservation and management amongst landholders; and
- facilitating a 'conservation economy'; enterprises that yield net positive gain for the natural environment.

Various governments have articulated plans, strategies and programs to address north Australian issues but these come and go or shift focus at a pace inconsistent with the need for long term commitment. The present federal government's shift to a strong development emphasis has not been accompanied by a complementary program to manage connected environmental issues at any of the local, regional or national scales. For the Northern Territory, the Territory NRM Plan picks up some of these issues, but budgets are small and highly variable.

Those with a particular commitment to northern Australia and sound management for maintaining and (preferably) enhancing its natural and cultural heritage need to look beyond the essential but increasingly dynamic role of elected governments to identify and commit to strong goals, like those articulated by Woinarski and colleagues. We consider that Development by Design can be a critical contributor because it embodies many of these robust ideas. If well-designed for and implemented consistently in north Australia, it can particularly advance regional planning, protection of core sites (whether within the formal reserve system or outside); promotion of compatible economic activities, fostering collaboration and facilitation of a conservation economy.

In considering the place of DbD in north Australia and the Northern Territory in particular, we emphasise these important principles and spend little time agonising over failures and successes of other strategies and programs. However, we do put a good deal of effort into understanding the biophysical, social, cultural, and legal structures and processes within which DbD must be made to work. The task is neither conceptually nor operationally simple, but we consider the opportunity too important to be deterred by temporary shifts in policy or aversion to complexity.

Above all, we are convinced that a key strategy will be to find ways to harness a portion of the effort and investment going into development of northern Australia, not only to manage impacts of new development, but to rescue systems chronically degraded over decades. DbD offers one of those ways.

Context

To examine the biophysical, socioeconomic and cultural landscapes with which DbD must articulate to be effective, we follow the following path. First, we provide more detail of context, including natural and cultural heritage values, contemporary patterns of land use and their interactions with heritage values. We find that all tenures and their associated land and resource suffer chronic problems of pervasive adverse processes that are inadequately managed because of long-term under-investment, exacerbated by displacement of people from their lands. The conservation reserves are not immune from this problem. They show, for example, some of the worst fire management regimes of any part of the landscape. There is a need for positive interventions irrespective of the north's development trajectory. Ongoing neglect is not benign.

We then examine in more detail the processes contributing to the present malaise and the directions they may take under a regime of accelerated development. We identify as principal concerns: continued over-grazing by domestic herds and feral animals; intensification of grazing requiring modification of native pastures; land clearing for agriculture and intensified pastoralism; development of infrastructure for all forms of development but particularly unconventional gas; use and management of fire; water extraction for all expanded activities; and water pollution. We identify the pulse of land clearing that will accompany agricultural development as warranting particular attention.

The potential for exploitation of shale gas is of special interest. Risks of groundwater pollution and problems with disposal of fracking waste can arguably be managed by regulating for high standards for well construction and water management. However, the relatively close spacing of wells - for accessing gas held tightly in strata requiring fracturing from central points - has the potential to introduce an unusually invasive form of development of which local people have no experience. Large fields will require tracks and pipes connecting wells ramifying through the landscape. In our view these will create an entirely new set of management challenges, especially in fire maintained landscapes. These sorts of issues of large scale management and flow on effects for other land users and for biodiversity appear unlikely to be addressed by a current Northern Territory inquiry into hydraulic fracturing, which has been confined to narrow technical issues. Much has been made of the incentives provided by carbon farming to drive better fire management, but those approaches may not be applicable in more fragmented landscapes populated by mosaics of fire sensitive infrastructure or new agricultural producers.

On water extraction, work on both the Daly and Roper Rivers indicate that dry season flow regimes are maintained by groundwater inputs . Plausible levels of extraction can increase the frequency of no flow conditions. Impacts on other (off-stream) water dependent ecosystems can be expected. Recent decisions to make large allocations from an important aquifer in a less risk averse way (by reducing the period over which rainfall records are modelled and so reducing apparent frequency of low rainfall conditions) raise obvious concerns about risks of over-allocation and attendant environmental damage. Risks associated with reduced flows are exacerbated by threats to water quality from mining and agricultural pollution. Acid mine drainage is a particular problem in many Territory mines. Agricultural sediments and chemicals can cause both acute local effects as well as long term chronic effects like those damaging the Great Barrier Reef. Impacts on water quality are of particular concern in the region's two major perennial or near perennial rivers where ecology and cultural significance are substantially defined by the extreme water clarity associated with groundwater input from limestone aquifers.

Abundance and distribution of invasive species appears likely to continue to grow unless new investments in control are made. And likely forms of development will almost certainly increase weed problems.

Finally, we consider the socio-economic status of those communities (especially Indigenous people - most of the population outside the few major towns) and identify both risks and opportunities. The risks are that the people who are presently disadvantaged will remain so even if substantial developments occur in their vicinity. Benefits from major developments will flow mostly to investors and workers from outside the regions, while local people deal with the environmental costs. Some analyses suggest that by damaging the customary economy, irrigated agriculture may lower real incomes for Indigenous people.

As major landholders, Indigenous people face difficult decisions about future use of their lands with real consequences for economic futures and capacity to discharge cultural obligations to lands and resources. Unfortunately, despite the compelling evidence for failure of large scale projects to deliver benefits to remote or regional communities that actually outweigh the social or environmental costs, there are no serious plans for reducing such costs and ensuring that more of the benefits of northern development stick locally. Accordingly, a diverse group of north Australian Indigenous leaders has proposed an Indigenous "prospectus" for northern development setting out the conditions under which Indigenous landowners may seek to co-invest actively in orthodox development, including agricultural ventures on their lands.

Given the strength of incentives and external pressures to join the mainstream economy in one way or another, it should not be assumed that Indigenous landowners will be unwilling to take the risks revealed in the long history of failure of agricultural and other orthodox use. Unless landowners have access to alternatives, Indigenous lands will not stay in the "minimum use" category with which most are presently labelled.

Some of the essential actions for enduring regional development, like repair of public education systems, are principally the province of governments. Others can be taken by industry, perhaps through bilateral agreements with landholders and their local communities. Offsets may provide an important vehicle for facilitating local participation in management of developments and capturing socioeconomic benefits locally, while reducing environmental and amenity costs.

Land and natural resource management policy and law

Next, we consider the policy and statutes of the Northern Territory in land and resource management, and their utility for confronting these issues.

The NT lacks a strong planning culture, whether for regional development, land use or conservation. The absence of well articulated plans with wide community support may position external boosters to overwhelm regional and local perspectives , priorities and knowledge. Weaknesses in land use planning are not constrained by gaps in laws but apparent unwillingness to apply them to land use, environmental and conservation goals. None of the government's major policy statements deal seriously with planning for regional development and large scale conservation.

We find that law for pastoralism, the most extensive land use, is unsuited to regional planning because it obliges its administrators to promote economic viability of the pastoral industry. This may be difficult to reconcile with (say) offsite effects damaging neighbours (e.g. escape of exotic pastures, sedimentation of waterways) or optimising configurations of land use to protect ecological function.

Other laws covering soil conservation, declaration and management of reserves, management of wildlife including feral animals, heritage laws and weeds management all provide powers to secure lands against damage and for other public benefit, although they have rarely been deployed as part of a wider planning framework. The *Water Act* (NT) is conceptually distinct from other resource management laws in providing explicitly for allocations of water to the environment, and to cultural use. It provides a comprehensive framework for water allocation plans which in theory at least could put environmental management on equal footing with other purposes. The *Fisheries Act* (NT) seeks fairness and equity in access to the fish resource and provides capacity to make management plans and declare fisheries reserves. Taken together, these laws are potentially useful for making robust, enforceable plans for sustainable regional development and complementary conservation actions, including some protection of valued sites. However, they lack an overarching framework within which to coordinate their application. None make explicit provisions for offsets but do offer mechanisms that could be used to secure them against adverse actions. No statutory protection is complete because Territory law allows mining on parks.

Laws governing extraction of non-renewable resources (and geothermal energy) offer a different perspective. They start from the position that environmental damage is inevitable, and require damage to be reduced so far as "reasonable and practicable". They can provide for protection of sites from mineral or other extraction but under Ministerial discretion. Decisions can be readily reversed without obligation for public consultation or reference to Parliament. The largest areas of land reserved from mining are elements of the Defence estate. None of the resource extraction laws provide explicitly for offsets for environmental detriment.

The *Mining Management Act* (NT), however, may oblige developers to provide social and economic benefits to communities outside the mining site but affected by its operations. There is no similar power in related petroleum law although that law is presently under review, in part to accommodate the special demands of unconventional gas extraction. Scope to apply the suite of resource extraction laws to development and conservation planning appears limited.

Environmental assessment law and policy

The Territory's environmental assessment laws are similar in general intent and structure to most other Australian jurisdictions, albeit much less prescriptive on detail. The number of "legacy" mines is large enough to require a levy to fund remediation, indicating that assessment performance, or perhaps more accurately, the regulatory decisions made despite assessments, were often poor. Mines now described as legacies were approved under current EIA law as little as 15 years ago.

Arrangements have recently been substantially improved with the enactment of laws to create an independent statutory Environment Protection Authority (NTEPA). In its short life (from January 2013) the Authority has been very active in issuing guidelines on its processes and interpretation of obligations, and investigations into problematic mining developments.

From the perspective of this study, however, there are some less attractive features. Guidance on environmental offsets dismisses any role for the NTEPA, noting that no Northern Territory law provides for them. This stance raises interesting questions regarding the organisations' capacity to meet obligations under the NT's bilateral agreement with the federal government. Under this agreement the federal government agrees to accept reports generated by the NTEPA. How can NTEPA maintain the expertise necessary to deal effectively with offsets for matters of national significance, as provided under the federal Offsets Policy?

Confusion is exacerbated by other guidance on socioeconomic impacts. Here the NTEPA proposes that developers should coordinate economic and social impact assessment with "any perceived need for environmental offsets". NTEPA appears to expect developers to "pay off" environmental damage through social benefit packages that have, for example, in the past included items like community swimming pools, that make important contributors to recreation and health in remote and impoverished townships, but clearly have no connection with environmental condition.

Territory law, policy and practice leave an important gap or at least idiosyncratic variation in application of the mitigation hierarchy that others might choose to fill or correct. Otherwise management of environmental quality in the Territory is likely to fall below standards applying in other jurisdictions, where there are general obligations to compensate for unavoidable residual environmental damage with at least equivalent environmental benefits.

Offsets and Territory environmental policy and law

We also examine provisions of the law that may establish standards for quality of environmental management and hence set a baseline for identifying beyond compliance behaviour to qualify for treatment as valid offsets. We look beyond common candidates to consider actions in regard to water use or other matters that may have an impact on biodiversity and other conservation values.

In brief, Territory law to protect environmental values mostly works by proscribing certain classes of actions which vary markedly among asset classes and processes. Where options for government support of positive conservation actions are provided, criteria and practice for determining support are poorly developed. Where laws provide specifically for trading off environmental values for other benefits - using terms like practicable, reasonable, optimum - they provide no framework for determining acceptability of tradeoffs. We are aware of no substantial body of local case law establishing thresholds for failure to observe loosely specified statutory or common law duty of care to protect environmental values. It is therefore difficult to discern patterns that might inform general rules about how to recognise and reward beyond-compliance behaviour.

Given gaps in law and precedent, those interested in purchasing, promoting or providing offsets in the Northern Territory may need to derive *de novo* some broad criteria for recognising actions that clearly go beyond compliance. We turn now to considerations that might inform those criteria.

Recognising and rewarding beyond-compliance actions

Statute to statute variation in treatment of basic obligations, ambiguity, little or no case law on relevant provisions of Territory statutes, and some apparent inconsistencies confound clean identification of beyond-compliance actions. The issues created when government chooses to vacate the offsets space are, in our view, best managed by building a framework from basic principles. Among the most fundamental of these are that (1) only actions are clearly not explicitly required under law, and (2) generate net costs (in the broadest sense) for the person(s) or organisation(s) taking them, can qualify as legitimate offsets. Working from these principles, elements of an offsets framework matched to the Territory situation might have the following features.

Actions warranting special recognition (and ultimately support) as exceeding obligations or a duty of care in regard to natural and cultural heritage must always:

- improve the condition of the biophysical environment
- produce clear and significant public benefit
- require actors to forgo rights or elements of rights and/or incur costs to deliver public benefit
- show measurable changes in the type and intensity of relevant management activities to demonstrate real shifts from business as usual practice
- substantially exceed requirements under relevant law.

Actions are more like to satisfy these conditions when they achieve one or more of the following:

- protection of environmental values that are not integral to the profitability or sustainability of the approved or prevailing land use on the offset site

- remediation or repair of damage caused by others, including work to prevent ongoing damage
- benefits off-site that are enjoyed by interests other than the actor, including the general public
- collaboration and coordination of actions that increase effectiveness of community and government management of threats to environmental values
- risk averse approaches to management of threats when those risk-averse approaches clearly exceed prevailing standards
- direct, substantial and highly specified contributions to community or formal government conservation programs
- early adoption of less damaging land or resource management practice that demonstrably betters codes of practice or standards adopted by neighbours active in the relevant industry.

Actions are less likely to satisfy the above conditions when
- delivery of environmental benefit is incidental to or hard to separate from private benefit
- benefits sought or delivered are not recognised as significant in relevant national, Territory or regional plans or strategies
- benefits are delivered entirely through application (including re-imposition following lapse) of standards of practice that are widely adopted in the relevant industry.

Applying these principles and criteria to impacts of the type that are most likely to occur under accelerated development raises a number of issues requiring resolution.

Land clearing

Given increases in rates of land clearing likely to accompany the most plausible changes in land use, there will be frequent opportunity to offset the biodiversity and other impacts of land clearing. Under carbon markets, additionality can be demonstrated by surrendering a permit to clear. At larger, including the national, scales claiming carbon benefits will require demonstration that rates of land clearing have fallen relative to a well established baseline. In the Territory a robust baseline will be hard to establish because rates have been predominantly low with brief bursts of activity. And clearly "greenfield" sites like most of the Territory will have no land clearing history.

Land clearing guidelines made under the *Planning Act* create no requirement for or mechanisms to create offsets, but the process of approval, including site visits, discussions of alternative clearing configurations and the like do offer opportunities for identification of beyond compliance actions. And although it has never been done and processes for recognition have not been developed, landholders might choose to forgo all or part of the clearing for which a permit was approved, subject to entering into binding agreement to protect the site from clearing for an extended period .

Offsets based on direct like-for-like protection of equivalent areas of common and widely distributed vegetation are of limited utility. Arguably, it is be better to focus on actions to adjust approved clearing to minimise environmental detriment at and around the clearing site. Such actions, like matching retained vegetation across property boundaries, are not easily prescribed because their utility is strongly context dependent, but may provide better targets for recognition and support.

Such adjustments might involve some loss of on-property production delivering public benefits in conjunction with compatible action on neighbouring sites. Such cooperative arrangements would obviously require active coordination by a group or organisation capable of providing an overview of net benefits and then acting to secure them, perhaps by binding contracts. Experience suggests that achieving recognition of offsets through statutory covenants may confront difficulties in the Territory environment, and parties may need to develop other suitable arrangements.

Grazing management

Taking entirely out of production areas of land types used routinely for grazing on native pastures, where there is no evidence of land degradation, clearly goes beyond compliance. Less obviously, there may be cases where stock densities are reduced below those usually regarded as sustainable (perhaps based on carrying capacity analyses), to protect particular values unique to a site or values of a type that are not usually considered as requiring maintenance on pastoral land.

We argue that a pastoral lessee may be regarded as having exceeded the general duty of care and so gone beyond compliance where actions:

- reduce or could reduce production and income below levels enjoyed by peers operating to industry standards and related determinations by the Pastoral Land Board; and
- generate costs that do not produce compensating increases in production; and
- improve environmental outcomes in ways that are not confined to measures of land condition used to assess compliance with the *Pastoral Land Act;* and/or
- protect specified on-site environmental, cultural, heritage or ecological values that do not create specific legal obligations but are nonetheless recognised by community interests as warranting special consideration.

However, government or Pastoral Land Board support for arrangements that reduce orthodox commercial production is likely to be problematic. For example, in extension materials on a change to the *Pastoral Land Act* to more easily secure approval for non-pastoral use, no mention is made of carbon or other offsets or payments for other ecosystem services.

Water extraction use and quality

A water use offset, say to cover use of water by a mine over several years might operate by meeting the cost of leasing a water entitlement to be held for an equivalent period by a relevant environmental organisation. This would ensure that the amount of water used consumptively did not increase during a mine's operations. Less abstract benefits could be demonstrated by diverting a portion of a production entitlement to the environment to enhance values otherwise suffering some detriment like, for example, an on- or off-site water-dependent ecosystem under stress from locally or regionally lowered water tables. Similar actions might be taken for cultural flows.

However, entitlement holders reducing use below permitted take from the consumptive pool would, in the absence of formal diversion to another beneficial use, most likely cause regulators to reduce the entitlement and reallocate an equivalent amount for consumption elsewhere.

Securing water-based offset benefits long term will require a durable arrangement to shift water allocation from the consumptive pool to environmentally positive use. Arguably the most secure offset arrangement would be a reduction of the consumptive pool and an increase in a formal allocation to the environment under a water allocation plan approved in accordance with the *Water Act*. An alternative would be for a developer to obtain an entitlement on market and donate or sell it to an environmental institution at peppercorn (or at least below-market) valuation. Given that all trades must be approved by the regulator, government may choose to disallow such trades. It is also unclear how regulators would treat such re-deployments when it came to reviews of water allocation plans and entitlements. In the absence of established processes and given apparently negative government attitudes to offsets, attempts to redeploy water use is likely to be difficult. There is a significant risk of perverse outcomes such as reduced pressure on the consumptive pool through offsets being used to justify acceptance of (for example) increased mining usage.

Mining and petroleum exploration and extraction

Actions taken by miners to offset on-site detriment will most often involve some private cost to acquire environmental benefits generated off-site by others or, if the developer involved has control over lands outside the mining site, forgoing income by reducing, for example, grazing pressure on a held pastoral lease. In the latter case, it will be important to ensure that the actions taken go well beyond those specified in relevant law or prescribed by the Pastoral Land Board.

As noted elsewhere, mining law could be used to help "secure" offsets of any type by reserving their sites from future mining. This level of protection is, however, easily reversed. Greater security might be sought by setting offsets as a condition under the *Mining Management Act* (or petroleum or geothermal equivalent). However, the language of mining laws ties conditions tightly to specified activities on the mining site. Attempts to deploy this law to require offset actions in other (off-site) places may be open to challenge. Even if such arrangements were thought to remain within power, for the reasons already canvassed in regard to water, relevant regulators are unlikely to entertain such an approach. We suggest that use of mining law alone to secure offsets is unlikely to be palatable to regulators, or effective.

Fire regimes

Given the ubiquity of adverse fire regimes, large scale demonstrations of effectiveness and relatively well understood costs, improving fire management to achieve measureable improvements in the condition of landscapes and biodiversity values will remain a particularly rich source of offset opportunities. There have been discussions between NAILSMA and organisations maintaining infrastructure in remote settings about fine scale fire management to reduce fuel loads near sensitive facilities. If agricultural and unconventional gas developments do in fact occur, these sorts of opportunities may increase. However, unless they also address biodiversity or similar issues they could not be treated as environmental offsets. Facilitating employment without improving biophysical environments may be more properly considered as compensation for social impacts.

Gaseous pollutants

Benefits in emissions abatement and carbon sequestration in vegetation can be generated by actions to improve fire management, reduce grazing pressure from both managed and feral stock and protection of sites from land clearing. The federal government is particular interested in sequestration of carbon in soils through improved grazing or other agricultural management. However, potential for increasing soil carbon and measuring change accurately has not been demonstrated in northern Australia. Demonstrating additionality in avoided deforestation will be difficult for the reasons already given, and the relevant federal Minister has indicated disinterest in (non-Kyoto) carbon credits through better control of feral animals. A proposed Eissions Reduction Fund (ERF) will buy credits only if they are already included in Australia's national greenhouse gas inventory. Accordingly the best options for carbon-based offsets remain with fire management, for which new methodologies in abatement and sequestration are under development.

Invasive species management

In weeds management, there may be circumstances in which a disproportionate effort (going beyond strict compliance) from one landowner may reduce costs for others, including government, because their property is in a critical location (e.g. traversed by a heavily used road corridor) for achieving effective regional weed control. In addition, shifts in choice of methods might attract support under some conditions. For example, use of herbicides may involve some risk to other values or human and animal health, even when used strictly in accordance with guidelines. In situations where there is particular concern about the potential for non-target effects or other unintended consequences, support to adopt methods that reduce these kinds of risks may be warranted, especially where those methods involve greater cost or effort.

The Territory Parks and Wildlife Conservation Act provides for feral animal management plans setting out obligations of landholders, but no plans have been made. In their absence, it would appear that outside pastoral lands and declared feral animal control districts, any level of control could be regarded as going beyond compliance or common practice.

Some landholders derive benefits from the presence of feral stock. Where incomes have been earned from exploitation of feral animals at levels that do not also mitigate their environmental impacts, effective control may require reduction to low densities, at which commercial exploitation is no longer tenable. In such cases, treatment of feral animal control programs as warranting recognition may be argued at levels that offset the income lost, particularly if the site does not produce other income and control produces benefits extending beyond the site. As argued in other contexts, offset projects recognised as additional would involve some loss of private benefits to deliver public benefits or reduce public costs.

Because eradication of most feral animals is unlikely, assessing effectiveness of control can be challenging. Focus on the damage they cause will provide the most relevant measure of offset value, but may be expensive to measure.

Ranking options

To summarise, no Territory laws explicitly enable or set conditions for offsets, or even obliquely acknowledge their role in environmental management. They set vague and inconsistent "baselines" for duty of care for the environment and so provide limited guidance for unambiguous recognition of beyond compliance actions. Aside from carbon farming offsets, for which standards are set in federal law, it will be necessary for offset providers and buyers in the Northern Territory to agree on their own criteria for recognition and validation, perhaps drawing on existing international standards. Formal accreditation under such standards can be complex, slow and expensive.

A plausible response to this situation is for risk-averse buyers to prefer offsets that are built on strongly secured sites managed in accordance with long established procedures (e.g. in national park management) endorsed or applied by governments and so seen to require less emphasis on precise measurement of specific environmental benefits. A number of Territory laws - in particular the *Territory Parks and Wildlife Conservation Act*, *Heritage Act*, *Northern Territory Sacred Sites Act*, and *Fisheries Act* - can individually and (more strongly) in combination, offer substantial security. Whether the Territory government will cooperate to deploy these instruments remains to be seen.

We have canvassed a wide array of options that step outside existing offset schemes. Given all of the considerations summarised above, we suggest that the most immediate and realistic opportunities, ranked in approximate order of plausibility under existing conditions, are:

(a) Carbon farming under current and emerging methodologies and law.

(b) Biodiversity benefits deploying individually or in combination:

- fire management
- reservation or other legally (including contractually) secured protection of favourable wildlife habitats
- pest control (weeds and ferals) tied to rehabilitation of damaged sites
- rehabilitation of sites previously cleared of native vegetation.

Federal law and policy

The federal government has embarked on a process to streamline environmental regulation. Proposed and recently enacted changes to the *Environment Protection and Biodiversity Conservation Act* chiefly delegate roles to the states and territories. They may not in themselves directly weaken federal standards. But the incentive for the states and territories to compete with each other for major projects does invite the "regulatory creep" that is invoked to explain the change in law: but creep in the opposite direction, towards weaker controls. The existing tension between local or regional incentives for lower standards and the willingness of the federal government to over-ride state decisions under extreme circumstances arguably provides a more robust and stable system than one based on jurisdictional competition.

Offset requirements are included as a condition of approval of proposed actions under section 134 of the EPBCA. The language describing the sorts of conditions that may be set is broad and is clearly not constrained to on-site measures and actions, provided that the condition protects matters of national environmental significance. Offsets have been required as a condition of approval in 81.6% (*n*=38) of Commonwealth approvals listed in the DoE website in the first 5 months of 2014. And a significant proportion of those few where offsets were not deployed were for projects where offsetting was unavailable or unnecessary. If the Northern Territory Government and NTEPA's apparent disdain for environmental offsets is reflected in future decisions made under the bilateral, their absence would clearly represent a major shift in Commonwealth standards.

All jurisdictions have agreed to a review of all environmental legislation which would encompass "species and heritage listing and simplification of land planning" with terms of reference yet to be announced. It may be some time before the new legislative landscape is known. One area where the process of change has got traction is greenhouse gas management. The carbon pricing mechanism has been removed and support for operation of a carbon market dismantled. ERF will use public funds to buy emission reductions from individuals or corporations developing abatement or sequestration projects that are new, not required by law, and do not occur as a result of another government program. Safeguards are to be developed to inhibit big emitters from continuing to increase their emissions and cancelling out gains from the ERF, but mechanisms remain unclear. Government will seek lowest cost credits by reverse auctions.

The ERF as presently framed (July 2014) creates particular challenges for land sector providers:
(a) land sector projects drawing incomes only from sale of credits will be pitted against, for example, energy efficiency projects that reduce industry costs and boost long term profitability, independent of income from credits
(b) dismissal of environmental (e.g. biodiversity) and social (e.g. remote area employment) co-benefits from consideration in auction processes reduces net public gains from ERF expenditures
(c) one contract of 5 years is insufficient to recover often substantial investments needed to establish land management projects
(d) providers unable to meet projected credit production are penalised by being forced to buy credits to make up shortfalls, disadvantaging savanna burning projects where year to year variation is unavoidable
(e) uncertainty is increased because probability of bid success and prices may vary substantially from auction to auction, depending on the array of bidders who choose to compete.

This change will certainly make it more difficult for Indigenous groups in particular to establish savanna burning or other projects, but just how much more difficult will require some experience.

In sum, Delivery of DbD may be challenging under contemporary policy and fiscal settings. Potential to attract private and industry funding may, however, encourage some useful if relatively passive support from government, especially in access to mechanisms for securing offsets over the long term. In its justification of the need for fundamental change in Commonwealth and State/Territory relations, the federal government has invoked the notion of subsidiarity. The Queensland Government has taken a related step in repealing aspects of the *Wild Rivers Act* and placing development decisions in the hands of local authorities under the *Regional Planning Interests Act 2014*, which covers areas of regional planning interest, including Strategic Environmental Areas (SEAs). The present turmoil in environmental policy could open spaces for innovation by non-government actors in systems of support and governance at regional scales.

New approaches and new roles for non-government actors

We have argued that past government-driven approaches to conservation in northern Australian have failed. And there is the risk that accelerated development will exacerbate that failure. Acute change and the chronically damaging commonplace will combine to test the resilience of natural systems and the commitment of those who seek to look after them.

One possible response to this coupling is to see private and public investments in the new as an opportunity to redress the old and intractable. Directing a small part of projected northern investment to offsets that deliver net environmental benefit is the most obvious mechanism for realising that opportunity. Although regrettable, apparent withdrawal of the Northern Territory government from this space may open up additional options for creative and credible programs based on collaborations among industry, conservation and philanthropic NGOs, and land owners and managers. Development by Design provides a well-established vehicle for designing and presenting ambitious projects and negotiating the necessary partnerships to achieve them. But its effective implementation, especially with Indigenous people as major landholders, will require an approach to offsets that responds to both the particular biophysical attributes of the Territory and the social circumstances of those best positioned and most inclined to take up the role of offset provider.

Territory-shaped offsets

Environmental offsets must provide genuine biophysical benefits that are at least equivalent to estimated or measured residual detriment. That obligation is no different in the Territory than in any other jurisdiction. However, we do suggest a few nuances:

- In determining the acceptability of a project, views of all significant sectors of society should be properly considered. In the case of an extreme landscape modification like the re-routing of the McArthur River, objections of local Indigenous custodians of the area were over-ridden, presumably by concerns about the wider public interest in seeing the project proceed. There may be cases where, despite formal approval, local people will find a project so offensive that they will decline the opportunity to provide offsets.
- Adding Indigenous perspectives to estimation of residual detriment may create additional difficulties in the already difficult task of ensuring offset equivalence. This should not prevent efforts being made to incorporate those views in offset design.
- Preference for like-for-like offsets should not be permitted to thwart opportunities to gain environmental benefits. Where performance is likely to be more robust and net benefits guaranteed by accepting a less than perfect match of marginal features of detriment to offset, robustness should be preferred.
- Robustness and security can be improved by designing offsets to draw on local strengths and commitment while also seeking to build local capability. Long term security will be enhanced by compatibility with local views and skills and contributions to community development.
- All offsets should require active management. Passive protection based on attempts to exclude disturbance is a poor strategy in the non-equilibrium systems of the wet-dry tropics. But more importantly, people on country in meaningful employment is so fundamental a goal for north Australia that it should feature strongly in all design and delivery decisions.

The central argument here is that offset quality and security is best guaranteed by seeking and if necessary generating support for offset goals and mode of operation in the society in which they are embedded. Appeal for socially positive design is not an argument for trading off environmental performance for social benefits, but rather designing for social fit: so that biophysical benefits are delivered more effectively and enduringly. The social and biophysical "space" within which we position effective offsets is illustrated in Figure s1 below.

Designing biophysically effective and socially positive offsets

Constructing offsets to sit in the upper right of our diagram requires an appreciation of the society in which environmental concerns are expressed and managed. Important motivation for Indigenous peoples' participation in conservation programs is the desire to regain access to traditional lands and the resources to reassert customary land management practice. Key features of customary practice identified by Indigenous land managers involved in offset delivery include:

> *connection*: of offset providers with kin and custodians of knowledge and site; and of sites with each other so that no action is taken in isolation from its biophysical or cultural context

expression of identity: exercise of authority and obligation; authority relevant to land management may be held by individuals or groups different from those exercising formal authority in a community

knowledge and skill: engaging local (situational) knowledge and skill is necessary to satisfy cultural obligations and secure optimal performance of land management actions

seasonality: a matching of required activity to socio-cultural and biophysical dynamics; to promote integration with community life and strengthen social cohesion

power and empowerment: respecting local decision making processes and methods and avoiding unnecessary interventions or prescriptions; to maintain and build confidence and capacity

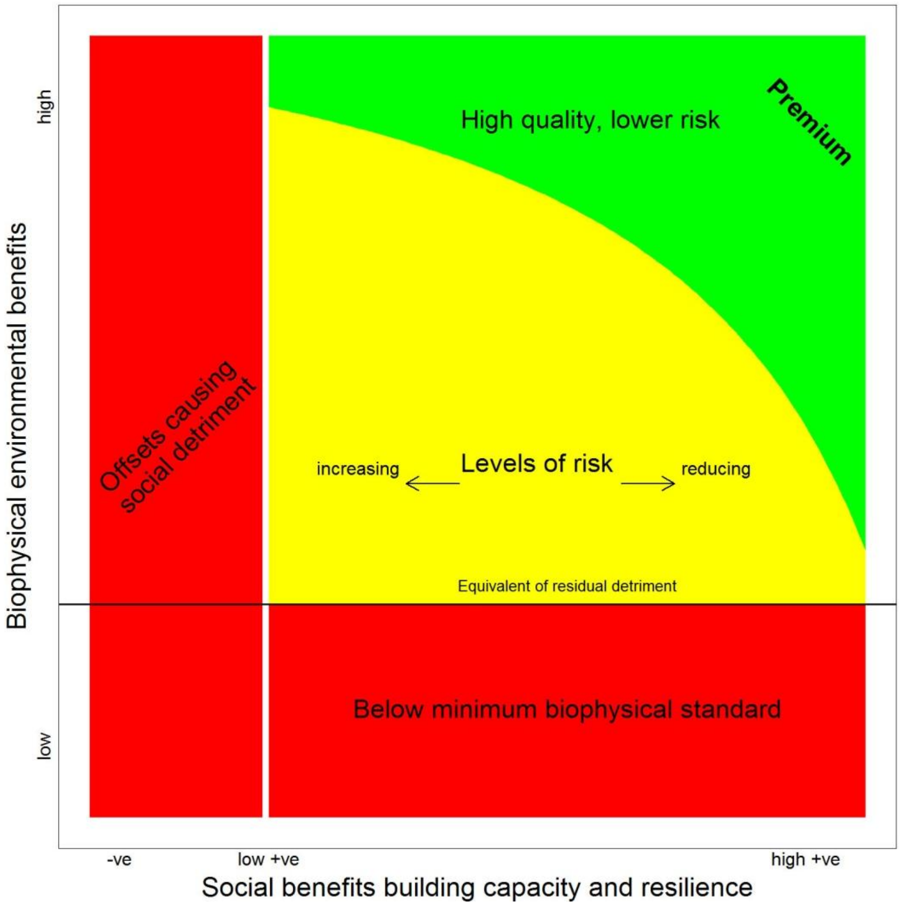


Figure s1: Hypothetical relationships among estimated biophysical environmental and social benefits for offset design in the Northern Territory. Offsets that fail biophysical equivalence tests cannot considered irrespective of social benefits. Offsets so poorly designed as to cause social detriment (e.g. damaging native title rights and customary economies) are rejected (also shown in red). In the yellow area, all offsets ostensibly meet minimum standards but are high risk because of uncertainty of measurement and/or capacity of providers to deliver, especially if local communities have not been successfully engaged and/or context is actually or potentially unfavourable. If no or low social benefits of a type that improve land and resource management capacity and social capital are delivered then environmental benefits sought would be a substantial multiple of detriment to manage risk (upper left of yellow sector). That multiple may be reduced where social capital enhance local management commitment and capability (right of green sector). In general, design to offer both strong environmental benefits and substantial local social benefits - to build capacity and resilience at the offset site and beyond - should be most favoured (top right corner).

These issues should be reflected in all processes for design and implementation of offsets. But they are also important for refining criteria for socially positive offsets. It is just as important to get these right as to deal well with technical issues like biophysical equivalence. Some of the most significant of the criteria we identify are:

Acceptability: Offsets that involve or create plausible risk of loss or reduction of local social capital or damage local customary or orthodox economies should not be considered.

Connectedness: Design of offsets that are vulnerable to management context, as most are, should show how management is matched to compatible actions in neighbouring sites, how Indigenous practice contributes to improved security, and how social cohesion will be improved by strengthening cultural links.

Empowerment: All offset agreements will be designed to empower local people through informed decisions about participation, tailored approaches to delivery and the structure and management of supporting institutions. Obligations, benefits and authority will be established unambiguously.

Respecting local knowledge and skills: Delivery of agreed offset products will draw on real strengths in relevant Indigenous knowledge, skills and experience.

Seasonality and integrability: Offset activities will fit well with other social and work obligations of key individuals and groups and draw on institutions supporting other activity.

Equitability: Agreements will include provider obligations for equitable distribution of benefits among participants, to assure purchasers that their investments will indeed generate social capital.

Location: In general, offsets will be located to maximise net environmental benefit. However, if relevant offsets are available in a timely way from the individuals, group or close affiliates who most directly suffer environmental detriment, they should be selected ahead of equivalents available at similar prices from other providers.

Regional priorities: Where regional groups have prepared or approved local conservation or development plans, whether or not formally endorsed by government, offset arrangements will at least be compatible with, and preferably support implementation of those plans where they promote good environmental outcomes.

Sustainability/durability: Offsets will be designed to draw on existing or build new institutions and skills capable of supporting active management over the long term.

Accountability (and quantifiability): Offset providers will keep records and agree to make public statements of social benefits derived from offset provision, using metrics or surrogates based on statements of community aspirations for socio-economic development and well-being.

Additionality: Social benefits realised through engagement in offsets provision will not be the same as or counted towards benefits specified in social compensation packages covering negative social impacts of developments. If social benefit packages developed outside environmental offsets frameworks include direct or indirect support for land or resource management, then there should be no requirement to generate biophysical environmental offsets sought by the developer.

Equivalence: Socially-responsible offsets will be designed to generate equivalent environmental benefits at costs similar to more routine offsets. If a purchaser seeks formal recognition of additional biophysical benefits and/or social benefits, a premium may be paid.

Timeliness: All offsetting actions will begin as soon as practicable after residual environmental detriment is known. Search for socially optimal offsets will not unduly delay identification and implementation when alternatives satisfying other criteria are available.

Active management: Offsets requiring active engagement of community members are more likely to produce enduring social benefits and secure offsets more strongly than passive offsets.

Monitoring and evaluation: All offset projects are subject to monitoring to verify delivery of biophysical benefits. Agreed monitoring and reporting frameworks will include indicators of social impacts on local communities, especially measures relating to capacity to sustain inputs.

Observing such criteria will do much to foster a strong and growing role for the owners of much of the north's land in an effective and resilient offsets regime.

Processes for a non-government offsets regime

Systems that are less dependent on government will draw instead on relationships among non-government environmental groups, industry and landowners. A serious effort to build such a system will demand much from its architects and participants. A minimum set of activities will be to:

(a) adopt standards and other components of an offsets framework compatible with the features outlined above;
(b) promote that framework to potential Indigenous and other offset providers and refine its detail in response to feedback;
(c) maintain a watching brief on statements from governments and industry on development directions and about individual development proposals;
(d) scan NTEPA and DoE (Cwlth) websites for notice of intent (NoI) and referrals or their equivalent under the EPBCA or other relevant federal legislation;
(e) track EIA processes through the same websites, identifying potential impacts for which offsets may provide a useful response;
(f) initiate exploration of opportunities to generate new offset projects or apply existing projects to particular developments;
(g) maintain a database of offset options, opportunities, providers and projects underway;
(h) alert development proponents to opportunities to apply offsets to their project(s) and invite dialogue on standards and potential providers;
(i) alert potential offset providers to emerging or actual opportunities;
(j) on expressions of interest from industry or other developers, facilitate initial design of relevant offsets by relevant providers or refine existing projects, including details of institutional support and other essential features;
(k) prepare written outlines of potential offset projects, including details of the type and level of residual biophysical detriment being compensated, type of compatible offsets potentially available, and other important features including duration, uncertainty and risk and where plausible, an estimate of cost;
(l) as EIA processes unfold, refine or archive offset proposals as appropriate;
(m) where offsets appear to be required by regulators (Commonwealth) or seen as desirable and sought by industry, make proposals to potential buyers to initiate serious negotiations on supply;
(n) relate development and offset proposals to formal and informal regional or local land use and conservation plans or programs;
(o) support both providers and buyers to draft related agreements and facilitate related consultations with landowners and their legal representatives; and
(p) advise relevant regulators and government agencies of proposals and seek their engagement to secure protection of offset sites from future incompatible development under relevant law.

These activities can be grouped into three distinct sets of tasks.

One is the day-to-day challenge to identify and support potential providers to respond promptly to opportunity, as individual development projects roll out or development precincts are announced. This function requires knowledge of and careful matching of the providers with already demonstrated capability to specific developments, plus the knowledge and skills to fill gaps in capability, especially weaknesses in the institutions needed to support long term commitment and performance.

The second is to go beyond *ad hoc* responses to individual opportunities, to foster new and improved capacity across an expanding range of services. This requires an appreciation of likely demands for particular offset types in different areas of the Territory, awareness of interest and capability among potential providers, and the credibility and resources to develop and help implement training programs, including engagement of new providers in projects run by others or local acceptance of less demanding projects that provide, with appropriate support, good training and testing options.

The third is to build, document and oversee application of an offsets framework robust enough to accrue credibility and capable of working at modest ongoing cost. What might an effective institution look like, and what would be its essential features?

We suggest that the list of attributes will necessarily include:

- independence (of government, industry, and providers)
- relevant technical credentials
- record of performance in land and/or natural resource management
- moral authority (demonstrably high ethical standards)
- commitment to sustainability of development
- knowledge of and long term commitment to NT/northern Australia
- understanding of Indigenous culture and land management obligations
- understanding of and interest in local livelihoods and regional development
- no inherent or direct financial or other conflicts of interest with role(s) in offsets design and implementation
- additional durable sources of funding and financial strength
- compatible existing role(s)
- credibility with landholders
- knowledge of and good relationships with relevant industry (mining, oil and gas, agriculture)
- productive relationships with research groups (Universities, CSIRO, etc)

This demanding set of features appears likely to exceed the reach of any individual non-government or not-for profit organisation. However, many organisations are capable of making important contributions to a comprehensive package. Key roles will be to frame the concept and present it to others, and to craft an agreement about how parties will work together and the sorts of contributions each party will make.

A hypothetical model for a non-government offsets process

As a stimulus for debate and discussion, we propose a loose working model, including identification of potential participants and their roles. We emphasise that we have held no discussions with any of those nominated and some may reject entirely or seek to vary such an arrangement. Nonetheless, we consider it useful to promote serious thinking by going beyond abstractions.

We build our proposition around three organisations that clearly have an interest (in one case a statutory role) in such an endeavour: TNC through its longstanding support for Indigenous land management and sponsorship of this project; the Northern Land Council through its obligations in law to protect the interests of traditional landowners and to assist individuals and communities to carry out commercial activities; and NAILSMA through its role to support Indigenous people in land and sea management. We propose that these organisations take on the roles outlined below (Figure s2) to create and operate The Territory Offsets Program (TOP).

The Nature Conservancy
Protecting nature. Preserving life.™

Establishment phase

- develop framework
- select standards
- negotiate agreement with other parties
- execute agreement
- join TOP Board

Operational phase

- provide technical support
- support establishment and development of offset-capable groups
- develop biodiversity offset options
- promote offset opportunities with potential buyers
- support individuals and groups to develop proposals and projects
- develop monitoring systems
- market products with industry associates

NORTHERN LAND COUNCIL

Establishment phase

- develop framework with partners
- include offset provision among active enterprise support activities
- approve policies to require environmental offsets in all major developments
- develop a process for decision-making and offset approval
- join TOP Board

Operational phase

- identify offset capable groups
- support landholders to negotiate offset arrangements
- support individuals and groups to develop proposals and projects

The Territory Offsets Program (TOP)

Establishment phase

- revise existing NIES structures
- establish not-for-profit company
- appoint Board members

Operational phase

- maintain registers of proposals and projects
- identify potential providers
- promote offset opportunities with potential providers
- support individuals and groups to develop proposals and projects
- market products

NAILSMA
NORTH AUSTRALIAN INDIGENOUS LAND AND SEA MANAGEMENT ALLIANCE

Establishment phase

- develop framework with partners
- negotiate agreement with partners

Operational phase

- review and refine framework
- promote awareness of opportunity
- support individuals and groups to develop proposals and projects
- support groups in negotiation with developers

Territory Natural Resource Management

Establishment phase

- consultation
- include offset role in plans

Operational phase

- support individuals and groups to develop proposals and projects
- promote projects with members and government
- assess offset role in plans

Figure s2: Potential participants in a non-government program for environmental offset design and implementation in the Northern Territory. The TOP program would when established be operated by a not for profit company built on the constitution and structures already established for carbon farming.

Exploring operational feasibility

Having considered the conceptual and policy space in which DbD might operate in the Northern Territory, we next examined the biophysical environment, using the best available data to which we could gain access. Datasets are described in Attachment 7. Our ultimate goal was to identify areas of high conservation/heritage value in areas that are likely to face land use change in the mid-term future. We did not attempt to assign specific time frames but rather looked for ways of ranking prospects of change.

Natural heritage

We built our exploration of biodiversity around point records of individual species of flora and fauna. Because records are relatively sparse (1 in 2400 and 2150 ha for fauna and flora respectively) we aggregated to sub-catchments, which averaged 36,148 ha in area (albeit highly variable). We mapped apparent species richness of sub-catchments across the study area, seeking evidence of sites of unusual richness (number of species) for both flora and fauna.

Results were ambiguous but suggested clumping of apparently rich mainland sub-catchments in: the Darwin/Finniss catchment to the East Alligator River catchment; the Daly River catchment; more diffuse records in the Moyle and Roper River catchments and an arc from Keep River to Timber Creek. Some elevation of ranks in Gulf of Carpentaria catchments derives from coastal and island values. The Tiwi Islands also show somewhat elevated apparent species richness. It is more than coincidental that we identified some clumping in areas where the NT also nominated SoCS, because we used similar data.

Arguably the most striking features of the data relate to the geographic skewing of records. To illustrate, the mean number of records from sub-catchments with centroids within 1^{o} of coastal latitude (12-13^{o}S) was 2089 and in an inland 1^{o} span (17-18^{o}S) was 138 records, even though the sampled inland catchments were on average more than 50% larger than the coastal. More significantly, most sub-catchments appeared to be under-sampled (Figure s3).

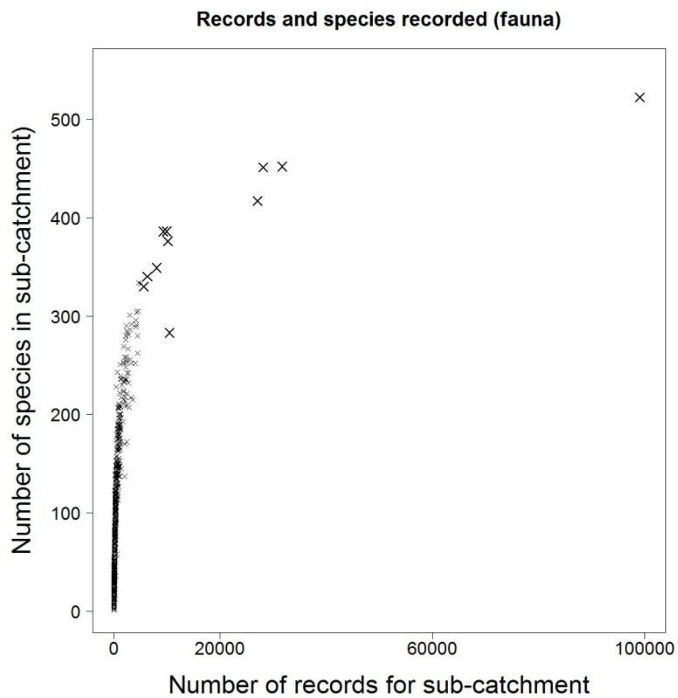


Figure s3: Increase in number of species of vertebrate fauna recorded in sub-catchments with number of records. The relationship can be described by a simple linear regression of the form log(species) = 0.27 + 0.74log(records) (r^2=0.93 , $F_{1,1053}$= 13420, P<<0.0001). Symbols are larger for sites with more than 5000 records.

It is self evident that there will be a strong association between number of records and number of species catalogued in building a comprehensive record, it would also be expected that this relationship would break down as the number of species detected approached the number of species present. In the great majority of sub-catchments we appear to be well short of this point, with ASR increasing rapidly with more numerous records. Most catchments remain in a sampling space where additional effort will add species apparently new to the region. Exceptions may arise in a few very well sampled catchments in the northern Top End with more than about 5000 fauna records. Those 11 sites with more than 5000 records are in the adjoining Finniss (3), Adelaide (2), Mary (1), South (2), East Alligator (1) and Daly (2) River catchments surrounding Darwin.

This is not to say that the records bear no relationship to underlying ecologically-determined patterns. Using simple statistical models, after accounting for variation in sub-catchment area, we were able to relate apparent species richness to broad scale landscape attributes including annual rainfall, topographic variation, diversity of vegetation types and the spatially dominant vegetation type. Models based on richness of threatened or otherwise notable species or indices derived from them returned generally similar results, but given fewer observations were statistically weaker. However, given the evidence of chronic under-sampling, it would be unwise to use such models to direct investments in conservation programs.

Arguably only the areas that had the most records, along the northern coastal strip from Darwin through to western Arnhem Land, could be shown on the basis of these records to warrant special conservation attention. Some of those regions were subject to more intensive sampling (e.g. CSIRO in Kakadu in the 1980s and 1990s) because they had already been recognised on many grounds as warranting protection or were subject to threat of change (e.g. Coronation Hill: Braithwaite and Woinarski 1990). And major investments have already been made, illustrated by the more than 4.35 million ha of reserves and IPAs in the Kakadu/West Arnhem region.

Cultural heritage

We made similar maps of sites registered by the Aboriginal Areas Protection Authority but avoided indicating precise locations. Sites were widely dispersed. Evidence of clumping was most apparent in the separate archaeological sites recorded by the NTG's Heritage Branch, which may be a function of the patterns of activity of professional anthropologists and archaeologists. The most parsimonious interpretation of spatial patterns of sites registered and recorded by the AAPA is that Indigenous people continue to accept obligations to protect sites on their ancestral lands, irrespective of present tenure, and that important sites occur throughout the study area.

An important feature of the site information presented here is that a substantial proportion of sites are valued on attributes associated with water. This raises particular obligations to go beyond concerns about environmental effects of water use to consider cultural issues. There is no precedent for allocations of water specifically to protect such values, although the 80:20 rule allocates 80% of annual flows or recharge to the environment and other public purposes, which might include cultural water.

Maps of the distribution of wildlife important in the customary economy were uninformative. They provided no guidance to areas likely to be particularly significant to Indigenous people, but again showed that such species are widely distributed and well-sampled areas tended to record more such species. Wherever major developments that have the potential to impact larger species like macropods are sited, they are likely to affect aspects of the local customary economy.

Northern development: anticipated directions of change

Key features of the present government's vision for north Australia are:

- a food bowl, doubling Australia's agricultural output
- two million tourists pa, an increase of 33%

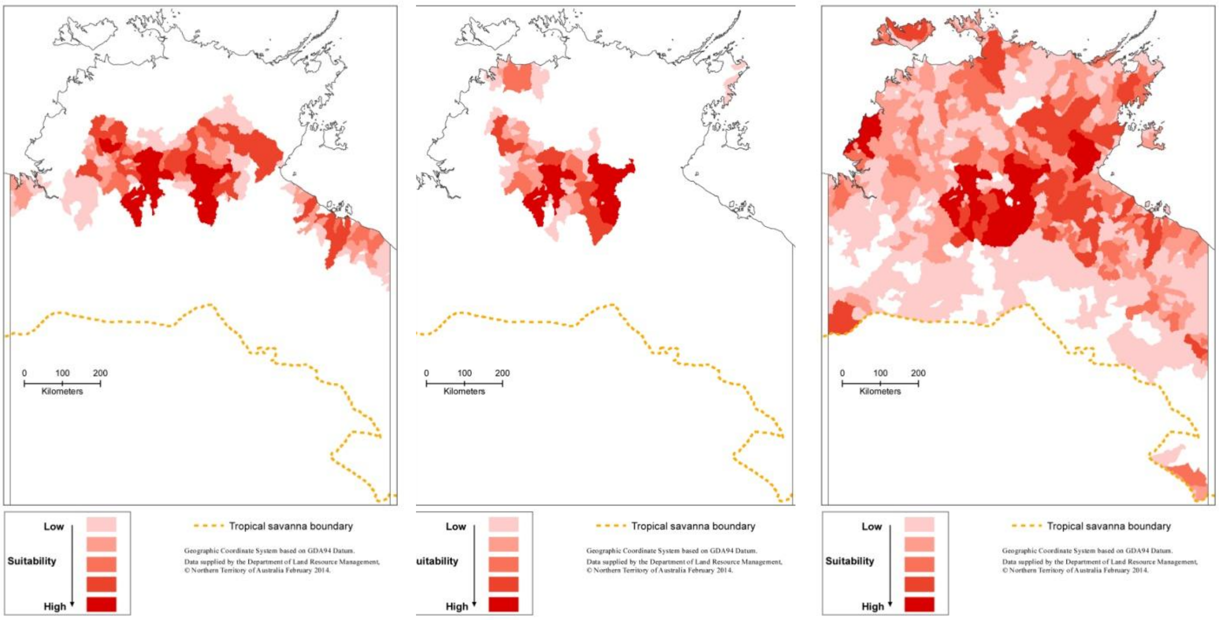
- an energy export industry of $150 billion pa, an increase of about 50%
- enhanced infrastructure to service these changes, including water infrastructure.

These and the subsequent report of a committee of the Australian Parliament indicate that a DbD strategy may need to consider:

(1) substantial increases in areas of the savannas used for irrigated agriculture, rain-fed agriculture, forestry and more intensive beef production;
(2) increases in both onshore and offshore gas extraction and processing, including unconventional oil and gas;
(3) ongoing increase in the number and diversity of active mineral extraction and processing sites;
(4) large numbers of tourists seeking increased access to presently unvisited or little visited sites; and
(5) more and larger built infrastructure in both remote sites for all targeted land uses, and in major centres.

Agriculture

The Northern Territory Government has produced a statement of areas considered suitable for agricultural development, based on a conjunction of suitable soils and groundwater. We used this information to assign indices of agricultural prospectivity to subcatchments.



(a) Broad scale rain-fed field crops

(b) Broad scale irrigated field and row crops

(c) Spatially constrained (patchy) irrigated field and row crops

Figure s4: Maps of relative prospectivity of sub-catchments in the Northern Territory savannas for agriculture. It should be noted that these maps and the analysis on which they are based offer no judgments about the plausibility of successful agricultural development but rank relative suitability based on presence of suitable soils (most often patchily distributed) and nominal availability of water.

Sites in the Daly River catchment, an established agricultural area and the Roper River where development is occurring on the western margin, are particularly favoured. The Adelaide River catchment close to Darwin may be a site for a substantial on-stream water impoundment and/or off-stream storages.

Mineral extraction

The Department of Mines and Energy identifies sites in the Daly, Roper River and a number of catchments in the Gulf of Carpentaria as prospective.

Unconventional oil and gas

Large areas of the study region are regarded as highly prospective. Work to prove reserves is most advanced in the Beetaloo Basin (Figure s5).

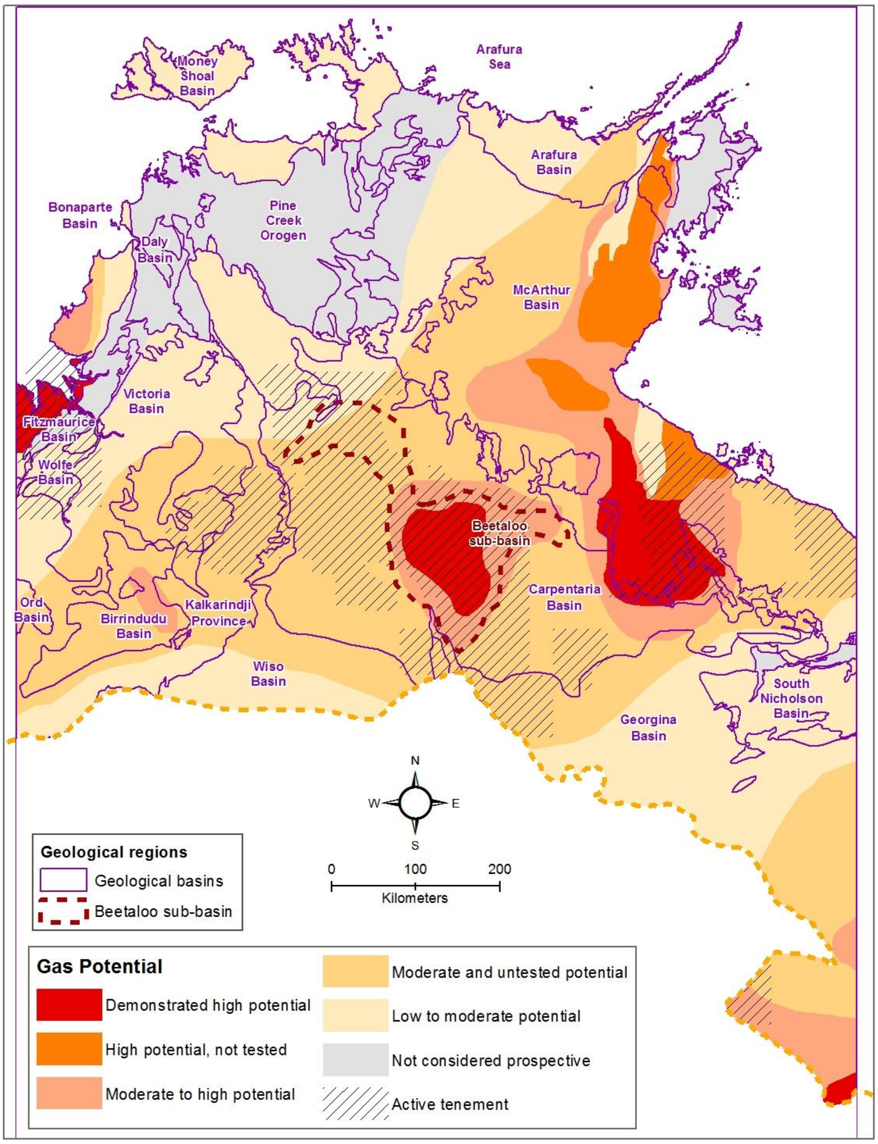


Figure s5: Exploration leases issued under petroleum law on which operators and DME report recent exploration and/or flow testing activity for extraction of tight oil and gas from shale.

Areas regarded as having confirmed high potential totalled 3.0 million ha, untested high potential 2.1 m ha, medium to high 6.5 m ha, untested medium 24.6 m ha, and low prospectivity 19.6 m ha. Only 8.8 m ha were considered to offer no opportunity. Accordingly, most sub-catchments (75.3%)

included areas considered at least a little prospective. This apparent ubiquity of opportunity will probably not withstand practical scrutiny. For example, in considering these assignments of potential further, we discount for broken surface topography which may add to development costs.

Choice of case study area

To identify an area for finer scale work, we looked for concentrations of values and drivers of change. We gave no weight to NT SoCS in the process, but overlaid the top decile of values (biodiversity and cultural in a combined index in which they were equally weighted) on subcatchments also ranked in the top decile for both agricultural and unconventional gas prospectivity. We ignored mining for this initial scan because of the relatively much smaller areas likely to affected. This identified scattered sites in the Kakadu region, Moyle and Daly River catchments, Roper River catchment and several catchments in the Gulf of Carpentaria. We did not seriously consider the Kakadu area because of already major investments. Other sites were discounted on isolation compared with the Roper River which is close to the Territory's major north-south highway and to existing active developments (agriculture in the west and unconventional gas in the south. Presence of active Indigenous Ranger groups supported by well established resource management organisations (e.g Yugul Mangi Development Corporation) was also influential.

Roper River case study

With the move to a single, albeit very large, catchment, we re-examined asset mapping and point data in relation to drivers of change.

Vegetation

The region supports no strikingly unusual or rare vegetation associations, but arguably has special values in large areas of Lancewood, a relatively restricted *Acacia* forest type that is sensitive to fire and other disturbance, and considerable expanses of mostly riparian monsoon forest that is at risk from feral animals, weeds, poorly managed grazing and changes in river flow regimes and groundwater depletion.

Flora and fauna (including notable species)

Total number of species of vertebrate fauna in the catchment was 482 (number of records=25487). Species recorded for sub-catchments ranged from 0 to 269 (mean=73.1, sd=77.0, *n*=63). There was wide variation in the number of records for sub-catchments (range 0-3077). The median number was 78. Twelve sub-catchments (19.0%) were un-sampled. Sub-catchments without fauna records were often substantial in size (mean area=18,769 ha, range 694-50122 ha). Overall, the region is relatively weakly and patchily sampled for fauna with an average density of records of 0.9 km^{-2}.

The single record for an endangered species (NT categorisation) is an historical record (1911) for the Golden Bandicoot *Isoodon auratus* (Woinarski et al. 2007). The single critically endangered species is the Northern Quoll *Dasyurus hallucatus*. Records for threatened species (766 excluding near threatened) in this large catchment are relative sparse compared with well sampled catchments like the much smaller South Alligator River (n=5565) in Kakadu National Park and Finniss River (near Darwin). Fauna of particular concern in the region include the Northern Quoll and larger varanids vulnerable to cane toads. Species sensitive to fire include the Partridge Pigeon, Gouldian Finch and Brush-tailed rabbit rat. Records are too sparse to indicate the size of local populations or sites where conservation efforts might productively be focused. Some of these same species and some additional species were also EPBCA-listed (Figure s9).

The total number of vascular plant species recorded for the catchment was 1790, from 32,730 records. Individual subcatchments recorded from 0 to 741 species with a median of 51. Sampling was spatially patchy with a range of 0 to 5140 and median of 78 records per subcatchment. Seven subcatchments (12.5%) had no records. Areas of sub-catchments with no records ranged from 694 to 8632 ha. There were no threatened flora, but 17 near threatened species were in the database.

Cultural heritage values

The Roper River catchment encompasses the lands of a number of Indigenous language groups, most of whom appear to have maintained close connections with their estates. In the east on the Arnhem Land side of the Roper River, are the Wanadarang, Nunggubuyu, Ngandi, Ngalakgan and Rembarmga. South of the river and in the east are Yugul, Marra and Alawa. On the western side of the catchment, Jawoyn, Mangarayi and Yangman are the principal languages. This illustrates the cultural diversity of the region. A proposed Indigenous protected area which extends outside the catchment includes Ngalakgan, Ngandi, Yugul and Wandarrang, Nunggubuyu and Ritharrngu language groups.

There are 1188 AAPA-registered or recorded sites in the Roper River catchment, with 30.3% of them attributing significance to features associated with water. Most sites, irrespective of features mentioned in nominations, are located close to rivers and streams. For example, 71.1% of registered site had boundaries mapped within 50 m of streamlines. We interpret this result to indicate that issues affecting flows and water dependent ecosystems along the length of the Roper River will require particular attention. Correspondingly, developments that avoid drainage lines will also avoid many (but by no means all) culturally important sites.

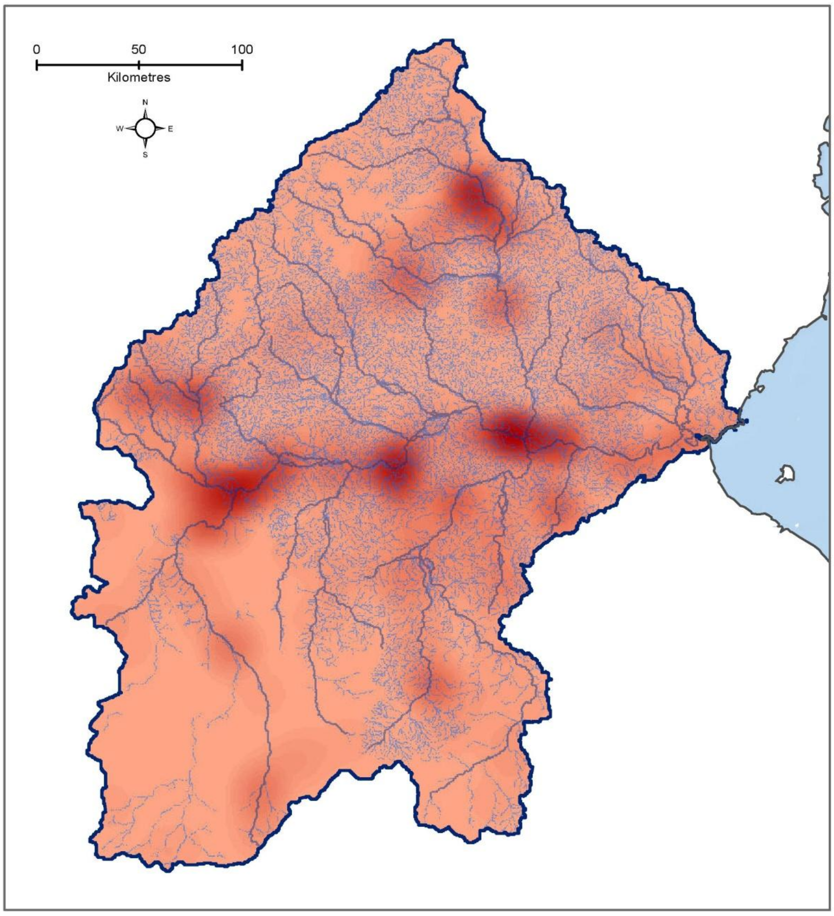


Figure s6: Density (dark shading) of sites registered or recorded by the Aboriginal Areas Protection Board derived by kriging. There is a strong association of sites with rivers and streams and many site descriptions assign significance to water bodies.

Land tenure

Indigenous people hold exclusive title to approaching half of the catchment and have had formally recognised or are claiming non-exclusive rights to most of the remainder, so that recognised Indigenous interests may ultimately extend over 94.3% of the catchment (Table s1).

Table s1: Extent and type of Indigenous land interests in the Roper River catchment

Tenure type	Area (ha)	% catchment	% indigenous interests in land
ALRA scheduled	3,566,721	47.1	65.7
ALRA (yet to be scheduled)	0	0	0
NT Indigenous Freehold	1,142	0.02	0.02
ILC holdings	51,031	0.67	0.9
Native Title determination (exclusive possession)	0	0	0
Native Title determination (non-exclusive)	1,809,348	23.9	33.3
Total all determined interests	5,428,212	71.7	100.0
Native Title applications	1,711,922	22.6	31.5
Total freehold equivalent held	3,618,893	47.8	66.7
Total including applications	**7,140,134**	**94.3**	**131.5 (of existing holdings)**

Society and economy

The population (usual place of residence) in 2011 was 3552 persons, or a human population density of 1 person in 2259 ha (or about 3500 ha per person of working age (>15 years). It is more difficult to describe other aspects of the region's economic profile because figures are aggregated at larger scales to protect confidentiality. These larger units do not align well with catchment boundaries. However, some impression of employment status can be gained from figures for larger settlements in which many of the region's people reside. The median weekly income for Indigenous people in the centres listed was $218 in Numbulwar, $269, in Ngukkur and $268 in Minyerri. The median weekly income in the Northern Territory is $745.

Drivers of land use change

Here we focus on agriculture (including irrigated pastures) and unconventional gas as the sources of change with the potential to disturb large areas.

Agriculture

Large areas are ranked highly for irrigated crops and annual horticulture. The largest contiguous highly prospective areas run in an approximately south-easterly direction from Mataranka on the western margin of the catchment.

Unconventional gas

Highly prospective sites are located particularly in the south and central-east of the catchment straddling the Roper River. The central-east node coincides with a large part of the proposed Yugul Mangi Indigenous Protected Area (see Figure s9).

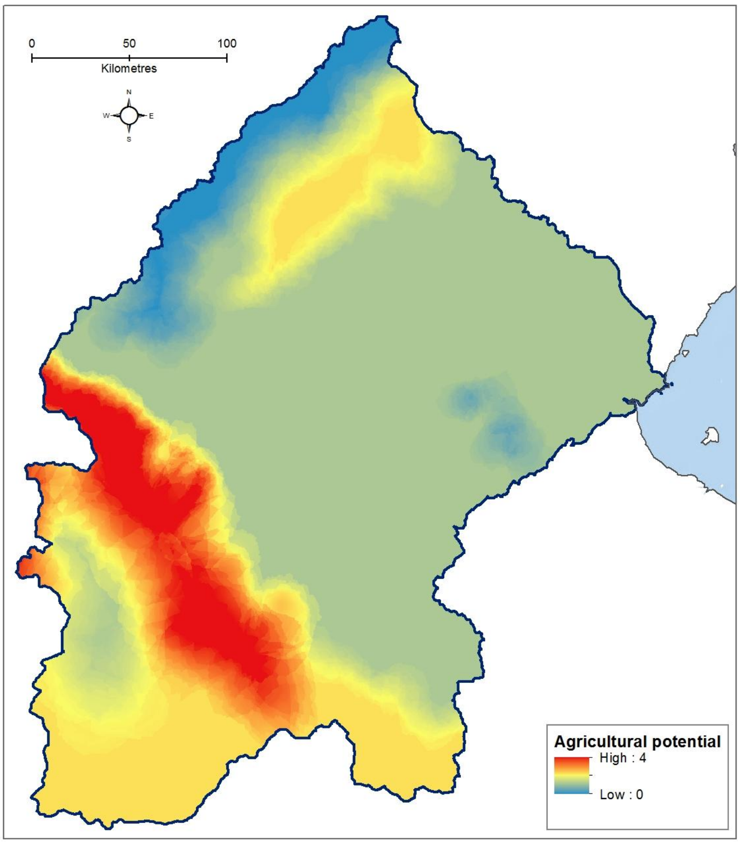


Figure s7: An abstraction of the maps of Pascoe-Bell et al seeking to integrate the different potential uses, taking the highest value at each point in the landscape. Interpolation used ArcGIS kriging The quanta indicated have no particular meaning.

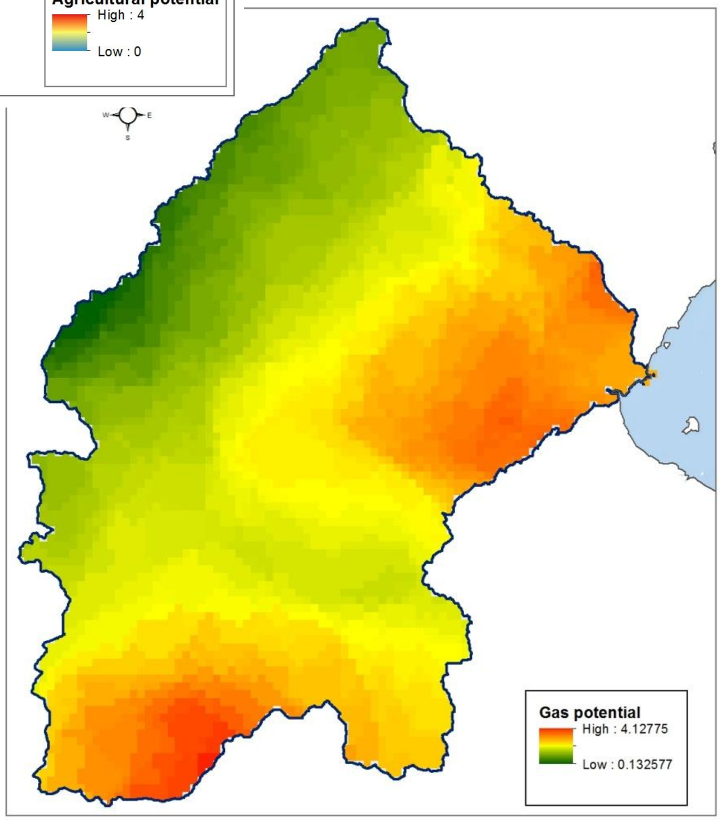


Figure s8: Abstraction of an index of shale gas prospectivity discounted for broken terrain and interpolated using ArcGIS kriging.

Intersection of heritage values and drivers of change

Flora and fauna

Of the records of notable fauna identified in Territory law and practice, 79% intersect with areas of some prospectivity for agriculture (including intensified pastoralism) and 89% with areas prospective for unconventional gas ranked at or above moderate potential. Corresponding figures for EPBCA-listed species are 78% and 78%. None of the intersections could be said to indicate a site known to be especially significant for the species concerned (Figures s8 and s9).

These observations may act as triggers for more comprehensive examination of the significance of sites for threatened species when particular developments are proposed at or close to these points. Because developments may occupy large areas, despite the sparcity of records for species listed under the EPBCA, there would appear to be some prospect that they would trigger referral. Although the approval of the proposed IPA does not constitute declaration of a park under the EPBCA, it may be an important influence on likelihood of referral and nature of conditions proposed on any development. Activity in and around the SoCS could act as a trigger for NTEPA assessment.

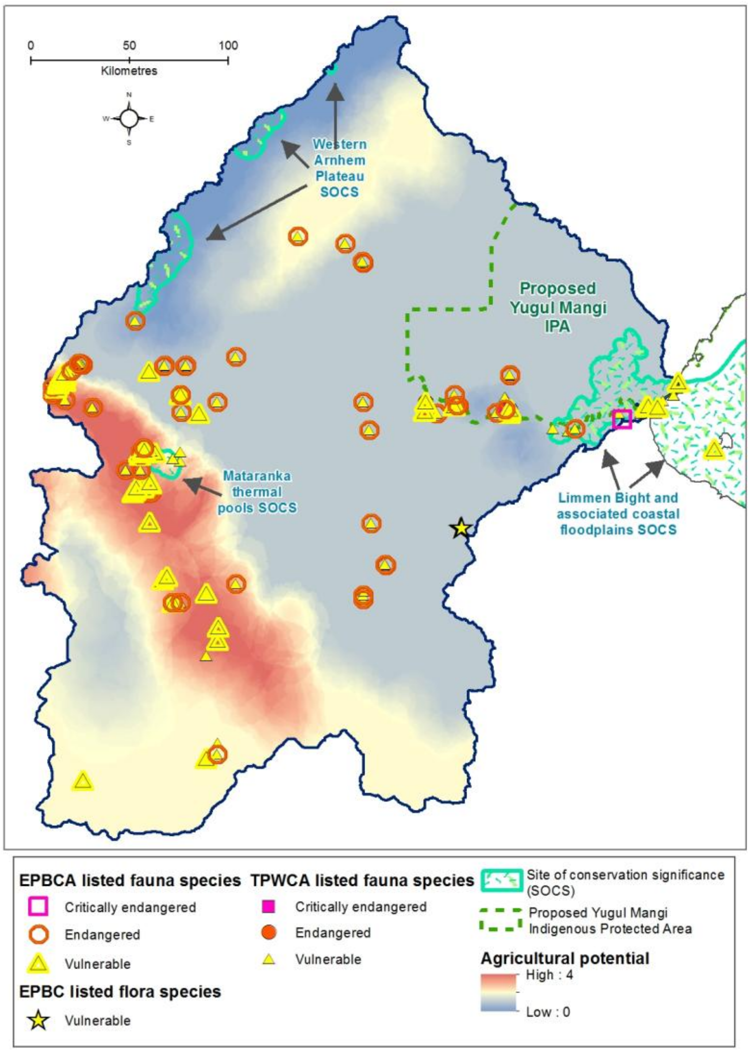


Figure s8: Intersection of listed species records and other areas of special conservation significance with areas of high prospectivity for agriculture in the Roper River catchment.

Point records of notable flora are too sparse to contribute meaningfully to identification of areas of strong potential conflict. 57% of records for Territory listed species coincide with the most prospective areas for agriculture and 88% with sites above moderate potential for tight gas. It should, however, be noted that these records were for near-threatened species. There are also intersections of prospective development regions with Lancewood forests.

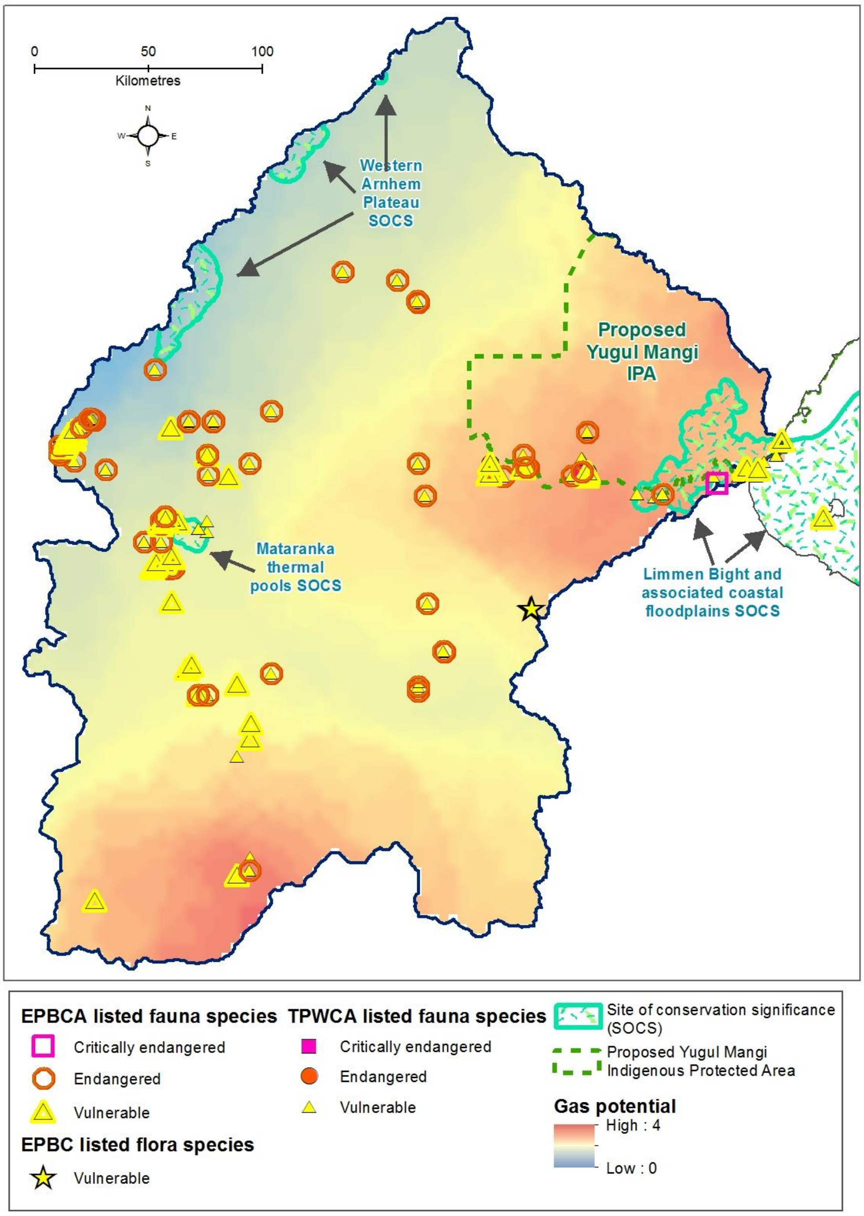


Figure s9: Intersection of listed species records and other indicators of conservation values with areas of high unconventional gas prospectivity in the Roper River catchment.

Cultural heritage

There are clear nodes of focus for protection of cultural sites, conspicuously associated with the Roper River mainstream and some other major waterways. Equally conspicuously, there are sites where those nodes intersect with areas prospective for broad scale irrigated agriculture. Clearly development in such areas will require careful consultation and planning (Figure s10).

There are also some important overlaps of areas of substantial cultural significance with sites prospective for shale gas (Figure s11). Traditional owners and other Indigenous people will seek careful negotiation and planning before development proceeds in or around such intersections.

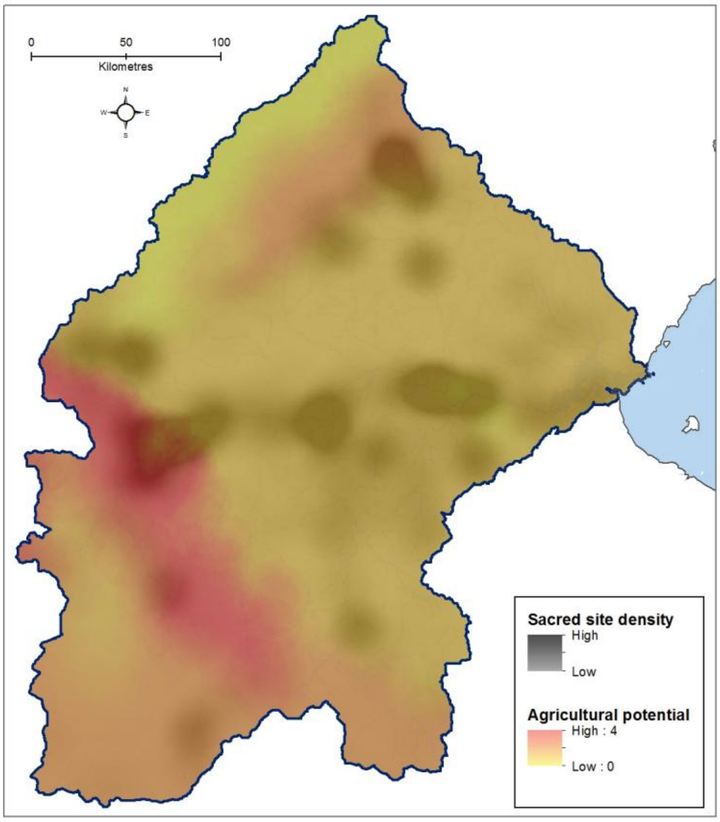


Figure s10: intersection of nodes of cultural sites (dark shading) with areas favourable for agriculture.

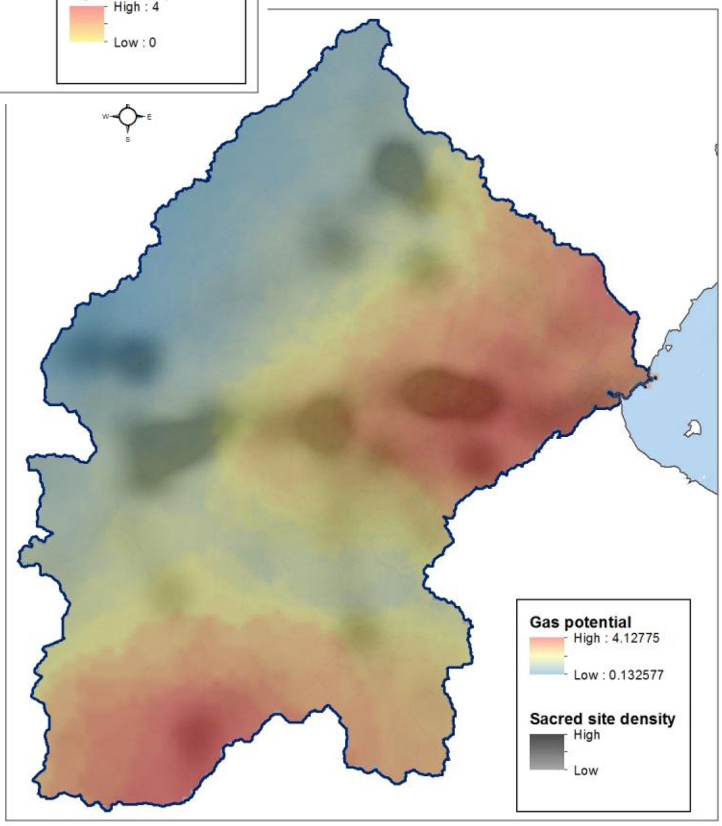


Figure s11: Intersection of nodes of cultural sites (dark shading) with areas favourable for unconventional gas.

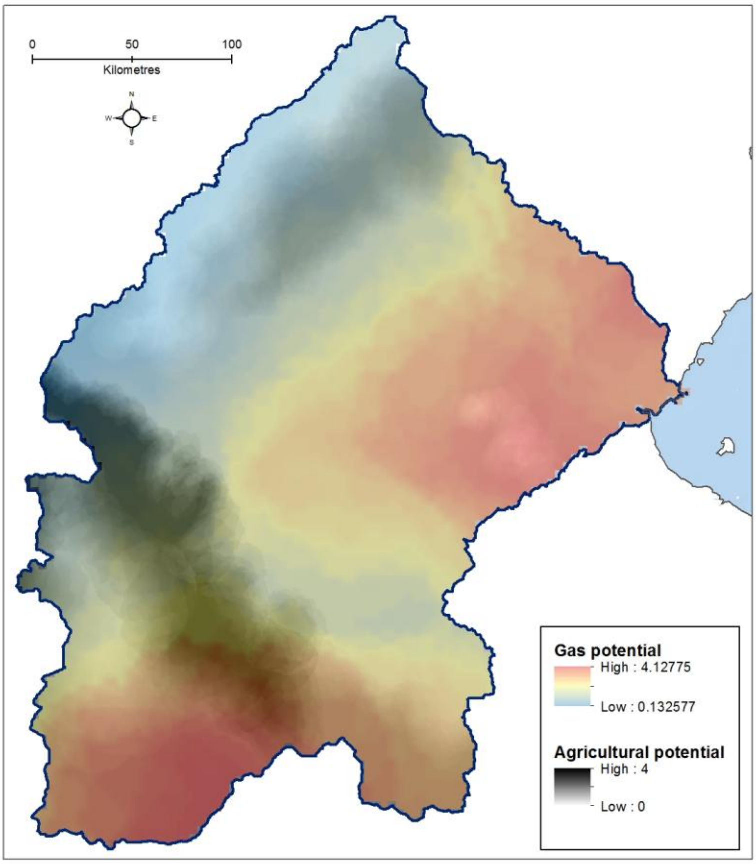


Figure s12: An area of overlap between areas highly favourable for agriculture and for shale gas occurs at the southern end of the catchment. We are aware of no government mechanisms to resolve such conflict.

Prognosis

There would appear to be a number of opportunities for large scale offsets should the need arise.

Carbon farming - savanna burning

We have considered options for a savanna burning project in the area of the proposed Yugul Mangi IPA, most of which has annual rainfalls of < 1000 mm and so falls outside the coverage of the existing savanna burning methodology. Using descriptions of eligible vegetation/fuel types and emissions parameters from a proposed new lower rainfall methodology we have estimated average annual emissions over the period 2000-2009 at 40,600 tonnes CO_2-e. Fire frequency is high but less extreme here than in some other parts of the catchment, with an average of 34.7% of the area burning annually. The fire is mostly late (24.3% of the total project area).

We propose that an ambitious but realistic target would be to shift the fire regime to 20% early fire and 10% late fire (proportion of site burned annually in each case) while reducing the total amount of fire by a little less than 5%. This would realise abatement of about 9,100 tonnes CO2-e pa. A more aggressive approach might return up to 50% more abatement. We consider that on the basis of experience elsewhere, targets of this order could be achieved by a fire team of 5 and relatively modest use of helicopters to meet labour and operational costs at a price of about $15 per tonne CO2-e. Whilst a lower rainfall carbon sequestration through fire management methodology may be some time in development, the total carbon benefit through enhanced storage in woody vegetation and coarse litter will greatly increase returns.

We, however, consider that the important benefit from establishing a savanna burning project in this region will be strategic: to drive a pan-Arnhem Land fire management cooperative which can build collaboration in other areas. Independent but coordinated groups will be positioned to support each other to achieve shared goals and reduce the risks of severe and unmanageable wildfire in any part of the region.

Loss of native vegetation

We have estimated that 3-5% of an area with a productive shale gas field could be cleared of native vegetation to facilitate access and insert and protect infrastructure. Depending on the level of commitment to impact minimisation, the amount of clearing could be considerably greater. There will be no incentives to reduce clearing on pastoral land, where lessees may welcome removal of dense vegetation like lancewood forests, which have a particularly low grass over.

Operators of gas fields could, however, be required to offset such clearing, which may encourage approaches to design and layout to reduce disturbance to the maximum extent practicable. Indigenous landholders will be in a strong position to provide such offsets to compensate for on site losses of biodiversity value. They may also offer offsets for carbon losses through savanna burning or other carbon farming projects. There may even be options to offset clearing related carbon emissions by skilled management of fire on development sites.

The situation with clearing for agriculture is less clear, even though environmental impacts may be substantial. Agricultural developments, even when they involve land clearing much greater in area than required by other forms of development have rarely undergone formal environmental assessment. And given a general antipathy to offsets, the Territory appears unlikely to seek them for agricultural clearing unless required by federal triggers such as the presence of one or more threatened species.

Impacts on water-dependent ecosystems

Despite great significance for biodiversity through damage to water-dependent ecosystems, impacts of water use either through direct withdrawal from rivers or streams or by drawdown of aquifers are likely to be the most difficult to offset. There will be considerable challenges in demonstrating cause and effect, measuring impacts, and in finding meaningful compensating actions if impacts are demonstrated. An archetypal water dependent system, namely jungles developing around perennial springs may offer some options.

An artificial and high cost mode of compensation of limited scope will be to supplement depleted flow by pumping in additional water from sources distant enough not to exacerbate the drawdown problem. Such approaches are unlikely to be of interest to local Indigenous providers. A more realistic option may be to protect lower elevation sites less affected by drawdown from feral animals or managed stock and so improve their condition. There would be some challenges in working out acceptable multiples of area improved to area impacted. Less direct options might involve protection of riparian vegetation that contains many of the same elements from fire or weeds. Choice of options may depend on assessment of the significance of the damaged site(s) as sources of water for dependent fauna.

Even more difficult will be compensation for damage to in-stream habitats affected by say, reduced flow and increased turbidity that displace or degrade in-stream communities. Responses would be necessarily large scale, such as protecting and rehabilitating a substantial length of another tributary or (less desirably) an independent system previously degraded by stock and/or feral animals.

We have already alluded to the difficulties under present regulatory practice of surrendering or at least choosing not to use water entitlements and so effectively reducing the size of the consumptive pool. These practical difficulties may be overcome when water markets are in place, but this appears unlikely to occur until systems are approaching or have reached over-allocation. A better process would see offsets deployed early to prevent or help manage the risk of over-allocation.

We assume that gas exploration and extraction will be conducted to minimise pollution risks to groundwaters and hence that acute or chronic impacts on water quality will be treated as unacceptable and hence not be candidates for offsetting. Some level of agricultural pollution is perhaps inevitable if large areas are developed. Again effective control of feral animals may help reduce the total amount sediment entering water bodies and so be considered as offset candidate. Quantification may present challenges.

Invasive species control

Weeds of national significance were recorded in 32 of the region's sub-catchments. The most frequently reported species are *Parkinsonia aculeata*, *Jatropha gossypiifolia* and *Acacia nilotica*. *Gamba grass*, a severe fire weed, and *Mimosa pigra* are present. Invasion of agricultural and shale gas fields by Gamba grass would greatly exacerbate fire management problems. There will be strong operational and conservation incentives to contain the spread of this species in particular.

Difficulties with weed control are likely to increase under agricultural of unconventional gas development because of the large areas disturbed. Weed control would need to be a component of most land "set aside" type offsets, such as those that might be required to compensate for land clearing. And offset providers may obtain associated work in weed control unrelated to offsets.

We do not have details of areas severely affected by weeds, but it is possible that eradication from sensitive sites (like restoration of riparian fringes) could arise as offset for clearing of dense vegetation in other areas.

We have already alluded to indirect offsetting of impacts from water drawdown by protecting vegetation closer to the water table from feral animal impacts. In addition many other offsets will require that feral animal impacts are minimised even if they are not the principal focus. Feral pigs, which have been recorded as present in 5 of the region's sub-catchments can have severe impacts on natural systems and are important agricultural pests. In the event that agricultural activity accelerates, demand for feral pig control is likely to increase.

Some of the species at risk in the catchment are likely to be vulnerable to feral cats. Methods of control are not well developed but may be an important obligation if loss of habitat for small mammals is being offset.

Cultural assets

Although not usually considered as environmental assets, the presence of numerous sacred sites protected under Territory law in areas prospective for development could offer potentially powerful triggers for a process like DbD and increase the benefits from its deployment. In areas of high site density incentives to negotiate configurations for development that minimise conflict will be particularly strong.

From an Indigenous perspective, impacts at and around sacred sites may considered functionally similar to environmental impacts as more generally understood. Many sites will be recognised for connections with native plants and animals and proper protection of those sites regarded as important influences on these species' future status. It would be productive to consider such issues in tandem with more "mainstream" issues in design to minimise ecological impacts. And consideration of the intersection of specific Indigenous concerns with orthodox conservation objectives should also influence the design and delivery of offsets. For example, siting offsets to protect particular species could be chosen to also offer enhanced protection of important sacred sites (e.g. larger buffers) and the connections between them. And *vice versa*.

Protection of infrastructure

Protection of gas or agricultural infrastructure (e.g. from fire and ferals) could require some of the same methods used in offset delivery, and so offer an opportunity to expand work. It is also possible that the particular demands of fine scale management to protect such infrastructure over relatively large areas could be coupled with other work (e.g. protection of substantial cat exclosures, management of Partridge Pigeon habitat) that would also require fine scale fire management.

This brief scan of options for offsets that may arise in the Roper River catchment is incomplete, but it demonstrates that at least some of the likely impacts of the most likely forms of development are legitimate candidates for offsets. There will be opportunities through careful design for locating both developments and offsets to minimise conflict and maximise environmental benefits. And to address multiple objectives. That process will work best if it combines orthodox perspectives with the obligations of Indigenous people to protect differently conceived but related aspects of landscape structure and function.

Discussion

The apparently determined withdrawal of the Northern Territory government from engagement with offsets and the NTEPA confounding of biophysical impacts with social impacts are surprising and depressing developments, suggesting that government is prepared to move away from well-established best practice. It is difficult to see how the NT can claim to meet national and international standards when it appears to have rejected the best tool available to promote no net loss of environmental quality, a target endorsed by industry peak bodies and many large businesses.

Good offset policy and practice implemented through government is an approach to maximising net public benefit from development. Withdrawal of government does not necessarily mean that such goals cannot be effectively pursued. Offsets done well also protect private interests in land and existing forms of production; and can generate additional private benefits through employment to deliver them. Non-government interests in the Northern Territory have the capacity to assert influence that can at least partially replace the coercive powers of government. Indigenous landowners can control access to their land in ways that are unavailable to others. Other groups do not entirely lack influence either, especially in shaping public opinion. For example, competition between committed food producers and coal seam gas developers has done much to drive public disquiet about unconventional gas. There is potential for competition between shale gas developers and agriculturalists even in the remote Roper River region (Figure s12), as agriculture spreads eastwards from Mataranka and shale gas extraction moves north.

A loose coalition of groups with shared concern for environments and equity can perhaps fill the gap left by government. The potential benefits from skilled application of DbD principles and process are worth the effort. But there are also some challenges unrelated to the behaviour of governments, or perhaps more accurately, a long term consequence of past behaviour. The information held on environmental attributes is not up to the task of informative comparisons of different parts of the landscape that is an essential requirement for effective DbD. This will create uncertainty about the quality of decisions choosing one site over another. The two obvious solutions to this problem generate additional costs. One is to conduct thorough surveys designed around the impacts to be compensated prior to selection and implementation, which may create unacceptable delays. The second is to design high quality monitoring system that are capable of picking up evidence of the improvement or maintenance of the values sought. The latter is probably most practical but will certainly add to costs and may, if the original interpretation was in error, reveal unpleasant surprises that put the reputation of the provider at risk. As argued earlier in regard to offset design, risk of underperformance can be reduced by applying a substantial multiplier to area of the offset site, again adding to cost of acquisition and/or management.

There are substantial risks in taking up the "government replacement" option we have suggested. Obvious alternatives are too seek to persuade the present or a future government to change policy. Aside from the NTEPA guidance there has been no clarifying statement: from relevant agencies or at the political level. This may ease willingness to backtrack and take up offset issues in a relevant agency, despite the decision of NTEPA to play no role. There are some opportunities in the Roper River area to test the waters and build relationships in advance of land use change.

Essential features of a new offsets framework

Filling the offsets void requires attention to a number of important issues. Government plays several key roles in deployment of offsets:

(1) establishing the intent of the environmental assessment process, as a quest for no net loss
(2) regulating to require offsetting as compensation for losses of environmental quality, and setting real penalties for failures to comply
(3) setting standards for offsets
(4) securing offsets in law
(5) establishing well understood and consistent process.

As already noted, government rejection of the role of offsets arguably represents a repudiation of the principle of no net loss from major developments.Fortunately, some industries have endorsed both this principle and the role of offsets in achieving it. Many large companies will expect to engage in offsetting of residual damage. And a critical group of landholders, namely Indigenous people, have considerable leverage in a capacity to deny developer access to their lands. If individual landowners, their land trusts and quasi-governmental Land Councils understand and seek to benefit in reasonable and productive ways from deployment of offsets,they are positioned to promote their use, irrespective of the views of government.

Many non-government organisations have developed environmental standards of various kinds that have been influential in overcoming poor management: these are arguably best developed in regard to carbon farming, where the remit is often broadened to address wider issues of sustainability, including protection of important ecosystems like forests (CCBA 2008; GSF 2013a,b). Standards for biodiversity offsets have been developed by groups like IUCN in collaboration with industry. There is no barrier in principle to non-government offset providers and facilitators adopting standards that will be well understood nationally and internationally. The summaries of Territory legislation here can be used to ensure that proposed offsets satisfy regulatory additionality (ie they do more than meet the standards required of all landholders).

Arguably, the most significant problem arising from government withdrawal is the loss of power to formally secure offset sites under laws that sets high standards for protection and at least ameliorate some forms of intrusion. (Noting that no site is entirely protected from the mining and energy sectors). A weaker form of security will be available in binding contracts between landowners, offset providers and offset purchasers, probably with financial penalties for failure to comply. These may be sufficient guarantee of long term obligations to maintain an offset.

Government and their public servants are masters of process. Although rote form filling is often criticised, the burden of well established procedures - run to published policy - ease with exposure. Clients know exactly what to expect. In contrast, a system run by a group of organisations of the sort we have suggested may initially appear somewhat *ad hoc*. However, this can be overcome by commitment to well-documented and simple processes.

In our view the real obstacles to a non-government offsets program in the Northern Territory are the linked issues of commitment and resources. All of the organisations named have other obligations and may struggle to get the resources they need to neet existing obligations. Taking on a substantial task like this will require access to additional funds.

The knowledge issue

In addition to these political and operational difficulties, in northern Australia generally and the Northern Territory in particular, DbD faces large gaps in knowledge with no immediate prospects of more than very incremental improvement. Design of any conservation management system on a significant scale depends on several levels of understanding: a description of the landscape at a level of resolution congruent with the intended use; a general understanding of how the landscape functions; and an appreciation of how organisms use the landscape and the resources they need to sustain their presence. In addition to these basic understandings, that could be unique to a particular combination of site and use, a process like DbD requires an ability to make meaningful comparisons among sites.Descriptions of sites are usually captured in maps which seek to divide landscapes into components that are more similar to each other than to other differently classified sites, and where the user can readily grasp the differences between the classes. This trite pre-amble is important for understanding one of the key difficulties for comparative and predictive studies in the Northern Territory.

Mapping

The major vegetation mapping product for the Northern Territory was completed in 1990 at a 1:1,000,000 scale. There has been relatively little coordinated broad scale vegetation mapping since. Advances fall into three types: larger scale mapping at a few locations, often using different methods and to different standards for different purposes. For example, a vegetation map at 1:50,000 was made for the area surrounding the Mt Todd mine, which supported the endangered Gouldian Finch. Detailed maps have been made at a range of scales for particular vegetation types like mangroves and *Melaleuca* forests. But the World Heritage Kakadu National Park has no large scale vegetation map, despite commitments in the current plan of management.

Most additional mapping has been done as Land Systems (1:250,000) or Land Units (up to 1:15,000). The difficulty with this form of mapping is that because it was done site by site over many decades, it tends to be non-hierarchical and tailored a particular purpose and to the dominant features of a particular study area. Lynch (2012 and references therein) describes some of the difficulties of translating general descriptions in original surveys to consistent feature descriptions. Efforts have been made to join up different surveys at 1:250,000 scale but comparability across boundaries of original surveys may be problematic. For the Roper River catchment, the principal survey was completed in 1990, but did not cover the whole of the catchment. Other components were mapped at different times in conjunction with other landforms which may have influenced descriptions. It is therefore difficult to compare different parts of the catchment with confidence, or to collapse categories to work at different levels of resolution.

Consistent vegetation mapping is available through the National Vegetation Information System (NVIS) and is usable in the Territory down to Level V. In addition to information on structure this level names 3 dominant species at each of the traditional upper, mid and ground strata. Whilst useful for broad comparisons, such mapping will not necessary identify plants that may provide key resources for fauna.

There is no joined up soil map at a scale useful for comparative work, although the land systems and land units mapping contain soils information which could be interrogated with some effort and probably with support from agency personnel. A 3' digital elevation model is available. Rainfall data from stations is very scattered and for many parts of the Territory estimates are taken from surfaces modelled by the Bureau of Meteorology, which acknowledges the difficulties caused by sparse stations (for example in the recent past but now corrected, estimates of monthly dry season rainfalls were sometimes small negative values). Geology maps of wide coverage are very small scale and even regional maps are at 1:500,000 or 1:1,000,000.

Point records of flora and fauna

The number of geo-coded records readily available from the relevant agency is superficially impressive for our study area, exceeding 1.2 million (but including some exotics). But as we have shown the spatial distribution is strongly biased to a few well-sampled areas. Species of conservation concern in our case study area were represented by 1 to a few records.

We have not obtained the quality of information needed to do a systematic examination of the influence of sampling design and sources on apparent patterns of species richness or presence and abundance of particular species. Arguably elements of the patterns observed, such as the Kakadu and Darwin regions appearing as the most species rich regions are influenced by sampling histories. The exponents for the species-area relationship (fauna 0.30; flora 0.37) in sampled sub-catchments (records >0) are higher than for mainland areas in general, including for savanna vegetation in Brasil. We suspect that slopes are biased upwards by gross under sampling of many areas. More detailed analysis is outside the scope of this study but warrants attention. The use of vertebrate animals exclusively is clearly also a weakness, but the invertebrate record is likely to be even more biased both taxonomically and by variation in sampling intensity.

Under such circumstances it is difficult to analyse associations with landscape features for predictive models or make simple site to site comparisons, no matter how good the thematic mapping of vegetation or other important landscape descriptors. And it would appear that the land unit descriptions that dominate finer scale mapping are not good surrogates for features important to fauna. Attempts to use 1:50,000 land unit mapping to support predictive models for fauna based on comparatively intensive local sampling for reserve planning in the Daly River catchment were disappointing (Owen Price, personal communication; DIPE 2003).

Formal government survey programs have greatly reduced over the last decade so the bias and related gaps in meaningful coverage of large parts of the Territory will not be quickly corrected.

We suggest that with the quality of data apparently available, a conservation planning framework of the sort described by Saenz et al. (2013) and used to inform decisions about location of developments to mitigate impacts would depend on expert opinion more than analysis and insight available from the region's fauna and flora records.

Habitat relations and dynamics of individual species

The response of some Territory fauna to habitat fragmentation has been studied directly, which may be particularly useful in sites under development for agriculture. Some caution may be needed for extrapolating from the relatively high rainfall Daly River - where the study was done - to the drier woodlands of (for example) the lower Roper River catchment.

Enough is known of population dynamics and/or habitat relations of a reasonable array of fauna and flora or harvest to make reasonable simulations of the impacts of habitat loss or degradation through development. To date this knowledge has been used chiefly for predicting impacts of pressures like fire. We did not run simulations. In passing we note that it would rarely be possible to base such simulations on a detailed understanding of response to disturbance such as that used by Copeland et al. (2009) in their study of the potential impacts of expansion of the gas industry. Courageous assumptions would be required.

In addition to technical criteria for selection, such indicators of wider impacts of land use change will require a match to the nature of projected change as well public interest in the status of the species or assemblage. A model based on responses of a common fish, the barramundi *Lates calcarifer,* to changes in brackish near coastal nursery habitats or floodplain feeding areas is likely to attract much greater public interest and stronger political response than one based on a rare wetland plant.

Idiosyncrasies of formal classification systems

The Northern Territory's system for allocating species to categories of threat and hence conservation significance uses established IUCN processes and criteria. The additional layers of significance applied in describing some species as endemics are based on less systematic approaches. Federal government assignments of significance and the associated referral triggers are based primarily on international treaties like the Bonn Convention covering migratory animals, which in many cases will be much less vulnerable to projected changes than other elements of the fauna. When such bias is combined with sparse inland records, distortions are inevitable. For the northern parts of the NT, SoCS appear to be so strongly influenced that a casual examination of the resultant maps could be taken to indicate that there is rarely much of value in the interior and that from a conservation perspective, all is well.

It is important to take account of these sorts of biases in considering the rankings of areas for conservation priority and the choice of offsets that may be promoted by such triggers as the matters of national environmental significance formalised in the EPBCA (Figures s9 and s10). The difficulties created by these sources of bias in identifying regions or sites where DbD might be preferentially applied are not entirely resolvable by improved analysis. More important is the fact that idiosyncratic assignments of significance influence the matters that get referred for environmental assessment in the first place, and may then determine the impacts nominated for compensation through offsets. Relevant conservation plans, including those built on DbD processes, will need to deal with such distortions.

Culture matters

Our exploration of the quality of information available to support DbD focused on the respect of the dominant culture for assignments of significance based on rarity and/or evidence of vulnerability to change. Uniquely, we also had access to records of the location of registered sacred sites and other sites of significance to Indigenous people, as maintained by the Aboriginal Areas Protection Authority. Those sites are valued for their place in Indigenous cosmology and related customary law, about which we claim no particular understanding. But it is clear that they reflect deeply held beliefs about the significance of living and non-living features of the landscape and their relationships with each other and their surrounds. We suggest that they therefore offer a most useful and compelling surrogate for Indigenous views of the significance of projected land use change: a perspective that is usually inaccessible to conservation planners.

Our summaries for the Roper River demonstrated that there are strong associations of these sites with particular parts of the landscape: in particular rivers that are likely to be vulnerable to agricultural development. We anticipate that networks of gas extraction wells and connecting infrastructure associated with unconventional gas may also cause concern. We therefore regard these records as a particularly useful for processes like DbD. Design of development configurations to take account of their significance will, in our view, strongly complement the sparse information held in flora and fauna databases.

To fail to give these records status in such processes would not only be socially inequitable, but also weaken the opportunity to engage the majority of the regional population and the major landholders in implementation of sound conservation planning processes and the deployment of robust offsets.

DbD and planning tools for Indigenous landowners

Indigenous leaders from northern Australia have articulated a pressing need for information and analysis to support decisions about use of land. However, formal planning processes (e.g. water allocation) most often address such issues in a piecemeal way. Paradoxically, given political rhetoric about engagement of Indigenous people with the mainstream economy, government support is most accessible for conservation planning, like the development of the proposal for the Yugul Mangi IPA. Those sources of planning support may be drying up and there is an urgent need to identify alternatives.

In contrast to most government supported processes, DbD seeks to understand drivers and the patterns of landscape change they will foster in tandem with conservation planning. DbD offers options for integrated planning for sustainable land use that are otherwise unavailable to Indigenous landowners. We have not sought to develop ideas or tools particularly directed at Indigenous users. However, we consider that the preliminary work done here offers some useful pointers to options to explore, in advance, implications of propositions about economic development that are likely to be put to them from within their communities of, perhaps more often, from outside them.

Next steps

We have made suggestions about the options available to fill the gap created by the Northern Territory's withdrawal from the offsets space. Those propositions have been made without consultation and are incompletely specified. Our intention here is to stimulate thinking about the real challenges that have been created not just for DbD processes but the environmental assessment process more generally.

At a more prosaic level, we suggest that work on this issue should continue, irrespective of reaction to the larger suggestion, including the following elements:

(1) NAILSMA continue to develop its thinking about the role of DbD and planning more generally in fostering Indigenous livelihoods built on land and resource management, including refinement of the preliminary analyses reported here and ways of building on them

(2) TNC maintain a dialogue with NAILSMA about these issues

(3) TNC particularly consider implications of notions of socially responsible offsets in the context of DbD and ways of strengthening partnerships with Indigenous groups more generally.

Conclusion

Indigenous ownership of a large part of the mega-diverse Australian continent offers globally unique opportunities for new approaches to sustainable development and biodiversity conservation. That opportunity does not originate in notions of stasis that may be thought to inhere in strong and ancient tradition. The knowledge and experience that inform tradition are critical for meeting obligations to land and ancestors, but in contemporary Australian society, so is access to the resources needed to maintain an active presence on lands while meeting fundamental social obligations and accessing services in health and education.

Many in Australian society appear to believe that they know better than Indigenous owners how those large areas of land should be used for national and local benefit. As illustrated by proposals from the Northern Territory, government may seek to press those views by reducing the rights of Indigenous landowners to make land use and management decisions. The proponents of these ideas appear willing to consign Indigenous landowners to passive observers of orthodox development directed by others: and others who have no particular commitment to care for the values of those lands.

An alternative to this bleak prospect has been formulated by the North Australian Indigenous Experts Panel and Forum. They argue that Indigenous landowners should be supported to plan carefully how to deploy land ownership to generate economic returns in ways that also strengthen capacity to discharge important customary obligations. They seek access to and unbiased interpretation of the best available scientific information, as well as the time and resources to consult meaningfully with traditional owners, *djunkai* (traditional land managers), and other community members about customary and other local knowledge for pursuing an optimal mix of benefits from land ownership.

The Development by Design program is entirely compatible with this vision. DbD seeks to accommodate new development by re-directing some resources to areas where they can be used effectively to enhance natural heritage values and maintain net environmental quality. Despite differences in perspective and motivations, there is a potentially powerful synergy between the biodiversity conservation goals of The Nature Conservancy and livelihoods goals of Indigenous landowners in land and sea management, and the mechanisms that both propose to reach them.

But realising that synergy will not be quick or easy. The formal scientific knowledge base is weak in many areas and will require strengthening. Ways must be found to access and apply local and situational knowledge and respect additional perspectives on values warranting protection. Particular challenges arise in building and maintaining capacity and commitment to deliver on long-term agreements that are inherent in offset provision. Building the partnerships needed to secure offsets in a political environment that de-emphasises environmental concerns and is actively dismantling related authority and process is a key contemporary issue. Success will require long-term commitment and direction of significant portions of total investments to building and maintaining relationships and capability.

The Nature Conservancy will need to consider carefully where it is prepared to invest and work in a spectrum of options: ranging from a leading conservation partner in sustainable use of Indigenous land and resources, lesser roles in financial and/or technical support, or chiefly within development structures and processes built by others. The strength of commitment required to take the former role should not be under-estimated.

2 CONTENTS

2.1 List of figures

2.2 List of Tables

3 GLOSSARY AND ACRONYMS

AAPA	Aboriginal Areas Protection Authority (Northern Territory) created in accordance with the *Northern Territory Sacred Sites Act*
additionality	a notional measurement of the effect of an intervention, including an offset: in carbon farming, claiming additionality typically requires demonstration that the benefit in reduced emissions or increased carbon storage would not have occurred under business as usual conditions (that whatever was done was not common practice) and that the benefit will not be lost by "leakage"
ALRA	*Aboriginal Land Rights Act (Northern Territory)* 1976: the federal law under which Indigenous land rights were recognised in the Northern Territory and communally held inalienable tile granted
AMD	Acid mine drainage or acid metalliferous drainage
AWC	Australian Wildlife Conservancy
BTEC	Brucellosis and Tuberculosis Eradication Campaign: a program concluding in the early 1990s to eliminate these diseases from the Australian cattle herd by testing and elimination of diseased stock and control of feral animals known to be carrying disease or otherwise compromising disease management
carbon offset	Offset based on reduction of emissions of greenhouse gases or storage of carbon in biological systems or other reservoirs. Includes abatement of some gases not including carbon, such as nitrous oxide, where they are potent greenhouse gases and/or are generated through processes influencing or connected with the carbon cycle
CFI	Carbon Farming Initiative - Australia's legislated scheme for recognising abatement of emissions of greenhouse gases or storage of carbon.
DFS	Definitive feasibility study (in regard to mining, petroleum and gas projects)
DoE	Federal Department of Environment
DSO	Direct shipping ore: ore of a quality (target metal concentration) that can be supplied to users with minimal processing
EPBCA	*Environment Protection and Biodiversity Conservation Act* 1999
feral animal	a non-native animal that has established self-sustaining populations in the wild; most often used in reference to wild populations of domestic stock or other domestic animals (pets); examples include water buffalo, cattle, horses, donkeys, cats and dogs
fracking	hydraulic fracturing of strata to release tightly held oil or gas - often involving substantial use of water and raising issues in disposal of polluted water and risks of contamination of groundwaters by escape of pollutants from poorly constructed or managed wells
IBA	Indigenous Business Australia
ILC	Indigenous Land Corporation
Indigenous	A generic term for people occupying Australia prior to European settlement in 1788 and often maintaining long term commitments to traditional lands and non-settler cultural norms
IPA	Indigenous protected area: an area managed by traditional owners under agreement with the federal government and recognised as contributing to Australia's systems of protected lands managed under agreement although not formally declared as a park or reserve under relevant legislation
IUCN	International Union for the Conservation of Nature and Natural Resources http://cmsdata.iucn.org/downloads/iucn_english_brochure.pdf
lands	defined to include waters overlying lands and so including some freshwater and marine environments

NAF	Non-acid forming (rock)
NAILSMA	North Australia Indigenous Land and Sea Management Alliance
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority. The sole regulator for petroleum activities in Commonwealth waters (outside territorial limits of the states and territory).
NRM	natural resources management
NT	Northern Territory
NTEPA	Northern Territory Environment Protection Authority
NTG	Northern Territory Government
PAF	Potentially acid forming (rock)
PFS	Pre-feasibility study (in regard to mining, petroleum and gas projects)
sacred site	A site nominated by Indigenous people and registered and offered protection under the *Northern Territory Sacred Sites Act*
savanna burning	a methodology developed under the CFI to recognise and reward emissions abatement (nitrous oxide and methane) achieved by reducing the area and changing seasonality of anthropogenic fire
SEA	Strategic Environmental Assessment
species richness	number of species recorded in a sub-catchment in databases held by the NT government, which due to limited survey may be substantially lower than actual species richness
SoCS	Sites of Conservation Significance identified by the Northern Territory government
Strategic environmental assessment	assessment of the environmental impacts of policies, programs or major developments or development types with large scale or widespread impacts
tcf	trillion cubic feet - units commonly used in describing gas reserves
TNC	The Nature Conservancy
TSF	Tailings storage facility
TWPCA	*Territory Parks and Wildlife Conservation Act*
wildlife	native plants and animals in unconfined populations that are self-sustaining without direct support from humans but which may influenced by human impacts on environments or harvest

4 MAP OF THE NORTHERN TERRITORY

This map identifies place names and river catchments that will be referred to frequently in this report.

5 INTRODUCTION

This study, funded by The Nature Conservancy (TNC) considers the opportunity to apply the Development by Design concept to the management of northern Australia's landscapes and their values. It identifies and examines issues affecting prospects for successful application and proposes sites for further work. The study is particularly timely because it precedes development of government programs to promote accelerated northern development.

5.1 What is Development by Design?

Development by Design is a component of TNC's Smart Development Initiative, which aims to ensure that future investments in production of food and extraction of water, energy and minerals are designed to minimise impacts on natural systems. "(TNC) has developed the science to enable governments, companies, and communities to use and share space, protect natural areas, improve resource management, and invest more wisely for a sustainable future"[1].

In brief, DbD builds on the mitigation hierarchy - avoid, minimise/restore and compensate - which is deployed in many orthodox environmental assessment processes to manage the impacts of individual developments (Kiesecker et al. 2010). Where there is no realistic opportunity to influence choice of sites for development (such as mining of a discrete ore body) and impacts cannot be entirely avoided or the site fully restored at reasonable cost or in a reasonable time, DbD supports and provides tools for choosing and locating compensatory offsets (positive compensating actions) that are equivalent to or exceed those residual impacts (e.g. Fitzsimmons et al. 2014). When there is some flexibility to choose site(s) for development (e.g. for drillheads for gas extraction; land clearing for agriculture or infrastructure), the DbD process can help select sites for both developments and compensating activities to minimise immediate conflict, and promote the long term security of those compensating sites to maximise net benefits (Kiesecker et al. 2009). In this role, DbD offers important opportunity for examination of alternatives to specific project designs, which, although formally required in most environmental assessment processes, are rarely seriously explored in practice (Fidler and Noble 2012).

In this second and arguably more significant role, Development by Design can complement strategic environmental assessment (Dalal-Clayton and Sadler 2005): of policy, programs and plans or very large (regional) scale developments (e.g. Saenz et al. 2013). Strategic environmental assessment is rarely overtly practiced in Australia, but is enabled by federal law (see later).

Recent difficulties with some large development proposals (e.g. Browse LNG[2]), government promotion of major investment in broad-scale agriculture (DFAT 2012; Petheram 2013a,b), and emergence of unconventional methods of gas extraction (fracking) are among many challenges emerging or re-emerging in northern Australia. Fracking raises particular concerns because it requires individually modest but collectively substantial facilities ramifying through large tracts of the landscape (e.g. Fisher 2012): a landscape that in the case of northern Australia, has so far experienced little structural disturbance. Government processes to drive accelerated northern development, for example a Parliamentary Inquiry initiated in late 2013, place no emphasise on understanding of potential environmental impacts and the capacity to effectively manage change[3].

[1] http://www.nature.org/ourinitiatives/urgentissues/smart-development/

[2] "Woodside Petroleum Cancels Onshore L.N.G. Project in Australia". New York Times.

[3] See the Committee's terms of reference at http://www.aph.gov.au/parliamentary_business/committees/house_of_representatives_committees?url=jscna/tor.htm.

Improving familiarity with tools designed explicitly to minimise conflict between development and conservation goals and support related planning would therefore appear to be particularly timely.

5.2 What are Offsets?

In describing DbD we have touched on the notion of environmental offsets. It will be useful in considering what is to follow to know the definition and potential role of offsets we have adopted.

Environmental offsets are positive measures designed to compensate society for the negative effects of actions to develop lands for production or more direct resource extraction. Offsets are sought outside a development site and may cover detriment caused within the site, or apply to more widespread (offsite) environmental impacts from by-products of production (often gaseous or water-borne pollutants). Some changes and the environmental detriment associated with change may be effectively irreversible.

In all other Australian political jurisdictions, offsets are therefore formally recognised as an important addition to the impact mitigation hierarchy. A three-component hierarchy underpins conventional environmental assessment and project approval processes: to avoid, minimise, and restore. Offsets recognise that there is always some residual detriment after reasonable steps have been taken to avoid or reduce damage; and that full restoration/ rehabilitation of the biophysical structure and ecological function of grossly altered development sites is improbable, at least on relevant timescales. The fourth, additional component, to compensate in an appropriate (environmental) currency for residual damage that cannot be practically mitigated, is offered by well-designed environmental offsets.

Developers are therefore asked to secure improvements in environmental quality outside the development site, after they have adopted best practice to mitigate impacts in the design and delivery of their projects. As a general principle, the outcome sought by regulators - and developers pursuing reputational advantage or a "social licence" to operate - is to secure environmental benefits at least equivalent to residual impacts, assuming developments also comply effectively with all other approval conditions.

The offset role in environmental assessment and impact management is sometimes criticised. Some criticisms originate in philosophical or ethical positions: that biodiversity and other environmental values are irreplaceable and cannot or should not be "commoditised". Others criticisms derive from conceptually similar concerns but are couched in terms of practice: how to demonstrate offset equivalence; how to avoid risks of offsets being used to "buy" project approvals for residual damage of nature and scale that would otherwise be considered unacceptable; and whose valuation of both impacts and offset benefits should count in assessments of equivalence? Most of the legislative and policy infrastructure that has been built for offsets is designed to grapple with these sorts of questions.

We consider all of these issues and many others in our examination of the role of environmental offsets in securing better environmental outcomes for northern Australia in general and the Northern Territory in particular.

6 BACKGROUND: THE NORTHERN AUSTRALIAN CONTEXT

Northern Australia is sometimes defined as the area of mainland Australia north of the Tropic of Capricorn (23°26'S)[4], an area of ~3 million km^2, or about 40% of Australia's continental land area. Other definitions are biophysically based: to encompass the seasonal tropics. In this region, of about 1.9 million km^2 or 25% of the continent, climate is strongly influenced by summer rainfalls accompanying the north-west monsoon. Landscapes are dominated by savanna vegetation with relatively sparse woody cover and predominantly grassy understorey[5]. Average annual rainfalls within the tropical savannas range from about 50 to more than 200 cm.

The Northern Territory is a State-like political jurisdiction (see below) occupying an area of 1.34 million km^2 (17% of Australia's land area). About 80% of its area lies north of the Tropic of Capricorn and 40+% in the tropical savannas (Figure 1). The north-south climatic gradient is steep with annual rainfall on the northern coast regularly exceeding 200 cm annually, but declining uniformly to 30-40 cm at the tropic of Capricorn and less than 20 cm at the Territory's southern boundary (at 26°S).

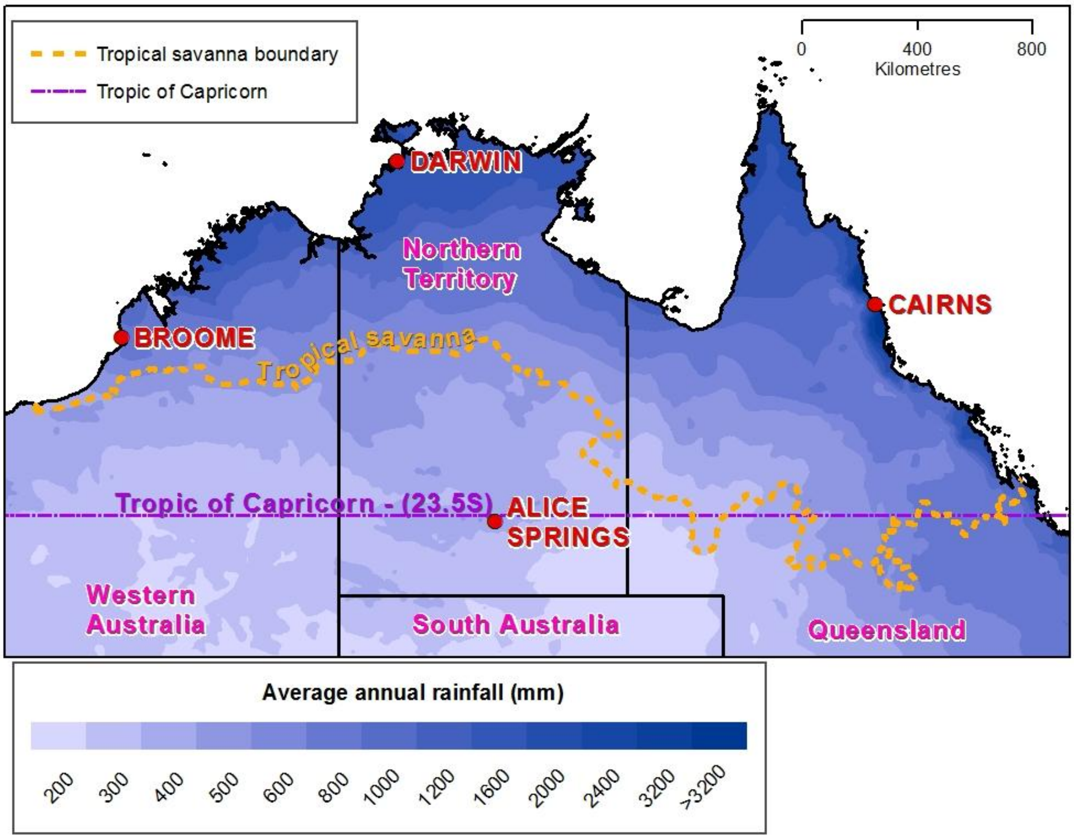


Figure 1:Map of north Australia showing the Northern Territory in relation to two of the boundaries proposed for delineating north Australian landscapes, and the steep north-south rainfall gradient.

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[4] The Parliament's House of Representatives Joint Committee on Northern Australia adopts this definition. See http://www.aph.gov.au/Parliamentary_Business/Committees/Joint/Northern_Australia/Inquiry_into_the_Development_of_Northern_Australia/Terms_of_Reference.

[5] See http://savanna.cdu.edu.au/centre/faq.html.

For the purposes of this study, we focus on that portion of the Northern Territory in the seasonal tropics as defined by the Tropical Savanna CRC (north of the upper dashed line in Figure 1). And in generalising from our results we consider only the savanna regions of northern Australia. Woinarski et al. (2007) provide a more detailed description of this region than we attempt in this introduction, where we are concerned chiefly to identify the sorts of developmental changes that are most likely to affect the region and its Indigenous people. We consider particularly impacts on natural heritage but also consider the ways in which effective conservation activities may interact with and support the protection of cultural heritage and produce benefits for local people.

6.1 Natural heritage

Despite continuous human occupation for about 50,000 years (Roberts et al. 1990) and the presence of European outposts from 1824, north Australia's landscapes have suffered relatively little obvious structural modification (Woinarski et al. 2007). However, throughout the period of human occupation, Indigenous land management practice - especially use of fire - is likely to have been important in creating and then maintaining a long term dominance of savannas with their relatively sparse woody vegetation and grassy understorey (Yibarbuk et al. 2001; Gammage 2011). Within this dominant matrix are scattered islands of topographically protected or culturally valued areas of denser trees and shrubs and wetlands. Coastal freshwater floodplain wetlands have probably been actively managed for human use since they emerged from the sea a few thousand years ago (Russell-Smith et al. 1997; Whitehead et al. 2003).

The spatially dominant non-Indigenous (settler) land use since first European settlement - extensive pastoralism based mostly on native grasses - did not require widespread structural change such as the removal of woody vegetation (Woinarski et al 2007). Land clearing to increase pasture production , including introduction of exotic pastures, is a relatively recent phenomenon in the northern tropics and has affected relatively small areas (e.g. AGO 2005), except in the south-eastern extremities of the savannas (Figure 2 below). For example, clearing of native vegetation for any purpose has been limited to less than 2% of the Northern Territory land area (Hosking 2002)

Despite the appearance of relative structural integrity through retention of native vegetation over most of the landscape, less conspicuous but nonetheless damaging change pervades savanna lands (e.g. Woinarski et al. 2001a,b; Whitehead et al. 2002; Franklin et al. 2005). Diffuse degradation of ecological function is driven by many causes: too frequent and often severe fire that displaces fire sensitive plants and reduces availability of resources for wildlife like shelter, fruit and seed; grazing by domestic and feral animals, also displacing native plants and suppressing their density and production of fruit, seeds and tubers; other exotic animals like cane toads preying on, competing with, poisoning, or carrying diseases affecting native animals; weed invasions displacing native plants; and saline intrusion into freshwater wetlands. All of these factors, some of which interact strongly wot each other to magnify change, have been identified as drivers of unwelcome change (e.g. Woinarski et al. 2007).

Well-documented symptoms of the running down of tropical savanna function include reduced abundances and contracted distributions of granivorous birds, low populations or disappearance of small mammals even from comparatively well-resourced national parks, landscape instability and soil erosion, and prematurely dry wetlands. These losses are not the result of striking structural fragmentation familiar in longer-settled and more actively modified Australian landscapes. Rather we postulate a functionally similar but much harder to measure process: conversion of networks of resource rich patches close enough to each other and dense enough to be exploited effectively by native fauna into fewer islands of more or less reduced plenty, embedded in a degraded and harder to navigate matrix. For example, it may be that none of the important resource-producing plants have been entirely lost from or even become rare in the landscape. They often remain widely distributed and in some places remain locally abundant, but in many other places now offer resources too sparse in space or time to sustain viable local or regional populations of the dependent fauna (Woinarski et al 1992; Whitehead 2002; Woinarski et al 2003).

Some factors driving these changes in northern savannas can maintain pressure or even increase the momentum for change, independent of any additional, organised human use of landscapes for any form of production. Adverse fire regimes result from deliberate but unauthorised or poorly informed ignitions for a local purpose (Russell-Smith et al. 2007). Once initiated under the wrong circumstances such unplanned or poorly planned fires spread to damage huge areas (Yates et al. 2008). On longer time frames feral animals and weeds show the same propensity to keep spreading while also interacting strongly with other pressures. Invasive exotic plants like Gamba grass *Andropogon gayanus* exacerbate fire management problems (Rossiter et al. 2003; Rossiter-Rachor et al. 2008). Buffalo suppress perennial grasses to alter abundance of a native annual grass, *Sorghum brachypodum* which in turn shifts the tree-grass equilibrium by influencing fuel loads and hence fire severity. Just removing the buffalo is then insufficient to restore the pre-buffalo system (Werner 2005; Petty et al. 2007). Other influences, like over-grazing by domestic stock, are exacerbated by low management intensity and weak infrastructure that allows concentration of impacts (e.g. around water) or fails to limit effects on more sensitive landscape types and features (Woinarski and Ash 2002; Franklin et al. 2005).

In remote areas, including most of the Northern Territory's land area, low human density outside the major centres, difficulties of access, and limited financial resources prevents the skilled human intervention needed to check such impacts (Whitehead et al. 2002). Conventional responses, like establishing conservation lands without adding sufficient financial resources or skilled managers may create new problems. For example, some of the worst fire management in the Top End of the Northern Territory occurs in national parks (Russell-Smith et al. 2009).

In contrast, the health of river systems is generally good. Water extractions for agriculture are in general limited with few systems being over-allocated to consumptive use. The few demonstrably over-allocated systems or those altered by large impoundments are most often used for delivery of domestic water to urban populations. Exotic aquatic plants and animals are relatively few and impacts local rather than widespread. This situation may be set to change with the cautious approach to management entrained by the National Water Initiative (see Sections 8.1.3.7 and 8.3.6 below) gradually giving way to more optimistic approaches to allocation. An illustration of greater environmental risk tolerance includes the recent decision of the Northern Territory Controller of Waters to use shorter periods of rainfall records to estimate variability and hence probability of years of unusually low flows (Applegate 2013).

Clearly there is great scope and need for improved management of northern landscapes. Demands for better performance will increase with accelerated northern development.

6.2 Cultural Heritage

Given particular connections of natural heritage to social and cultural matters, and the powerful influence of culture on conservation philosophy and practice, it may seem misguided to consider cultural heritage separately. However, the institutional reality is that they are viewed and managed in different ways in contemporary society, and our treatment of context for DbD needs to consider the implications of this institutional separation and deal effectively with it.

6.2.1 Indigenous heritage

To begin, it is important to reiterate that, despite often parlous socioeconomic conditions in remote areas (e.g. Whitehead et al. 2009), many Indigenous people remain strongly committed to living on their ancestral lands. Attachment to place may sometimes be influenced by assessment of the relative saleability of skills in competitive employment markets or the socioeconomic costs of residing at larger centres, but is likely to be more strongly determined by the pull of family connection and strong cultural obligations that contribute to non-economic aspects of well-being (Biddle and Sweet 2012).

Drawing reliable livelihoods from hunting and gathering in diverse tropical landscapes in which are embedded sometimes extraordinarily rich, albeit spatially patchy and seasonally variable resources, has not demanded elaborate or durable shelter or other built structures that often characterise European notions of cultural heritage. Nonetheless, north Australia is rich in tangible and intangible expressions of Indigenous heritage that warrant recognition and protection.

Tangible expressions of Indigenous heritage extend to the "natural" landscapes that contemporary conservation practice also seeks to maintain. Indigenous people undoubtedly influenced pre-settlement vegetation structure and composition and the fauna using the resultant habitats, through purposeful use of fire to favour preferred plants and animals (e.g. Russell-Smith et al. 1997; Davidson 2005; Altman 2009), facilitate access for hunting and foraging, and ease movement through the landscape (Gammage 2011), as well as meeting non-utilitarian cultural obligations. It follows that efforts to maintain natural heritage should incorporate Indigenous practice (Yibarbuk et al. 2001; Whitehead et al. 2003) and to take account of all of the motivations for adopting specific practices. Methods for applying Indigenous and situational knowledge in conjunction with formal scientifically based knowledge are increasingly available (e.g. Leidloff et al. 2013).

This sort of approach also accords with recognition of the continuous, multi-millennial presence of Indigenous people in many northern landscapes (e.g. David et al. 2011) as an example of "living cultural heritage": as a distinct set of values warranting protection. For example, descriptions of Kakadu National Park's outstanding universal value, in its World Heritage listing, refer to a living cultural landscape[6]. The success of land claims, despite daunting historical and contemporary obstacles, show that such enduring human connections with place, both utilitarian and spiritual, apply to many parts of north Australia. Arguably, these should influence decisions about development and recognition of biophysical and socio-cultural impacts, irrespective of formal recognition of such connections in existing law.

These durable connections are also reflected in objects of material culture such as tools, implements and ceremonial objects ranging in age from the ancient to the contemporary, and in numerous rock art galleries. In a few locations these galleries remain in active use. It is likely that many rock art sites remain to be formally recorded and most have no formal protection. More "transportable" physical expressions of culture in utilitarian and ceremonial objects are often protected and displayed in museums and art galleries, but often without the approval of their creators or traditional custodians.

Many Indigenous people in northern Australia continue to produce important items of material culture including visual arts and crafts, most of which continue to draw on continued connection with traditional country. Visual art in particular has built one of the few substantial and enduring connections of Indigenous people living and working in remote areas with the contemporary mainstream economy (SCECITA 2007).

Intangible cultural heritage has been defined as:

> *... the practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artifacts and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognize as part of their cultural heritage. This intangible cultural heritage, transmitted from generation to generation, is constantly recreated by communities and groups in response to their environment, their interaction with nature and their history,*

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[6] See http://whc.unesco.org/en/list/147/

and provides them with a sense of identity and continuity, thus promoting respect for cultural diversity and human creativity. (UNESCO 2003)

Among Indigenous Australians, cultural heritage includes assigning particular significance to biophysical features of landscapes and connection among them, usually associated with the actions of ancestor beings (Mulvaney and Kamminga 1999). Individuals or groups may have particular attachment to and responsibilities for particular sites, maintenance of connections among them, or for the health of populations of particular species of plants or animals. Some of these sites may have special significance for the maintenance of particular species or "natural" processes. Obligations to sites may be met in part by observance of associated ceremony. Knowledge of, access to, responsibility for and conduct of ceremony associated with some sites may be highly restricted within Indigenous society and entirely unavailable to outsiders, complicating formal protection of sites. Nonetheless, both federal and state/territory laws have been enacted for this purpose (see later).

Performance art (e.g. dance and song) derived in part from formal ceremony may be used to communicate more accessible aspects of Indigenous culture to local, national and international audiences.

Other important intangibles include the great diversity of north Australian Indigenous languages, most of which are at risk (AIATSIS and FATSILC 2005). And local language is needed for expressing accurately special obligations to country, defining phenomena of interest, and describing preferred states and processes and methods for achieving them, so that knowledge and skills can be transmitted effectively across generations. Working on country programs have become important vehicles for maintaining and transferring such knowledge (e.g. Garde et al. 2009) and, in the process, sustaining language (Hill et al. 2011). Unfortunately, the National Language Policy[7] makes no linkage of interests in sustaining language to obligations to manage landscapes.

6.2.2 Non-Indigenous heritage

Recognition of non-Indigenous heritage focuses mostly on buildings and objects associated with exploration, early settlement, the pastoral industry, and World War 2. They may also include living or dead natural objects marked by explorers or settlers and human gravesites in bush settings, but most formally recognised objects or places occur in urban or other highly modified sites. Some Indigenous heritage also includes representations of explorer or settler contact (e.g. Cooke 2009) and interactions with Macassan traders (McKnight 2011; Bilous 2011).

Many of these non-Indigenous places or objects are protected by formal heritage laws which create penalties for damage or removal, but have been much less used by Indigenous interests, probably due to concerns about loss of control over conditions of access and display (see, for example, Brown and Nicholas 2012).

Less tangible heritage in the sense of a recognisable northern non-Indigenous culture has been subject to little formal study and is compromised by origin of most non-Indigenous residents outside the region, and continuing high rates of population churn. Popular images of non-Indigenous life focus on outdoor pursuits, particularly including recreational fishing and hunting, chiefly of feral animals like pigs.

Policy and law for protection and maintenance of both Indigenous and non-Indigenous tangible heritage are considered further, later in this paper.

[7] http://arts.gov.au/indigenous/languages

6.3 Spatial patterns of contemporary land use

Broad scale patterns of land use in northern Australia based on the ALUM classification and 2006 mapping are shown in Figure 2 (map) and Figure 3 (relative areas showing north Australian savannas and Northern Territory savannas separately). Spatially dominant land uses are pastoral (on mostly leasehold properties), what has been called in these national datasets Indigenous traditional use, and conservation.

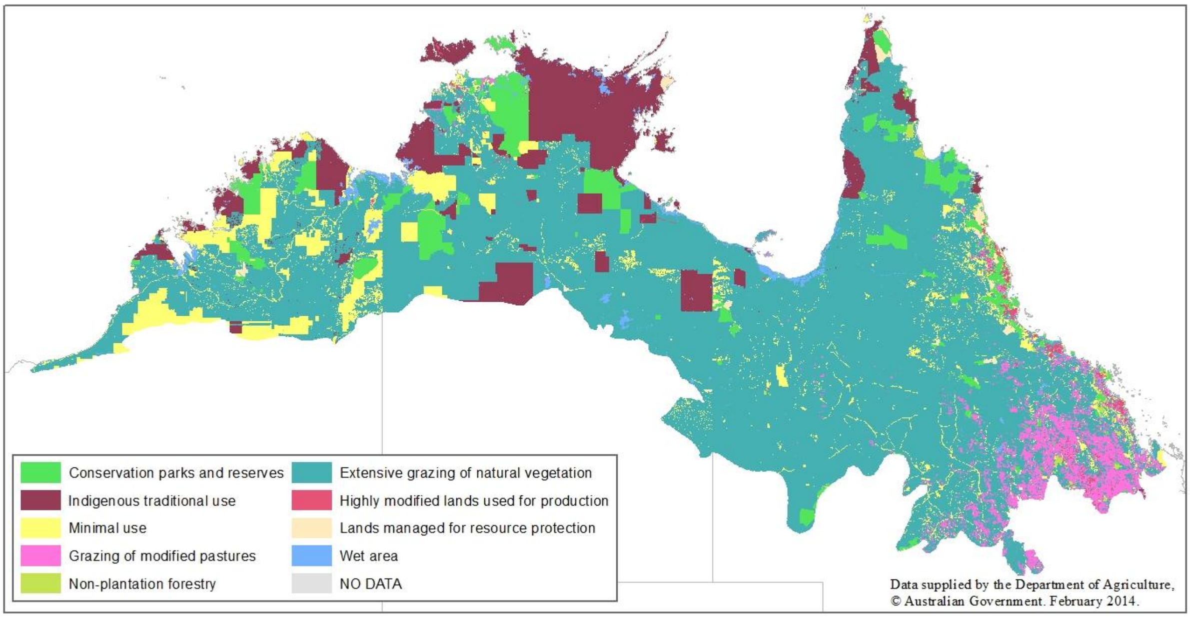

Figure 2: Map of dominant land uses in northern Australia, based on the ALUM classification and mapping up to 2006. Categories have been simplified to improve interpretability at these large scales. The map highlights the dominance of grazing lands, Indigenous lands, conservation reserves and the relatively small proportion in uses involving more intensive modification and their concentration in Queensland.

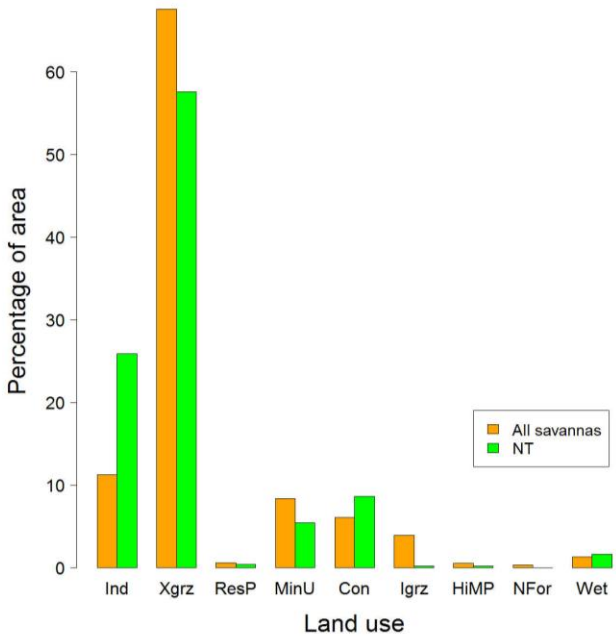

Figure 3: Relative areas of land uses in (a) north Australian savannas and (b) NT savannas. Ind=Indigenous traditional use; Xgrz=extensive grazing of native pastures, Resp=resource protection, MinU=minimum use; Con=parks and reserves, Igrz=more intensive grazing of modified pastures; HiMP=Highly modified (cropping and horticulture including irrigated); NFor=native forestry; Wet=wetlands and waterbodies. The proportion of land shown as Indigenous use is smaller than Indigenous ownership because Indigenous lands are also included in categories for reserves, extensive grazing and other uses.

The Northern Territory has a relatively larger amount of land held and used by Indigenous people under inalienable title, mostly granted under federal Aboriginal land rights law. In the savannas as a whole, areas presently under irrigated agriculture and other highly intensive (e.g. urban) uses are relatively small (Figure 3) despite some substantial scale agricultural developments like the Ord River in Western Australia and the Burdekin region of Queensland. Additional major developments in irrigated agriculture are proposed, with active planning underway for in increased agricultural use of the Gilbert and Flinders Rivers catchments in Queensland (see Petheram et al. 2013a,b) and the extension of development driven by the Ord River scheme into the north western (Keep River) region of the Northern Territory (Figure 2).

It is important to note that consideration of these large scale land use categorisations tend to de-emphasise mining and other resource extraction activities (Figure 4). With the exception of bauxite mining at Nhulunbuy (NT) and Weipa (Queensland), and some larger iron ore extractions, mines or wells active at a given time operate intensively and cause substantial disturbance in relatively tiny proportions of the landscape compared with other land use. However, they have the potential to have enduring and cumulative impacts on large areas, sometimes distant from their intensive local operations (see Sections 6.3.1.7 and 6.4.6 below).

From the perspectives of natural and cultural heritage custodians and managers, the particular significance of mineral, petroleum and gas extraction derives from the potential to enter new areas with few or no formal obligations to consider the concerns of land owners or the wider community. Ubiquity of access is illustrated by the map of exploration leases and areas presently reserved from mining at Figure 9 below. The fact that national parks in the Northern Territory are open to mining as a matter of routine under Territory law illustrates the longstanding and bipartisan support for primacy of this activity over other interests. Holders of title under the *Aboriginal Land Rights (Northern Territory) Act* 1976 are arguably in the strongest position to exclude mining, but rights have been weakened in the past (amendments to ALRA in 1980) but remain subject to recurring criticism from industry and Territory governments.

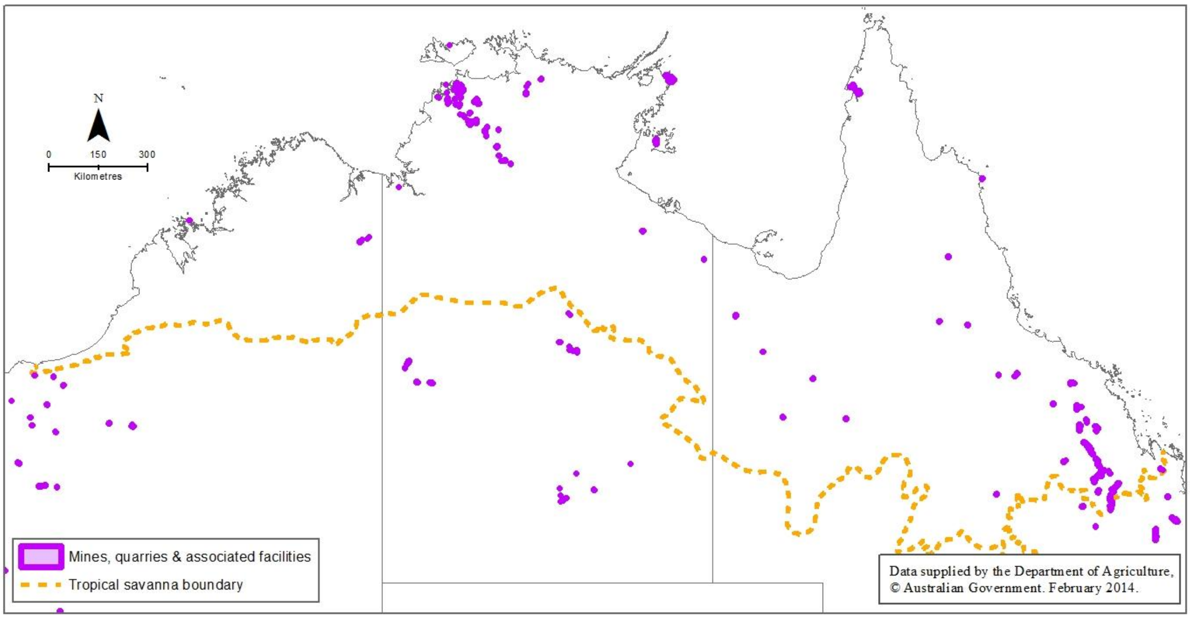

Figure 4: Location of mines, quarries and associated facilities taken from the Land Use of Australia, Version 4, 2005-06 dataset. This map is provided only to illustrate the general distribution of past mining activity (to 2006) in northern Australia. It should noted that points shown are not to scale.

6.3.1 Contemporary land use and status of natural and cultural heritage

In briefly summarising the status of the natural and cultural heritage of northern Australia, we have already touched on factors influencing that status. More comprehensive assessments of impacts of these patterns of use on the biophysical status of northern landscapes have been done in a number of ways.

6.3.1.1 Pastoral estate

Woinarski et al. (2007) suggested, by way of a global comparison, that relatively low average densities of managed herbivores and humans drawing on savannas for livelihoods limited damage. They suggested that north Australian savannas were likely to have retained relatively high integrity. Substantial areas of woodlands were, however, scored in their analysis as modified, predominantly due to commercial grazing.

Direct and indirect impacts of grazing animals on biodiversity are well documented. At the northern Australian scale, Franklin et al. (2003) found more severe declines of granivorous birds in areas of greater stock density. At the property scale, Woinarski and Ash (2002) and Woinarski et al. (2002) showed marked cross-fence differences in fauna between grazed and ungrazed sites, with some species decreasing in abundance and others, those favoured by disturbance, increasing.

Mechanisms driving on site change in biodiversity values include suppression of perennial grasses (Fensham and Skull 1999; Crowley and Garnett 2001) that produce important resources for wildlife (Dostine et al. 2001; Dostine and Franklin 2002), loss of shelter for taxa dependent on ground cover (Woinarski and Ash 2002; Kutt and Woinarski 2007), and increased woodiness of habitats (Kutt and Martin 2010; Carr et al. 2012).

In very poorly-managed and heavily over-grazed sites, loss of vegetation cover may compromise landscape stability, damage soil structure and function, and leak nutrients to damage on-site productivity and contribute to pollution of waters (Freudenberger et al. 1997). The potential scale of offsite impacts associated with changes in water quality are illustrated by effects of land use practice in the Burdekin and associated catchments on the Great Barrier Reef (McCulloch et al. 2003; Fabricius et al. 2014). Many of north Australia's worst plant pests were introduced to support pastoralism (Lonsdale 1994; Cook and Dias 2006; Edwards et al. 2004; Legge et al. 2011): introductions and spread continue. Changes in fire regimes designed to protect pasture or dictated by low fuel loads reduced by grazing are common. At least some of these grazing-related pressures may lead to structural change (Ludwig et al. 2001; Liedloff et al. 2001) which in some cases may be difficult or impossible to reverse (Sharp and Whittaker 2003; Rossiter et al. 2003; Werner 2005; Werner et al. 2006).

In sum, managed pastoral use, at the intensities observed over much of north Australia, has variable but sometimes substantial impacts on ecological function. And it has those effects over extraordinarily large areas, given this activity's spatial dominance (Figure 2 aboveand Figure 3 above). Direct effects are exacerbated by incidental or interacting factors like concomitant intrusions of unmanaged invasive animals and plants (Radford et al. 2014). Restoration of ecological function in more damaged areas will often require active rehabilitation as well as reduction or removal of grazing pressure.

Unfortunately, obligations of the Northern Territory Pastoral Lands Board to report regularly on condition of pastoral lands have recently been observed mostly in the breach. Monitoring is acknowledged to be inadequate and annual reports provide no meaningful data-backed assessment of trends in condition of these public lands at any scale (e.g. PLB undated). Nonetheless, areas identified as being of high conservation value have been documented on large areas of pastoral land (Ward and Harrison 2009; Harrison et al. 2009).

6.3.1.2 Indigenous traditional use

Indigenous use and management of lands and resources undoubtedly caused change and then maintained non-equilibrium and hence "unnatural" systems in the past (e.g. Gammage 2012), but has been so long established that contemporary conservation goals often aim at the situation at the time of European settlement (Yibarbuk et al. 2001). Some conservation laws refer explicitly to time of settlement as a baseline (see below).

In northern Australia, one of the most severe environmental management problems on all lands, namely wildfire, is due to the withdrawal, displacement or other weakening of Indigenous management (Russell-Smith et al. 2009). Restoring Indigenous management coupled with financial incentives to focus on fire has driven durable improvement in fire management over very large areas of high conservation value lands (Figure 5).

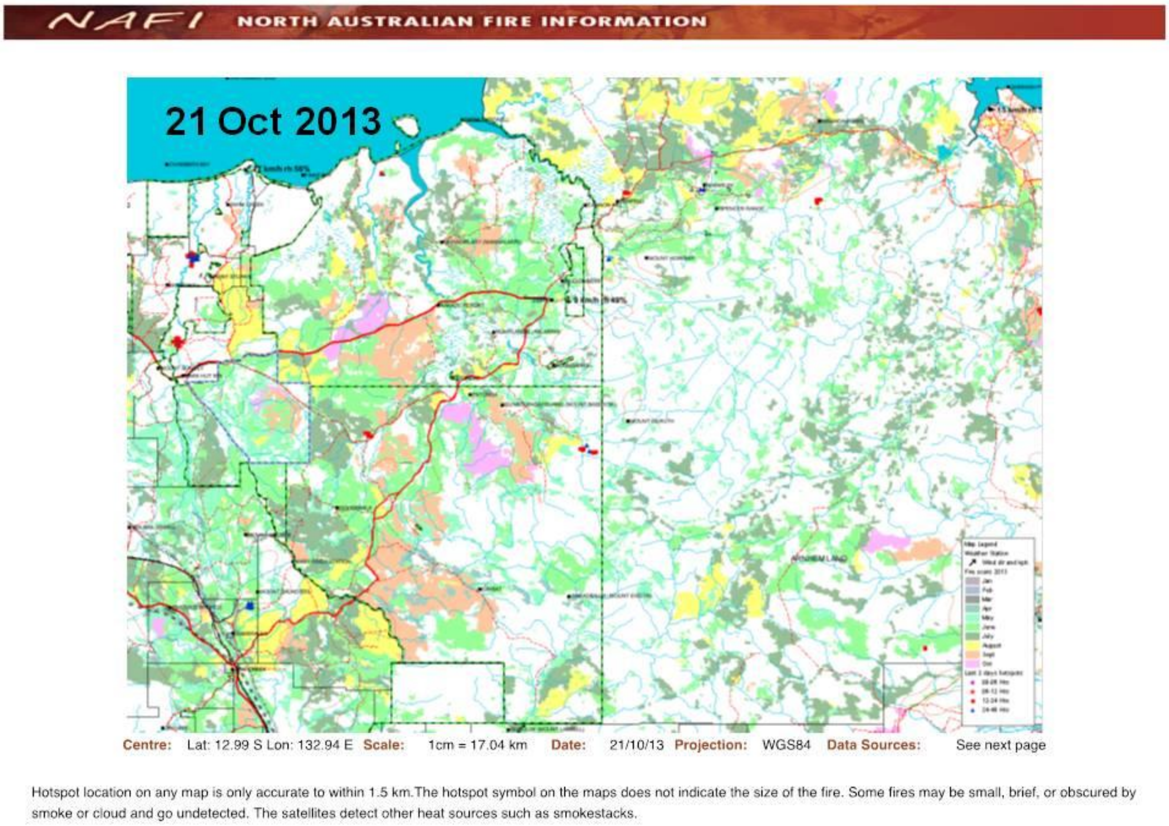

Figure 5: "Snapshot" of fire affected areas in Kakadu National Park and the adjacent WALFA project area (immediately east of the Kakadu boundary at the vertical dotted line in the centre of the figure) showing the contrasting fire regimes mapped for the 2013 calendar year. Taken from the NAFI website http://www.firenorth.org.au/nafi2/. Coloured areas are mapped fire scars and yellows browns and purples show later more severe fires.

Although precise figures are not available by land tenure, very little Indigenous-owned land appears to have been cleared of native vegetation or otherwise undergone significant structural modification anywhere in the north, except on the Tiwi Islands, where substantial areas have been cleared over several decades for plantation forestry. Most recently 30,000 ha's including areas of high conservation value Eucalypt forests were cleared for *Acacia mangium* plantations (van Osterzee and Garnett 2008).

Large areas of Indigenous land used for managed grazing are probably subject to the same sorts of loss of natural heritage values observed on other pastoral lands. Elsewhere (e.g in parts of Arnhem Land in the Northern Territory), large areas are also impacted, sometimes heavily, by unmanaged feral stock. These populations may be harvested for commercial returns and more often for subsistence and are valued by Indigenous people for their multiple contributions to livelihoods (Robinson et al. 2005).

In addition to introduced animals, contemporary Indigenous land managers are required to cope with an increasing array of highly invasive plants (grasses and woody species) that compromise natural and cultural heritage values in savannas and wetlands (Smith 2001). Many of these species threaten abundance of and access to native plants and animals harvested by Indigenous people as important contributions to livelihoods (Altman 1987, 2003).

Harvest of native wildlife for subsistence is probably more common on Indigenous-owned than on other lands, although rights to use wildlife for traditional purposes can be recognised on other lands under the Cwlth *Native Title Act* and are protected to varying degrees under state and territory laws. Indigenous landowners have no special rights to use native species commercially and so require permits from state/territory regulators and, if products are intended for export or associated with matters national environmental significance, federal government approval as well. Perhaps due to the distaste with which some view any commercial use of wildlife, commercial projects are sometimes saddled with absurdly onerous conditions that appear have nothing to do with sustainability (Whitehead 2000; Whitehead and Storrs 2003). On the other hand, regulators take a relatively relaxed view of use of parts of native plants in art works.

The few detailed studies of Indigenous subsistence use in the NT indicate that such use is sustainable (e.g. Brook and Whitehead 2005a,b), which, given a long history of use, is unsurprising when important aspects of traditional practice are maintained and wildlife habitats remain in good condition. Sustainability of harvests of dugong in the Torres Strait have been questioned (Heinsohn et al. 2004) but conclusions are compromised (McNiven and Beddingfield 2008) by difficulties in accurately determining total population size, the size and origin of the harvested population(s) (Marsh et al 2004), and difficulties in estimating some life history parameters (Kwan 2002).

Commercial use has the potential to add to pressure on harvested populations. Well-designed harvests of crocodiles appear to have no impact on populations on Indigenous lands or elsewhere (Fukuda et al. 2011). Moreover, prior to emergence of problems, some Indigenous organisations have sought support to examine sustainability of harvesting woody stems for carvings to be offered for sale (e.g. Koenig et al. 2005, 2011). This experience points to the potential value of co-management arrangements (Faust and Smardon 2001), given that central authorities distant from remote harvest sites will struggle to assert orthodox top down controls (Whitehead and Storrs 2003).

A number of major mines are located on or within the boundaries of Indigenous lands (e.g. ERA uranium mine at Jabiru, Pacific Aluminium at Nhulunbuy, Mt Todd near Edith River: Figure 6) and more have been proposed (e.g. the Aurukun bauxite deposit on Cape York). Experience in many locations shows that even major local developments can fail to deliver social benefits. Proximity to major mines has made no difference to the socioeconomic status of local Indigenous people over periods of up to several decades or actually generated net costs for local communities (Taylor 1999; Taylor and Scambary 2005), a pattern which is commonly observed in resource-rich regions and nations (see later).

Extractive industries may raise profound concerns about damage to landscapes in ways that confront peoples' views of their origins, obligations and risks of reactions from ancestor beings (e.g.

Lane et al. 2003). Arguably, contemporary treatment of such concerns, such as the Henderson government's decision to change the law to expedite expansion of the McArthur River mine by river diversion (Howell 2008), contributes to vehement rejection of applications to explore by some Indigenous landowners[8]. Concerns of traditional owners of Groote Eylandt led to a moratorium on seabed mining by the previous government, pending formal examination by the (then) Environment Protection Authority (NTG 2012), The present government subsequently "banned" seabed mining in waters around Groote Eylandt[9], although the area has not been formally reserved from mining (see Figure 9 below).

Areas of Indigenous land are likely to increase as existing and new claims work their way through rigorous native title and land rights processes (see below), as will demand to access them for various purposes.

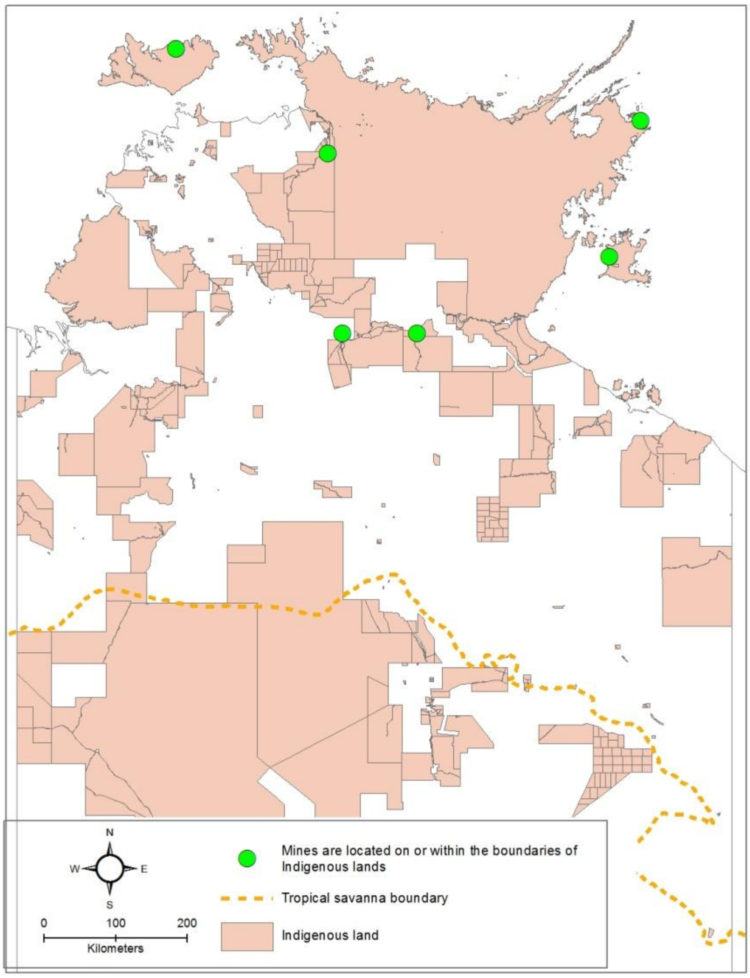

Figure 6: Mines within or on the margins of Indigenous land holdings.

[8] See http://www.abc.net.au/news/2014-03-19/maningrida-traditional-owners-flag-high-court-action-on-fracking/5332042?section=nt

[9] http://www.abc.net.au/news/2013-06-13/alison-anderson-seabed-mining/4751676

6.3.1.3 Conservation lands

In 2006, conservation lands made up 6.1% of north Australian and 8.6% of Territory savannas (Figure 3 above). A large proportion are Indigenous owned, including a number of areas managed through joint or co-management systems. Some sites included in these figures are Indigenous Protected Areas (IPAs), which are not formally declared under relevant law but run in accordance with management plans agreed with the federal government. Agreements are supported by modest federal government funding and sometimes by additional non-government environmental organisations. In general reserves are located in areas of low pastoral or other agricultural potential, including more broken topography.

The level of formal protection from disturbance offered by inclusion in the protected areas estate varies among jurisdictions and according to the underlying tenure. Arguably, formally declared reserves sited on Indigenous lands held under inalienable title and declared under federal law offer the strongest formal safeguards. But formal recognition does not in itself guarantee high quality management. Funding of the Australian protected lands network is regarded as generally inadequate (SCECITA 2007) and responsible agencies fail to measure and report performance in delivering on goals in formal management plans (ANAO 2002). Paradoxically, given the legislated intent of public expenditure on parks, it is therefore just as difficult to make evidence-backed statements about condition of land and natural resources on parks as on pastoral lands.

However, it is clear that many parks in northern Australia struggle to meet stated management goals. Fire management on three of north Australia's most significant protected areas is arguably worse than on most surrounding lands, irrespective of intended use (Russell-Smith et al. 2009). Small mammals appear to be continuing a long term decline across the north that may be as bad or worse in government-managed conservation areas as elsewhere (Woinarski et al. 2001, 2010, 2011). Feral animals often remain abundant in parks and little progress has been made in demonstrating the benefits of control in terms of values the reserves were created to protect (Bradshaw et al. 2007). There are important exceptions to these disappointing generalisations in the very successful program for control of the thorny shrub *Mimosa pigra* in Kakadu National Park (Boustead 2009, pp. 42-43).

In jointly-managed reserves, management performance may be challenged by divergent views on both objectives and good management practice (Lawrence 2000; Robinson et al. 2005). A good illustration of challenges is available in the fire management performance of the Indigenous-owned Kakadu National Park and the adjoining Indigenous-owned Western Arnhem Land Fire Abatement project area. The plan of management for Kakadu commits (predominantly non-Indigenous) management to use Indigenous methods for fire management. However, a substantially larger proportion of the park is burned each year than in Indigenous-run WALFA (Cameron Yates, unpublished data), skewing fire frequencies at more sites in Kakadu (Figure 7) to levels at which damage to biodiversity values appears inevitable (Woinarski et al. 2010). The general principle, based on Indigenous practice, of beginning prescribed burning early and conducting it strategically appears to have been implemented in such a way as to lead to more fire rather than less.

As budgets continue to contract, effort available to reserve managers appears to be increasingly skewed to visitor management. Some of the less formal structures like IPAs or sites managed by environmental NGOs may be less influenced by visitor pressures and so able to maintain focus on conservation activities, despite relatively modest funding.

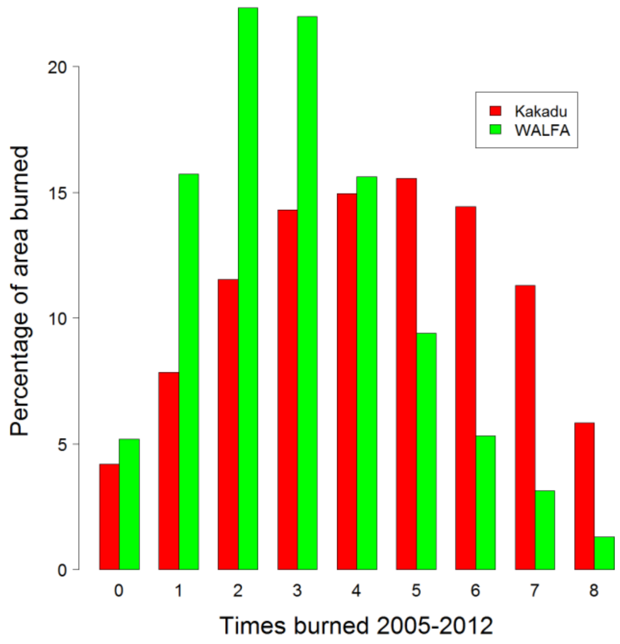

Figure 7: Variation in relative frequencies of fire in all non -floodplain sites in Kakadu National park over the period 2005-2012, compared with the neighbouring Indigenous-managed West Arnhem Land Fire Abatement project. Much more of the area of WALFA is burned at lower frequencies (e.g. 43.2% at 1 year in 4 or less) than Kakadu (23.6%). The total area of non-floodplain vegetation in Kakadu is 14379 km2.Taken from NIES 2014 with permission.

6.3.1.4 Minimum use (including Defence)

The minimum use category is comparable in size with the conservation estate (Figure 3). Much of the area is Defence land, used not for production but for training and associated military exercises, including use of live ammunition and aerial bombing practice. CSIRO studies several decades ago showed that Defence lands provided important refuges for some species, despite this sort of activity (Bell 1985). A 2008 audit (McKinsey and Company 2009) recommended consolidation of the "fragmented" estate into consolidated "superbases" which would probably compromise its present conservation value, but there have been no substantial steps to take up this option. Indeed, proposals have been made to expand the Defence presence in north Australia, which may lead to increases in the size of the northern Defence estate (Anon. 2013).

Defence provide little contemporary information on the natural or cultural heritage condition of their estate, although they have typically have well-developed systems for specifying objectives and requirements to deliver them. Compliance with the Cwlth *Environmental Protection and Biodiversity Conservation Act* is required on all Commonwealth lands, including the Defence estate. This means that non-routine activities like major exercises are subject to environmental assessment and steps to mitigate identified risks (see for example Aurecon 2012).

Yates and Russell-Smith (2003) showed that the Bradshaw Station Defence training area was subject to high fire frequencies, most notably in sandstone habitats that support high levels of obligate seeder species requiring long fire free intervals to maintain populations. As noted earlier, Woinarski and Ash (2002) found that military use at the Townsville Field Training Area was relatively benign compared with pastoral use of an adjoining property.

For achieving conservation goals, the Defence estate in north Australia and the Northern Territory savannas in particular adds an important layer of lands buffered against most types of development because of their obvious incompatibility with military use. For obvious reasons, mining is often excluded from the Defence estate (Figure 9 below), greatly enhancing long term security of such areas.

This classification also includes stock routes, as well as other areas held by governments that have not been available for production (often because unsuitable) but provide some protection for natural values, without being declared as reserves. Quality of management is likely to vary markedly, with feral animal and invasive plant management often weak.

6.3.1.5 Cropping, including horticulture

Areas subject to intensive agricultural uses take up a small proportion of total lands. Figure 8 below shows areas designated in the Australian land use classification as used for irrigated and rainfed agriculture in the Northern Territory. Much of the area is likely to be used for relatively low value crops, especially hay. During 2012-13 production from hay made up most (95%) of the modest value of crops (DPIF 2014) and used most of the area devoted to crop production.

Even though presently relatively small in extent, irrigated cropping areas in particular may cause disproportionate off-site problems through their use of water and associated pollution. Inputs like fertiliser and pesticides and mobilised sediments enter associated streams and ultimately neighbouring seas. We have already alluded to the problems seen in the Burdekin catchment, where sediment and nutrient movements from agricultural lands are contributing to damage to the Great Barrier Reef (McCulloch et al. 2003; Fabricius et al. 2014), with substantial inputs of sediment from irrigated sugar cane (Visser et al. 2007). Studies in the much less intensively developed Daly River (NT) catchment, on the other hand, show little contribution of agriculture (irrigated or otherwise) to riverine sediments (Wasson et al. 2010). The Daly River has smaller areas under development and presently no sugar cane. There is little evidence of impacts on the Arafura and Timor seas from sediments originating along the northern Australian coast (Alongi et al. 2013).

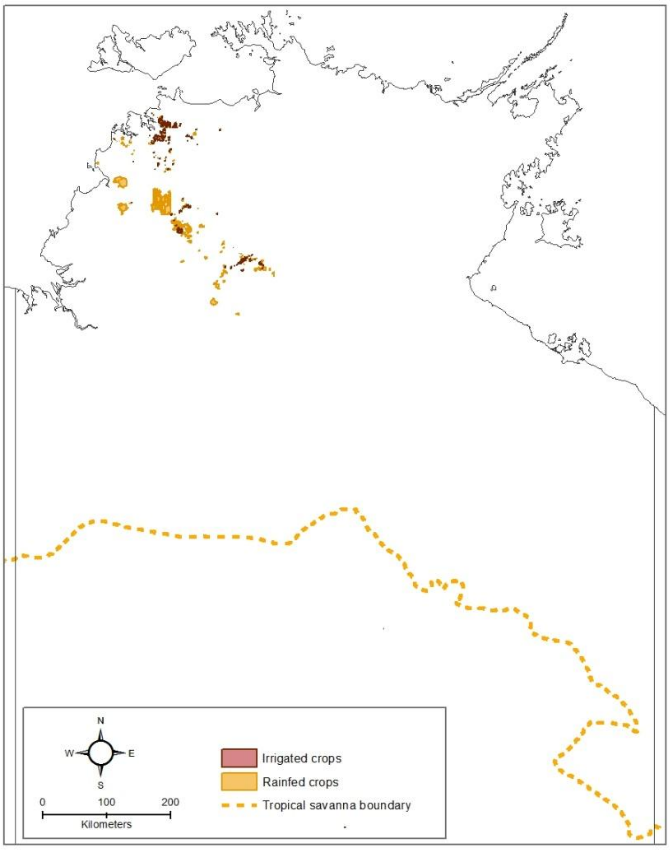

Figure 8: Areas of the Northern Territory used for rainfed and irrigated agriculture, using data and classifications from the Australian Land Use Map. Activity is concentrated in the Daly River catchment and in the Adelaide and Finniss River catchments near Darwin.

Indirect effects extend to on site destruction of and demands to suppress populations of abundant native wildlife that may consume or otherwise damage crops (e.g. Whitehead 1991; Marcsik and Clarke 1997), including pasture grasses[10].

6.3.1.6 Resource protection

This categorisation includes largely unmodified sites managed to provide "a sustainable flow of natural products and services". We have already considered the Indigenous traditional use component of this category. An important class of use in this set is protection of water catchments. Although these additional areas make up a very small proportion of total lands (category ResP in Figure 3 above), the catchment protection components in particular make useful contributions to conservation because they provide durable protection in areas that might otherwise be subject to agricultural or residential development. The proportion of the landscape devoted to these sorts of uses (aside from Indigenous title) is unlikely to increase much in the near to mid-term.

6.3.1.7 Mining and other extraction

We have not attempted to map mining sites to scale in conjunction with other uses because their sizes are mostly too small for meaningful presentation. However, there are many of them, spread patchily through the northern savannas (Figure 4).

Most of these sites will have experienced extreme disturbance necessarily involved in extraction of many minerals. Physical disturbance has in the past damaged culturally important sites, including sacred sites. However, much of the risk associated with mining activity comes from the risk of offsite effects through water- or air-borne pollution, competition with other users or the environment for water for on-site processing and development of infrastructure. Risks to other values are intensified because landholders have limited influence over the presence, scale or many aspects of design of mines or other extractive facilities on their land. Relatively small areas have been reserved from mining under Northern Territory law, and many of these are Defence lands (Figure 9). There are few areas reserved on conservation grounds.

Some post-extraction mining processes (e.g. heap leaching using cyanide) directly expose wildlife to risk of poisoning. Related mine wastes may be toxic and their secure long term storage in tailings dams and the like can be challenging in the extreme weather conditions experienced in many parts of northern Australia. One of the more significant impacts of large scale hard rock mines common in north Australia is acid drainage. Oxidation of sulphides in waste rock lowers pH of waters which in turn mobilises heavy metals. These processes can continue for very long periods. Pollutants may be carried long distances through stream flow, killing or debilitating wildlife (including plants) and sometimes accumulating in species consumed by humans (Markich et al. 2001).

There have been few reports of significant impacts of such pollution on wildlife in north Australia and none on humans, arguably because insufficient effort is made to monitor and, more particularly, publicly report impacts. The Rum Jungle uranium mine, where mining stopped more than 50 years ago and all related operations ceased in the early 1970s (Laurencont 2013), severely damaged in stream fauna of the Finniss River (e.g. Jeffree and Twining 1992) and contaminated 100 km^2 of floodplain. Heavy metal levels (including radio-nuclides: Mudd and Patterson 2010) remain high within the stream and overbank areas (Taylor 2007). It is probable that people who demonstrated ongoing connections to the site in their successful land claims harvested fish or other aquatic fauna from affected sites without full awareness of the nature and scale of pollution. This legacy mine continues to pose major problems and generate costs, despite repeated bouts of remedial work and large expenditures (Mudd and Patterson 2010; Laurencont 2013).

[10] http://riel.cdu.edu.au/blog/2014/07/protecting-vulnerable-land-from-high-wallaby-densities-in-the-spotlight/

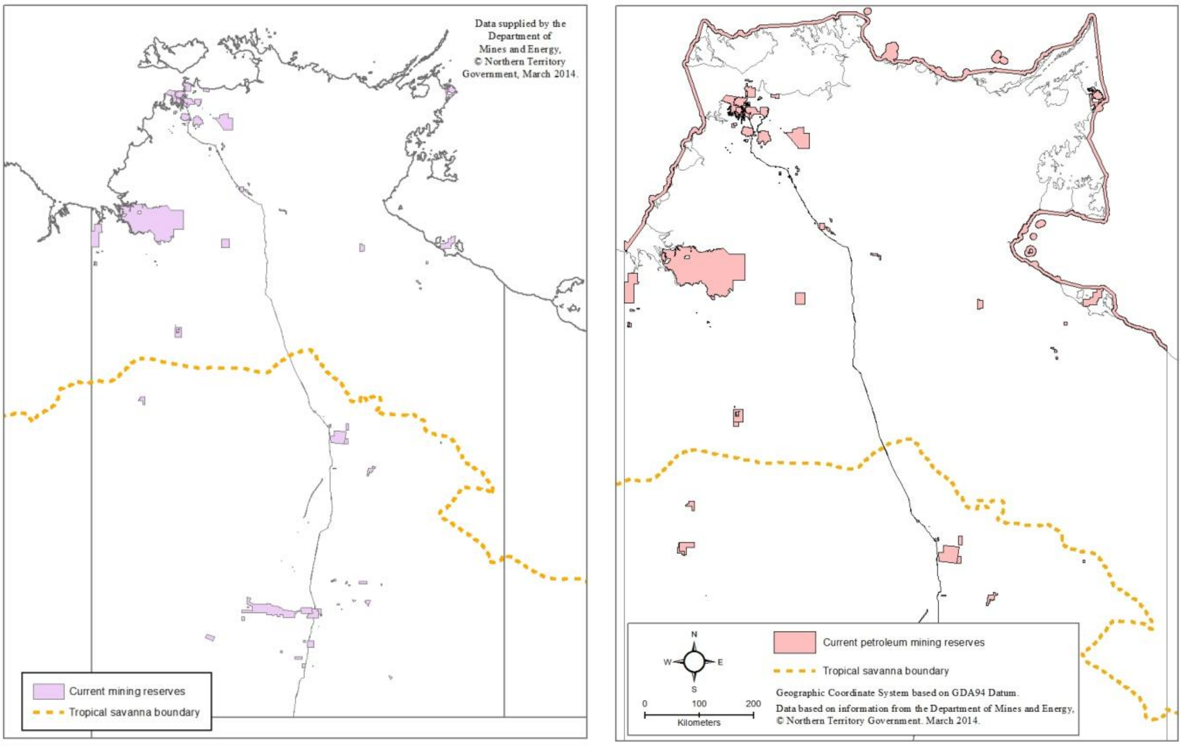

Figure 9: Map of areas presently reserved from mineral extraction and petroleum (oil and gas extraction) in the Northern Territory as specified under Territory law.

Monitoring and reporting of mining impacts is done to high standards in Kakadu National Park, where the Office of the Supervising Scientist was established to monitor, report and make recommendations for improved practice. Despite this oversight, mostly relatively minor failures of systems and equipment recur frequently enough to cause concern for traditional owners of lands around the Energy Resources Australia (a subsidiary of Rio Tinto) uranium mine near Jabiru. Older (mid-20th Century) mine shafts in southern Kakadu also continue to cause localised acid drainage problems but have been deemed not to require rehabilitation.

Usage of water for mines can be substantial and allocations are usually made outside formal water allocation planning processes. In many parts of north Australia, water markets do not operate effectively (Nikolakis and Grafton 2009) and mines may be unable to buy allocations even if the economics of the proposed operations made this plausible. It follows that substantial mining developments in regions where water use is already substantial will increase the risk of over-allocation or conflict with other use.

Arguably, the direct cumulative impacts of mining on the natural heritage of north Australia, including the Northern Territory, has been less significant than the less intensive but longstanding and ubiquitous impacts of pastoralism. However, mining exploration is ongoing, substantially subsidised by publicly funded geological survey and promoted by governments. Even with a weakening of the mining boom of the last couple of decades, there will be at least incremental increases in the number of active mines and other extractions in north Australia. The extreme difficulties experienced in managing many legacy mines suggest that there will be net increases in the number of sites requiring rehabilitation and increasing (cumulative) impacts on landscapes and waterways. Major new developments and widespread, multi-loci intrusions associated with unconventional gas and oil extraction (including fracking) are also plausible.

6.3.1.8 Summary and conclusion

Woinarski et al. (2013) assessed the status of biodiversity across sites in the Northern Territory using broad surveys of vertebrates conducted at different times but to the same general design. Sites were categorised as pastoral, Indigenous or conservation lands and variation among these categories considered in statistical models that also used rainfall, year of survey and rockiness as predictors. The authors concluded that there was a small but significant effect of tenure on vertebrate species richness and abundance.

However, the most striking result is arguably the slight and inconsistent variation among tenures for different taxa. The study could not be treated as a serious examination of the status of lands under different tenures, being weakened by, *inter alia,* strong inter-correlation of explanatory variables, the bias of mainland surveys to Kakadu National Park and the inclusion of sometimes small islands in the Indigenous category. Kakadu's role is particularly germane because the authors reject the obvious notion that results are influenced by initial selection for sites of reserves on their inherently greater diversity. Given the size of the Kakadu sample and its likely influence, this suggestion would seem to fly in the face of the arguments put for Kakadu's listing as a World Heritage site.

Franklin et al. (2008) found that burning was earlier and weediness was worse on European tenures, and feral animal damage worse on Indigenous tenures, and drew attention to the need to take account of the influence of management history. Earlier studies of Russell-Smith and Bowman (1992) found that weeds, feral animals and fire were adversely affecting rainforest isolates on all tenures.

Similarly, in our brief and incomplete scan of resource condition and management issues on lands subject to different uses, we have shown that all tenure and use types face often diffuse but widespread as well as sometimes intense management pressures. These demand responses tailored to their individual biophysical, institutional and social contexts. Conservation gains can be realised on all tenures by improved management.

The recent report of the Joint Select Committee on Northern Australia (JSCNA 2014) endorses the notion that north Australia is ripe for accelerated development and makes numerous recommendations to, *inter alia*, establish a Department of Northern Development; accelerate infrastructure programs in road, rail, ports and airports and water development; offer incentives for graduates to work in northern Australia; support Indigenous employment programs; frame a 20-year agriculture development strategy addressing regulatory constraints; improve access to land, including Indigenous land; and "harmonise" environmental regulation.

As in the past, realising ambitions for northern development will be slowed by the realities of harsh climate, poor soils, a weak infrastructure base on which to build and sparse human and financial capital. Nonetheless, coincidence of this push with new opportunities in unconventional gas; proximity to threshold levels of activity sufficient to justify private investments in major processing facilities for beef and other agricultural products; a determination of Indigenous interests to connect better to the mainstream economy and escape welfare dependence; and the prospect of greater Asian investment are likely to drive some acceleration in rates of change.

6.4 Important processes

The preceding treatment of the present status of natural and cultural heritage on lands under different use has identified a number of key processes impacting values. Here we consider likely trends in the significance of those pressures and identify some potential responses.

6.4.1 grazing

Few parts of northern Australia savannas are entirely free from grazing by exotic herbivores. In some locations grazing pressure from domestic stock is well managed to maintain landscape stability and soil condition; in others management is weaker, allowing over-grazing or intrusion of stock into sites that are unsuitable for grazing. In many areas, including some of those set aside for conservation, exotic herbivores are all but unmanaged and so cause significant damage to landscapes, soils, waters and their productivity.

Grazing pressures from exotic herbivores are probably as high now in the Australian savannas as they have ever been. Where feral animal densities have been reduced they have been replaced by managed cattle (Bastin and ACRIS Management Committee 2008). For example, the abundant buffalo removed from the Oenpelli floodplains under the BTEC program (see Robinson and Whitehead 2005 for a description of BTEC) have been replaced by agisted cattle.

Intensity of use of sites favourable for pastoralism is likely to increase with better management infrastructure, including improved fencing, modified pastures including irrigated pasture (Grice et al. 2013) and or/more watering points. These improvements will often be accompanied by increased removal of native vegetation and consequent loss of plant diversity. The simplification (lower grass species diversity) of improved pastures will reduce resources for many fauna (e.g. Whitehead 2000; Ferdinands et al. 2005).

Recently completed studies indicate that the additional areas suitable for intensification of this sort are a relatively small part of the huge expanses of the savannas (Petheram et al. 2013; Grice et al. 2013). Impacts on natural heritage from increased intensity of use of the most favourable sites can be ameliorated by managing the less favourable parts of the landscape more carefully, in some cases entirely eliminating exotic herbivores. Indeed, given the huge populations of feral animals and weak management of grazing in some areas, scope probably exists to produce net benefits if increased intensity and quality of management of favourable sites is accompanied by more intense and skilful management of the matrix to favour natural heritage values.

6.4.2 land clearing

Outside the northern tropics, Australia has seen, over its relatively short post-settlement history, an extraordinary rate of land clearing, extending into areas that have proven to be at best marginal for agricultural production. Rates of clearing remained very high until late in the 20th Century, when all of the Australian states tightened restrictions. The change after 1990 was sufficiently acute for Australia was able to continue to increase substantially its greenhouse gas emissions from industry and other major polluters and yet meet its commitments by reductions in emissions from land use change. The infamous "Australia clause" in the Kyoto Protocol was the vehicle for this windfall (Hohn et al. 2007).

The OECD, based on information provided by the Australian government in 2007, reported that "(a)ll Australian governments have agreed to stop loss of native vegetation through land clearing, long the chief threat to biodiversity in Australia" (OECD 2008, p. 21). The statements made to the OECD appear to have been misleading or misinterpreted, at least in respect of Queensland and the Northern Territory (see Figure 10 and 0 above), where substantial areas continued to be cleared. It is difficult to see how this clearing constitutes anything but a continued loss of native vegetation. The Australian Government's statements at the time perhaps reflected an expectation that northern

Australia would not be permitted to repeat the extraordinary levels of broad scale land clearing for agriculture seen in longer settled parts of Australia.

If that was the intent, the prognosis appears to have changed with renewed interest in large scale northern agricultural development (CoA 2014). For example, the Queensland Government has recently relaxed its vegetation clearing and river protection laws (through the *Land, Water and Other Legislation Amendment Act* 2013) and the present (2014) Northern Territory Government has withdrawn from consideration draft legislation for stronger controls on native clearing developed in 2010. Formal statements from the Commonwealth Government in connection with its Asian Century White Paper (Australian Government 2012) raise prospects of "broadacre" cropping in the north as targets for investors from mainland China (DFAT 2012). Indigenous land-use rights and environmental management are described as "sensitive issues (that) will need managing". Proposals for large scale operations requiring large water allocations and new water impoundments have already been developed[11].

Many land uses, like the pasture improvement already discussed, have very direct impacts because their orthodox application requires the removal of all or part of the native vegetation from the development site. A measure of total areas cleared of native vegetation can be inferred from the various land uses shown in Figure 2 and Figure 3. Uses like cropping usually require clearing of most native vegetation, and grazing of improved pastures is accompanied by extensive clearing to reduce competition of introduced pastures with native plants. Most clearing has been done in pastoral regions for improved pastures and on freehold land for rain-fed and irrigated agriculture (the uses labelled Igrz and HiMP in Figure 3 above). In 2006 these constituted only 4.4% of the total area of the north Australian savannas and less than 0.5% of the Northern Territory's land area.

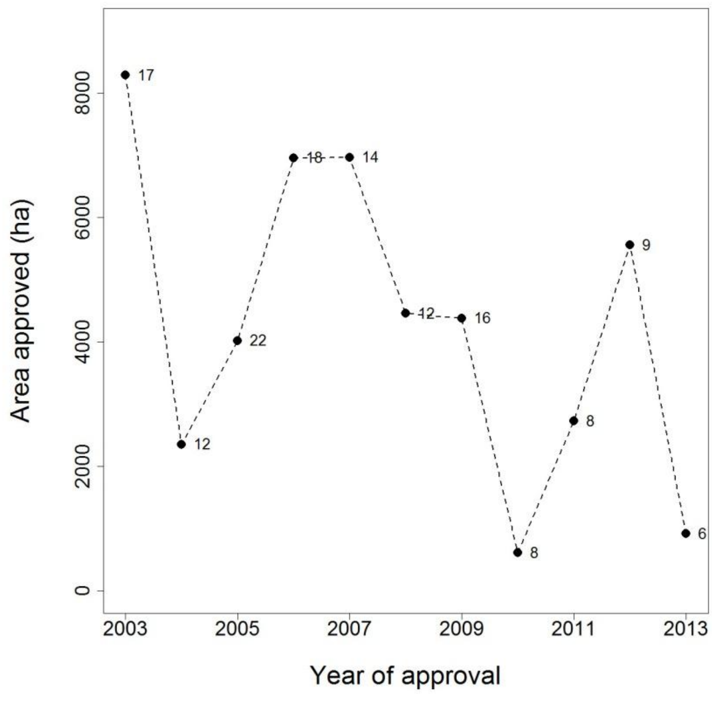

Figure 10: Areas approved for clearing of native (woody) vegetation in the Northern Territory from 2003 to 2013. The figure to the right of each point is the number of applications in that year. There is no trend in total area of approvals (r^2=0.18, P=0.10), but the number of applications fell significantly (r^2=0.54, P=0.006). Most of the approvals relate to the Top End, and the purpose was most often for pasture improvement (Table 1). The areas actually cleared will sometimes be less than approved.

[11] See, for example, http://i-fed.com.au/project/.

Surprisingly, given the mapping from satellite imagery carried out by all state/territory jurisdictions and the federal government, up-to-date, aggregated information on total extent and rates of clearing is difficult to obtain. For example, the Australian government, in its reports of greenhouse gas emissions associated with deforestation (land clearing) bases updates on estimates from a relationship between farming terms of trade and land clearing activity (see DoE 2014, page 13) rather than recent imagery analysis or information provided by the states and territories. Franklin and Preece (2014), in their treatment of threats to eucalypts in northern Australia, estimate an average rate of land clearing from in Queensland in 3 years after broad scale land clearing was prohibited in 2006, at 38,000 ha pa. Media reports indicate that broad scale clearing has begun in the Gilbert River catchment.

To provide a more direct contemporary view of the rate of approvals for land clearing, details of approvals granted by the Territory government (under planning law - see later) since 2003 are summarised in Figure 10 above and Table 1.

Table 1 : Numbers, scale and purposes for which approvals for clearing native vegetation were granted in the Northern Territory from 2003 to 2013. Note that the available figures do not include areas cleared for mining or petroleum exploration or extraction, which are controlled under mining law and not routinely made available to the public in readily aggregated form.

Purpose	Area (ha)	% of total approvals	Number of applications	Average size (ha)
Pasture improvement	34,460	73.0	70	492
Forestry	6,170	13.1	4	1542
Horticulture	5,156	10.9	47	110
Mixed agriculture	453	1.0	4	113
Defence training	386	0.8	1	386
Infrastructure	294	0.6	9	33
Industry	64	0.1	1	64
Aquaculture	32	0.1	1	32
Other	212	0.4	5	42
TOTAL	**47227**	**100.0**	**142**	**333**

We have shown that the extent of production or infrastructure-driven changes in landscape structure and function, where native vegetation is mostly removed, remains relatively low as a proportion of the vast savanna landscapes (Figure 3 above). However, some substantial swathes of country have been cleared in a few locations. One of these substantial areas of acute structural fragmentation in the Daly River catchment, showed measureable losses of species when more than 35% of native vegetation was removed and that losses became particularly severe at and above 70% removal (Rankmore et al. 2004). In a peri-urban situation Price et al. (2005) found that mammals were all but absent from substantial areas of intact but regularly burned habitat, but common in fragmented sites close to dwellings and protected from fire.

Complementing these studies of altered environments, which arguably involved sites changed too recently to measure impacts in full (losses may occur over very long periods after isolation: Patterson 1987; Newmark 1995), are important studies of naturally fragmented habitats and their resources. For example, Price et al. (1995) showed that networks of rainforest patches need protection over very large areas, if they are to maintain regional populations of the highly mobile frugivores that move among them.

Rates of land clearing appear likely to accelerate and the total areas cleared increase somewhat if the opportunities identified by CSIRO for irrigated agriculture (120,000ha; Webster et al. 2009; Petheram et al. 2013) and irrigated pastures (120,000ha; Grice et al. 2013) are realised in full. At the upper limits of their estimates this still represents about 0.12% of the area shown in Figure 2 above. But these sorts of higher value, irrigated uses represent only one source of the total likely demand for land clearing. Taking the NT figures from 2003-2013 as an indicator, clearing for non-irrigated use is likely to up to 8 times higher than for irrigated agriculture (Table 1).

Whilst these figures indicate that additional losses of native vegetation to approved clearing, even under a scenario of considerably accelerated agricultural development over (say) the coming decade will be in the order of 1% of so of the total savanna area, the impacts on natural and cultural heritage will clearly depend on their specific locations, the extent to which water demands compromise environmental and cultural values of rivers, streams, wetlands and other water dependent ecosystems like rainforests.

Accelerated land clearing for agriculture or improved pastures will cause a pulse in emissions of greenhouse gases as above ground biomass is removed and (usually) burned. Estimating the scale of emissions in CO_2-equivalents requires a number of assumptions about vegetation types cleared, mode of disposal of residues and and replacement crops. Law and Garnett (2011) estimated initial emissions of 415 tonnes CO_2-e per ha for northern forests and 136 tonnes CO_2-e per ha for woodlands in the north of the NT. Assuming an average net loss of 100 tonnes CO_2-e per ha and the upper CSIRO estimate of new developments, total emissions or irrigated developments could exceed 20 million tonnes CO_2-e. If pastoral leaseholders seek and regulators permit clearing for rain-fed improved pastures then emissions may be many times greater.

Indigenous landholders are well positioned to offset such emissions through better fire management for emissions abatement (Russell-Smith et al. 2013) and carbon sequestration (Murphy et al. 2009; 2010), and avoided deforestation. However, the policy uncertainty generated by repeal of the carbon price mechanism, establishing a publicly-funded Emissions Reduction Fund, and a need for workable methodologies will require resolution (NAILSMA 2014b).

Land clearing also leads to increased risks of erosion and the leakage of nutrients into associated waterways. These effects begin soon after land is cleared and before new uses have their additional effects (Harris 2001). Such pollutants are best managed on-site, but can perhaps be ameliorated by managing other sites to minimise or absorb sediments or nutrients. There may also be opportunities to deliver other environmental services for managing impacts of increased development on biodiversity, or water quality and availability.

Similar opportunities may be available to pastoral landholders on properties large enough to improve carbon storage or other ecosystem services on lands not used or less intensively used for pastoral production.

Land clearing has the potential to damage cultural heritage in a number of ways. First, capacity to exercise native title rights in hunting and gathering will be compromised. Second, the integrity of sites of particular significance may be damaged by removal of vegetation (see later).

6.4.3 infrastructure

Outside urban centres, terrestrial infrastructure developments outside mining operations constitute mostly roads, pipelines for gas and water, powerlines, and fence-lines occupying a relatively minor proportion of the landscape. They appear as ribbons and corridors traversing mostly structurally intact landscapes. They are significant because they introduce people, weeds, and feral animals into remote areas that would otherwise be buffered against human impacts by sheer distance from sources. Increases in the density of such intrusions can in general be expected to be incremental with more acute localised change in association with more or less independent developments like new mines. We make no attempt to separately assess vulnerability of natural and cultural values to such progressive change.

However, the development of fracking technology and the apparent prospectively of much of the northern parts of the Northern Territory for unconventional gas and oil (see Sections 11.1.3.6 and 11.2.3.1) creates an entirely new form of infrastructure development in numerous wells, linking roads or tracks, and pipelines that appears likely to greatly increase areas affected. Within an active fracking province, no sites will be distant and isolated by natural buffers from other disturbed sites.

To illustrate, the Western Australian Government indicates that with current practice established fields will see densities of wells at 0.44 per km^2. Fields may extend large distances over favourable geology and hence involve many wells. Once producing they are linked to each other by pipes, ultimately connecting to major pipelines. The length of pipes will vary with context, but it can be calculated that the length of pipe required to connect all wells to each other and/or a spine of larger pipe(s) in a 100 km^2 field is likely to exceed 70 km and often greatly exceed this length if topography is unfavourable. Protection of pipes from fire and accidental damage will require management of vegetation, including removal of woody vegetation and suppression of heavy grassy fuels over at least these distances. Even if run in relatively narrow corridors, the cumulative extent of disturbance will be substantial. With the most optimistic assumptions about layout and care to minimise areas of disturbance, it appears likely that 3-5% of a shale gas field will be severely disturbed, a great deal more subject to lesser disturbance, and the fire and other ecology of the whole of the field disrupted to some extent.

Unless pipes are buried, access for other land use will be curtailed. Tight gas production declines relatively rapidly as tightly held gas is released, generating major rehabilitation obligations for at least the removal of surface pipe and restoration of native vegetation.

Effects of such change will, as mentioned, flow through to other important processes such as fire and weed management. On the one hand, the unavoidable breaking up of fracked landscapes into relatively small compartments (in the few hundred ha) may improve capacity to manage fire for favourable regimes. On the other, obligations to protect infrastructure, access and workers from fire may require its effective exclusion from large areas, with unwelcome effects on some habitat types, including impacts from woody plant invasion of grasslands.

Clearly, a favourable unconventional gas field of substantial size presents significant land management challenges. Solving then may generate opportunities for Indigenous and other land managers.

6.4.4 fire

Fire is essential for maintaining savanna systems (Murphy et al. 2014). Fire regimes, and the role of Indigenous people in shaping them, changed dramatically in much of the Top End of the Northern Territory during the 20th century (Ritchie 2009; Levitus 2009). The loss of Indigenous people from their traditional lands through voluntary movement (Cooke 2009), disease, conflict, or deliberate displacement by government policy (Ritchie 2009) that drove these changes also occurred in other parts of northern Australia.

Related changes in fire patterns have been described in the Top End of the Northern Territory (Russell-Smith et al. 2009), in Cape York (Fensham 1997; Crowley and Garnett 2000) and the Kimberley (Vigilante 2000). In general, in areas from which Indigenous fire management was lost and not replaced by other active management, there appears to have been a trend to more frequent fires, larger fires and more severe fires (Russell-Smith et al. 2007). In small areas of more intensively managed pastoral regions, fire may have been be all but excluded (Ritchie 2009).

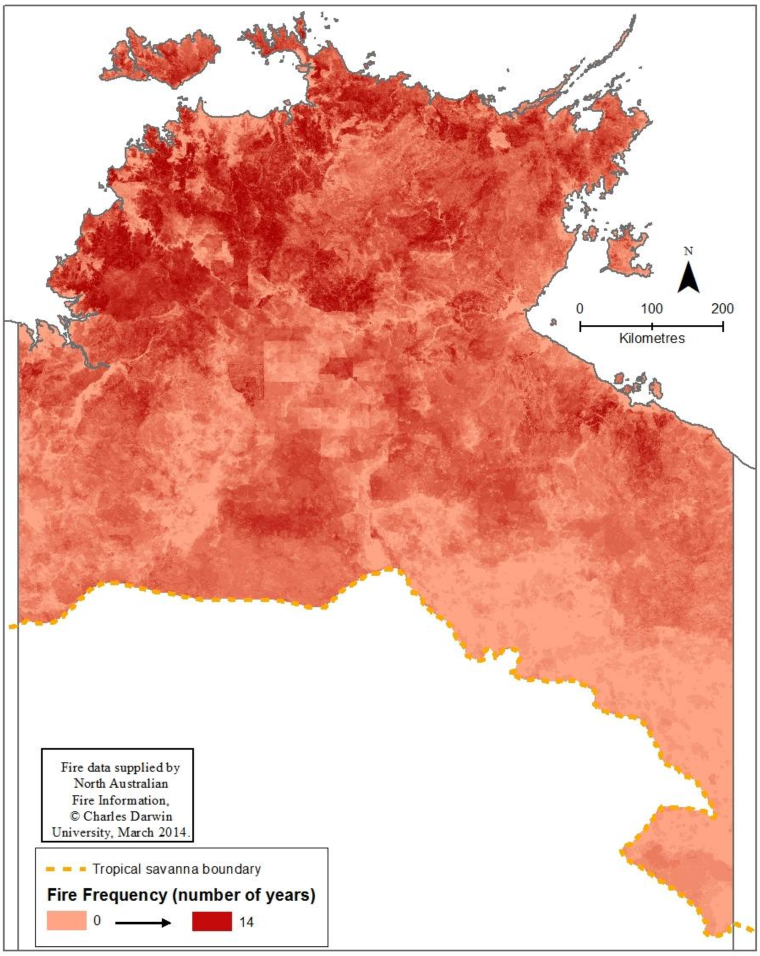

Figure 11: Fire frequency in the study area over the period 2000-2013 inclusive from mapping from MODIS satellite imagery (approx 250 m pixels). Areas of high fire frequency are particularly concentrated in the Top End, including the Daly River and Roper River catchments, and to a lesser extent, the Gulf of Carpentaria.

Changes in prevailing fire regimes have the potential to alter the structure of savanna habitats, nutrient dynamics, resource availability for fauna, and may cause direct mortality of plants and animals. Profound effects on many natural heritage values are inevitable and, in the case of plant diversity, convincingly demonstrated (e.g. Russell-Smith et al. 1998, 2002, 2012). Changes in fire regimes are also thought to be implicated in declines of vertebrate fauna in many parts of northern Australia, often through interactions with other threats like exotic predators (e.g. Woinarski and Recher 1997; Woinarski et al. 2011; Perry et al. 2011; Griffiths 2013; Radford et al. 2014).

Enough is known of fire effect and fire behaviour to begin to design fire regimes to achieve specific management objectives, and this has already been done at scales ranging from individual properties (e.g. Woinarski et al. 2004; Crowley et al. 2009) to the sub-regional (Russell-Smith et al. 2009; 2013). The large scale (28,000 km^2) WALFA "experiment" is particularly important in demonstrating that with adequate support and high levels of cooperation among landholder groups, it is possible to reassert control over regional fire regimes to meet environmental objectives. Repeating this success through appropriate incentives and governance arrangements matched to regional circumstances appears to be achievable, with similar projects now approved under federal carbon farming law in the Kimberley region of Western Australia.

Entrenching these operational gains will require similar effort to resolve present policy ambiguities, especially in regard to future access to carbon markets and treatment of rights in sequestered carbon.

6.4.5 water extraction

At present north Australia is in the happy position of having few water systems regarded as over-allocated (State of the Environment 2011 Committee 2011).

Major on-stream impoundments in northern Australia are presently few (Kingsford 2000), with most providing water for urban domestic use rather than irrigation. Large impoundments established predominantly to service irrigated agriculture in northern Australia include the Ord River Dam, and the Burdekin Falls Dam in Queensland (Figure 12 below). Both of the large impoundments in the Northern Territory provide water predominantly for domestic and industrial use in Darwin.

However, ambitious new plans apparently backed by federal and state governments are emerging (e.g. Petheram et al. 2013). Some of these may involve in-stream impoundments. Effects of in-stream impoundments are many and well understood. They include: seasonal change in flow regimes that fundamentally disrupt breeding cycles of aquatic organisms; loss of water and nutrient inputs to floodplains and estuaries; loss of connectivity among riverine and floodplain systems on which fish and other organisms depend; and downstream sedimentation (Wolanski et al. 2001).

Off-stream impoundments to harvest wet season flows have also been proposed. In the subdued terrain that characterises much of northern Australia, off-stream impoundments may require large areas and their effectiveness be compromised by evaporation, given high surface area to volume ratios.

There are no active proposals for new on-stream impoundments in the Northern Territory, although long term plans have identified sites on the Adelaide River system. Proposals for a substantial off-stream impoundment are in development (Powerwater 2013). However, usage of ground-waters appears to be accelerating, with major allocations made (e.g. Applegate 2013) and sought from the aquifers (Tindal and Ooloo) supporting dry season flows in the Daly River, despite incomplete water allocation planning[12] and the assessment by the North Australia Land and Water Task Force (Ross et al. 2009) that the Daly groundwater province may have then been close to full allocation. Northern Australia in general and the Northern Territory in particular support many high conservation value water dependent ecosystems (Kennard 2010) which will be highly sensitive to management of groundwater levels and flows.

[12] see http://lrm.nt.gov.au/water/water_allocation/plans#.Uztk3Vd7R04, which indicates that plans for the Tindal limestone and Ooloo limestone aquifers are "in progress".

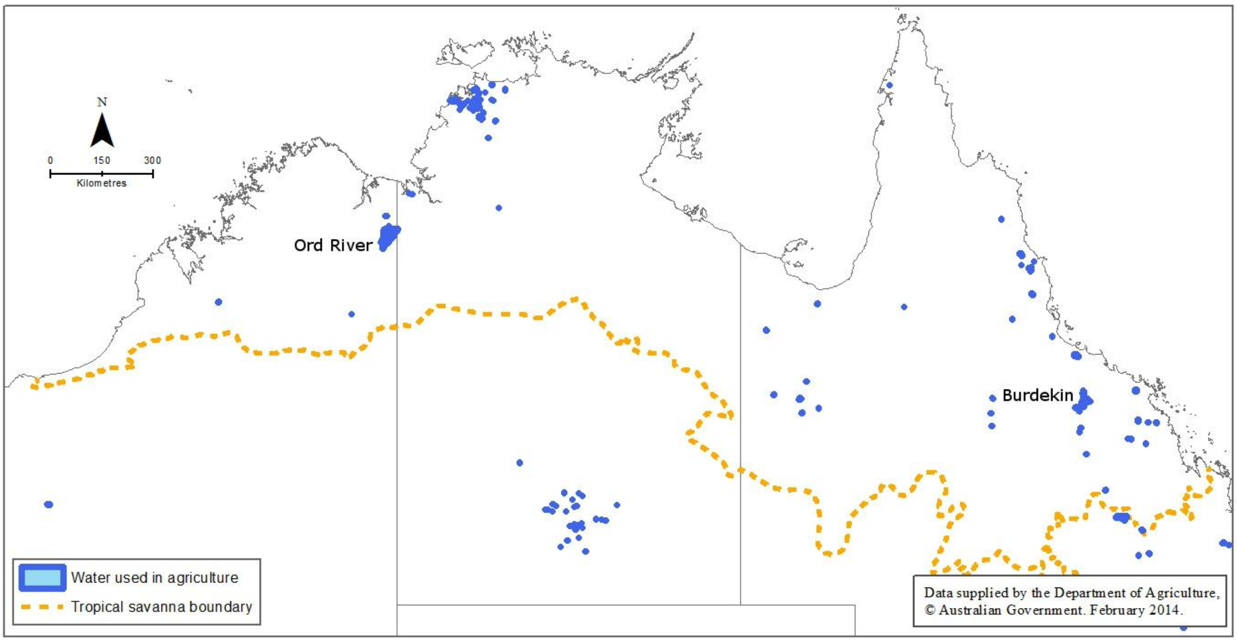

Figure 12: Locations of water use in agriculture from impoundments or substantial abstraction from ground-waters in northern Australia, based on the ALUM classification.

Allocations of water for mining are difficult to anticipate and plan for, and therefore are often made outside water allocation processes, adding significantly to risk of over-allocation or conflict with other water uses and users.

Despite apparent progress in development of Indigenous rights to access water for commercial as well as customary use (Tan and Jackson 2013), statutory reservation of water for Indigenous people has recently been abandoned in the Northern Territory[13], presumably reversing reservations made in the (completed) Katherine water allocation plan. Risks of groundwater resources being fully allocated before Indigenous landholders have an opportunity to consider options for use would appear likely to increase. Interventions to protect other statutory (native title) rights and cultural interests in water may also become more likely.

6.4.6 pollution management and mine site rehabilitation

Several sources of environmental pollution are likely to be particularly important in the emerging development trajectory for northern Australia: mining and petroleum extraction processes and associated waste; disturbance associated with higher densities of stock; runoff of chemical used to improve agricultural production; and salinisation associated with irrigation. The classes of pollutants to be managed include sediment, metal(loid) toxicants, pesticides and their breakdown products, fertilisers, excreta, and (principally) greenhouse gases. Spills of chemicals used in mining (e.g cyanide, sulphuric acid, sodium hydroxide) also pose risks.

Management of erosion and sediment movement poses particular challenges in regions experiencing intense rainfall events, common in north Australia. Pulses in sedimentation at some level are all but inevitable consequences of the disturbance associated with land use change. Waters discharged from mines carry suspended solids often many multiples of those from horticulture or other agriculture, which are usually higher than those from grazing of native pastures (Bartley et al 2012). Aside from the very large scale effects already identified for highly developed catchments

[13] http://www.abc.net.au/news/2013-10-09/nt-indigenous-water-reserve-policy-dropped/5012152

running to the east coast of Queensland, impacts from sedimentation are probably mostly local. But as the amount of land converted to agriculture increases, even lower level chronic sediment loss will steadily increase the risk of long term, large scale impacts.

Acid drainage is a principal cause of pollution from mines. Management of acid drainage includes capping rock dumps to minimise oxidation and water exposure, trapping or diverting contaminated waters, and disposing of polluted waters by dilution to "safe" levels during high wet season flows. Extreme events (cyclones or severe rain depressions) can lead to failures of containment and unplanned discharges (Duffy 2013). Acid production and mobilisation can continue for decades or longer (e.g. Taylor 2007). Difficulties can be exacerbated by multiple mines in the same catchment, leading to cumulative effects on water quality and stream biota (Canovas et al. 2014). Bauxite mines, if processing occurs on site, produce large quantities of highly alkaline waste (red muds) that similarly require long term storage (Brunori et al. 2005). Similar problems are common in all parts of Australia (e.g. Queensland Audit Office 2013), but exacerbated in the seasonal tropics by extreme climatic conditions, especially extreme rainfall events (e.g. NTEPA 2013a).

Difficulties of long term waste storage and other site rehabilitation measures, as exemplified by ongoing problems at Rum Jungle, Mt Todd and Kakadu National Park, are exacerbated by the acknowledged inadequacy (e.g. Queensland Audit Office 2013) of bonds required of mining companies to cover repair of mine sites. In recognition of the present large public costs (estimated at more than $1 billion), the Northern Territory has imposed a 1% annual rehabilitation levy but discounted total security requirements by 10%[14] (NTG 2014). The 10% reduction is promoted as reasonable in that it comes from a 15% contingency on estimated rehabilitation costs. But given past poor performance in setting bonds and the extraordinary costs already known and additional large highly problematic mines already in place (e.g. expansion of Mt Todd operations, Redbank Cooper mine, and McArthur River Mine) it is unclear how such a trade-off of capacity to meet future needs will create long term public benefit.

Extraction of petroleum (oil and gas) generally causes less disturbance than mineral extraction fo equivalent value. Concerns arise in relation to hydrocarbon spills, fugitive and larger gas emissions, and contamination of groundwaters through poorly constructed or contained wells. Disposal of water used in fracking and hence polluted by exposure to natural toxins and fracking additives can present difficulties. In common with othergovernments, the NT government has acknowledged public concern about this technology and has commissioned an independent inquiry into potential technical responses.

Levels of nutrients increase substantially in associated streams soon after land clearing (Harris 2001) and may continue to increase with input of fertilisers especially when poorly matched to the need of plants (Brodie and Mitchell 2005; Webster et al. 2012). Unsurprisingly, nutrient loads are higher in runoff from catchments with more intensive agricultural development (Joo et al. 2012). Bartley et al (2012) summarised data showing runoff from sugar cane fields to be particularly high in total and dissolved N and P. Intensification and diversification of cropping in new areas of the north (e.g. Petheram et al. 2013) will require careful management to avoid both local and more widespread impacts associated with nutrient runoff (Thorburn et al. 2013).

Pesticide loads entering waterways will most likely increase with intensification of agriculture (Joo et al. 2012). There are regular but mostly anecdotal reports of misused pesticides killing vertebrate animals in many parts of Australia (e.g. Bradley 2008). Compounds with long persistence times can have impacts on both aquatic plants and animals long distances from sites of application (e.g. Duke et al. 2005; Shaw et al. 2012) and for very long periods (Brodie et al. 2012). Effects of different toxins

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[14] http://www.nt.gov.au/d/Minerals_Energy/Content/File/MineralTitlesAct/changes/Levy_MMA_mining_securities.pdf

can be additive (Lewis et al. 2012). Shifts in community structure are possible (Magnusson et al. 2012). Careful management of application and runoff from fields is required to avoid harm.

Salinisation risk is high in many Australian irrigation schemes as water tables rise on removal of woody vegetation (land clearing) and through groundwater accessioning associated with irrigation inputs. However, the nature and scale of risks will vary with soil type and many other variables (e.g. Smith 2008; Smith et al. 2006, 2010).

All of the risks identified above will vary in likelihood and consequence with the scale and other design of agricultural developments. They will obviously be greater if visions of broad-scale development of the type promoted by the federal government (e.g. DFAT 2012) rather than more modest propositions based on assessments of land capability and water availability (Petheram et al. 2013) are pursued. Although similar processes may be underway in waters of our northern neighbours (Alongi et al. 2013), cumulative impacts like those seen on the Great Barrier Reef from a number of intensively developed catchments may not be replicated soon in other parts of north Australia. However, these observations do illustrate the intractable (wicked) problems that develop under *laissez faire* administration and associated failures to plan (see Sections 8.1.1 and 8.1.2).

6.4.7 invasive species

Invasive plants will be favoured by the disturbance of previously undeveloped sites and regions. And if not controlled, new entries will provide loci for invasion of neighbouring undeveloped sites. Some invasive animals that do better in and around human settlements can also be expected to spread into previously unoccupied site. Resources for weed control and public willingness to control infestations on private properties are demonstrably inadequate, obliging regulators to "give up" on eradication as an objective in areas already infested with weeds like Gamba grass (DLRM 2010), no matter how serious their potential impacts. For weeds and animal pests, this pragmatic approach is a recipe for such species to occupy quite quickly the whole of the area to which they are ecologically suited, with the exception of sites separated from major infestations and where there is strong commitment to exclusion and eradication. It is desirable that every new development in regions free of major pests be encouraged to adopt aggressive exclusion and eradication policies.

These approaches will be particularly important for invasive species like Gamba grass, which are high impact and costly to control once well established at high densities, but amenable to relatively simple forms of control early in the invasion and establishment process.

6.4.8 social issues

Promotion of accelerated northern development is seen by many segments of Australian society as a self evident good, because it will generate wealth that improves the well being of many. Unfortunately, the history of rapid, large scale development suggests that local people may struggle to access benefits even though they are exposed to environmental and other costs. The issues raised can be best understood by considering the position of the region's Indigenous people.

In the absence of targeted actions, the unfortunate reality is that few of the benefits of orthodox development will in fact reach Indigenous people (or any other remote residents), because the Indigenous and mainstream economies in remote and regional northern Australia operate mostly independently. Where these economies do intersect, benefits of (most often public sector) investments in Indigenous activity readily flow on to non-Indigenous businesses. But non-Indigenous agricultural and mining investments tend not to flow to Indigenous people unless there is explicit agreement with developers, and even then outcomes can be weak (Stanley 2010). Enterprises source most of their needs from outside the savanna regions (Stoeckl 2012). Fly-in fly-out staffing is one of the most obvious expressions of this relationship (or lack of it) with local communities (Cheshire 2010).

Stoeckl and co-workers describe this separation and the asymmetry of flow of benefits as the "great asymmetric divide" (Stoeckl et al. 2013a). They show that when impacts on access to the customary economy based on hunting and foraging are taken into account, economic benefits from developments requiring significant water extraction are further reduced.

If all direct impacts are taken into account, developments of the sort most promoted for northern Australia may reduce net Indigenous incomes (Stoeckl et al. 2013b).

Increases in demands for housing and basic services may force up prices, and local and state/territory services struggle to meet demand. Costs in loss of social cohesion around major developments can be a problem (KRSIS 1997a,b: Langton and Mazel 2008; Scambary 2013). These sorts of difficulties in capturing the benefits and in escaping the costs of large scale developments in the savannas are similar in kind to symptoms of the "resource curse" experienced by many developing nations. Countries highly dependent on resource extraction tend to experience lower economic growth. Within developed countries, similar effects are reported at the regional scale (Langton and Mazel 2008; Langton 2010; James and Aadland 2011; Mckenzie 2013).

Dealing with the "curse" requires recognition of the risks and then deliberate actions to overcome them. Passive reliance on trickle-down has been proven by long experience, including the recent Australian resource boom, to invite entrenchment of social disadvantage. Problems can be ameliorated by strong institutions for managing change, and especially by designing for innovation and diversification of local economies (Ville and Wicken 2012).

Indigenous north Australians will be most directly exposed to drivers of accelerated northern development occurring outside major centres. At present, most lack the resources to manage their lands - and the post-settlement pressures on them - as they would wish. Superficially, there would appear to be many options to advance individual or community interests through active participation in new developments.

As major landholders (Figure 13, 14, and 15) they could choose to take up or reject agricultural opportunities. They could leverage rights to refuse exploration rights to obtain benefits through bilateral agreements with developers (e.g. Galbraith et al. 2007). And those with appropriate education and good physical health might take up employment with developers. All of these options for accessing socio-economic benefits have the potential to create conflicts with other cultural obligations (O'Faircheallaigh 2008; McRae-Williams and Gerritsen 2010), but may be pursued because those benefits are badly needed. Reconciling cultural demands for Indigenous landholders with the economic and operational imperatives driving developers will often be challenging.

Nonetheless, we suggest that success in building the core of an Indigenous skilled workforce - skilled in both customary and orthodox practice in land and resource management - offers a unique opportunity to begin to bridge the divide. Serious commitment from government and industry to manage the environmental effects of accelerated northern development can make a substantial contribution to local economies.

If governments are to realise their stated ambitions for host regions and communities (NTG 2013a) to benefit from government and private investments they will need this and many other similarly well-targeted positive actions. To paraphrase recent federal government conclusions on the evolution of regional towns (BITRE 2014), remote communities need industry much more than industry needs them: and much more than rhetoric is required to correct the asymmetry.

Some of the essential actions for enduring regional development, like repair of public education systems, are principally the province of governments. Others can be taken by industry, perhaps through bilateral agreements between industries engaged in development initiatives and landholders and their local communities (O'Faircheallaigh 2003; 2008). Offsets may provide an important vehicle for facilitating local participation in management of developments and capturing socioeconomic benefits locally, in tandem with reduction of environmental and amenity costs.

6.5 Society and economy

We have sketched northern Australia as a huge area with entrenched land management problems and too few financial resources to deal with them. And in considering likely impacts of land use change, have raised some connected social issues. Here we add a little more detail on the demographic and socioeconomic issues raised by the potential for accelerated northern development.

6.5.1 Demography

The north Australian tropical savanna population, even including its major towns, is small (~750,000 in 2011), widely dispersed, and approaching 17% Indigenous[15]. Outside a few major towns, the savanna population is around 500,000, with Indigenous people comprising a much greater proportion of the population. In the Kimberley and Top End savannas, about half of the population is Indigenous, and in very remote regions generally, more than 90%. Nationally, 45% of the population living in areas classified by the Australian Bureau of Statistics as very remote is Indigenous (Taylor 2006). Projections to 2021 based on the 2006 census show higher rates of growth in the Indigenous savanna population (26%) than in the non-Indigenous population (15%) (Taylor et al. 2006). Preliminary analyses of the 2011 census confirm these sorts of trends nationally and in fact indicate Indigenous population growth rates higher than projected (Biddle 2013).

Around 19% of the tropical savannas region is owned or managed by Indigenous people (Figure 13 below) under a number of forms of exclusive title, ranging from 36% of savannas in the Northern Territory, to 6% in Queensland (Russell-Smith and Whitehead 2014)[16]. Determinations of and applications made for recognition of native title under the Commonwealth of Australia's *Native Title Act* 1993, indicate that, as of May 2013: (1) determinations have been granted for a further 22%, predominantly in Western Australia (Figure 14 below); and Registered or Scheduled Native Title applications (i.e. still to be determined) cover more than 43% of the tropical savannas region, ranging from 52% of Western Australian savannas to 40% in Queensland (Figure 15 below) (Russell-Smith and Whitehead 2014)[4].

Of the political jurisdictions (Queensland, Western Australia and Northern Territory) comprising north Australia, the Northern Territory conforms most consistently to the demographic patterns outlined over its entire area of 1.34 million km^2. The total population is small (~240,000) with average population densities the lowest of all Australian jurisdictions. The historically dominant industries of low intensity (extensive pastoralism) or relatively short enterprise lifetime (mining) have generated few nodes for larger permanent settlements. As a consequence, much of the population is located in two administrative centres 1400 km apart at the north-south extremities. Darwin, by far the largest savanna centre and major port, has more than half of the Territory population, which outside these two centres, overwhelmingly Indigenous and widely dispersed. About 12% of the nation's Indigenous people live in the Northern Territory but only 1% of non-Indigenous people. Most Indigenous people (70%) live on lands held under Aboriginal communal title (Taylor 2003).

Superficially, ownership of about 45% of Territory land (and 40% of our NT study area: Table 2) by the Indigenous population may appear to offer a favourable pathway for Indigenous socioeconomic advancement. But the other readily identifiable major land-holding group, namely pastoral leaseholders, generate only about 2000 jobs on an approximately equivalent area incorporating the

[15] Source: Australian Bureau of Statistics 2011 census figures, but including Local Government Area population data inclusive of major towns Cairns, Townsville, Mt Isa (Queensland), Darwin, Palmerstone, Katherine (Northern Territory), and Broome (Western Australia).

[16] Source of analyses cited in Russell-Smith and Whitehead 2014: Indigenous Land Corporation (May 2013)

most productive lands, and make a relatively modest contribution to Gross State Product while drawing on longstanding government subsidies and provision of related infrastructure. This history suggests that emphasis on orthodox production is unlikely to meet the future employment and other needs of a growing Indigenous population, land-owning or not.

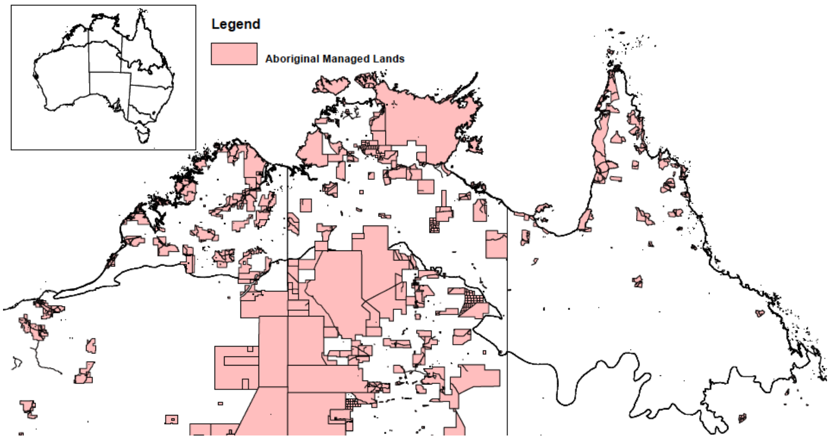
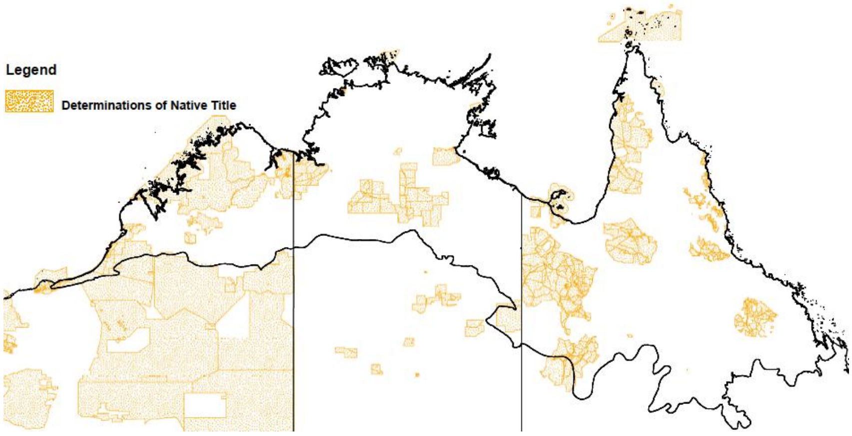


Figure 13: Indigenous owned or managed land (source Indigenous Land Corporation 2013)

Figure 14: Determinations under the Native Title Act, including both exclusive and non-exclusive (e.g. access for traditional use) title. (source Native Title Tribunal 2013).



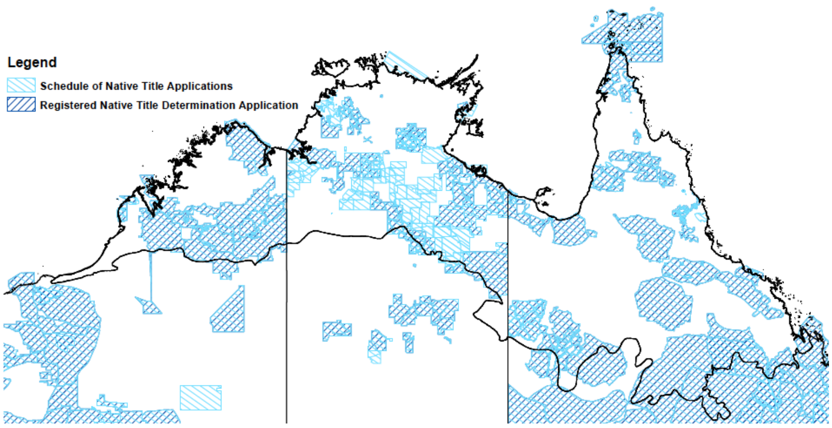


Figure 15: Registered applications for recognition of Native Title (source Native Title Tribunal 2013)

Figures 12-14: Indigenous-owned lands held under various forms of exclusive title and non-exclusive title, including federal and state/territory land rights laws. (a)Indigenous owned and managed lands (b) native title determinations (c) native title applications. Note that there is some overlap between these categories. Some lands held by the ILC may not have been divested to Indigenous bodies yet. See text for details of total areas involved.

Table 2 : Indigenous land tenure within the Northern Territory study area, illustrating the central role of Indigenous interests for achieving sustainable use of northern landscapes, including conservation goals.

Tenure type	**Area (ha)**	**% study area**	**% indigenous interests in land**
ALRA scheduled	23,698,762	36.7	65.0
ALRA (yet to be scheduled)	852,094	1.32	2.3
NT Indigenous Freehold	892,531	1.38	2.4
ILC holdings	233,758	0.36	0.6
Native Title determination (exclusive possession)	158,601	0.25	0.4
Native Title determination (non-exclusive)	10,679,384	16.5	29.2
Native Title applications	16,295,493	25.2	-
Total freehold equivalent held	25,835,746	40.0	70.7
Total all determined interests	36,515,130	56.5	100.0
Total including applications	52,810,622	81.8	144.8 (of existing holdings)

Across the Northern Territory, rates of population growth are highly variable, both through time and by location, being strongly influenced by non-Indigenous immigration and emigration (ABS 2012) often tracking local development opportunities (e.g. Taylor and Winter 2013). A large proportion of the non-Indigenous population is transient, with family ties elsewhere in Australia.

The Territory's Indigenous population is expected to continue to increase relative to the non-Indigenous population, particularly in the regions (Taylor et al. 2006; Biddle 2013). Sites of high local population growth are often poorly matched to areas of likely job growth (Taylor 2003) which is mostly confined to larger centres. Mobility of Indigenous people is chiefly temporary and occurs within the Territory (e.g. Taylor and Bell 2004). Repeated reviews have shown the ongoing failure of educational systems in many remote areas (Collins 1999; Wilson 2014). Many Indigenous people suffer from poor literacy and numeracy: as a result they experience difficulty in taking advantage of such mainstream employment opportunities as become available in the regions.

Moreover, morbidity and mortality rates are unacceptably high among the Indigenous population, and proving resistant to simple correction (see SCRGSP 2011 and earlier reports). Life expectancies among all age cohorts are far shorter for Indigenous people. Poor individual health or caring for others in poor health where there are no or weak support services, may compromise capacity or willingness to take up employment in the mostly physical work that is available to those with limited education, especially if that work is distant from homelands. On the other hand, there is increasing evidence that residence on traditional country and employment in land management is associated with better physical health and enhanced well-being more generally (Burgess et al. 2005; Biddle and Swee 2013).

6.5.2 Economy

North Australia has for many decades made a major contribution to the national economy, chiefly through extractive industries. But this role has not translated into the development of strong local economies. The Northern Territory economy in particular is an artificial and inherently fragile thing, buffeted by shifts in international markets for its mineral resources and pastoral produce, limited in capacity to raise revenue locally, and more or less stabilised by fiscal equalisation formulae bringing large subventions from the federal government. Transfers to a "mendicant" Territory are intended to meet the additional costs of delivering basic services to remote communities and, more generally, to address Indigenous disadvantage (Morris 2003).

Gerritsen (2010) posits ongoing economic weakness for north Australia in general and the Northern Territory in particular, despite government support for natural resource based development. Continued weakness will be driven by biophysical limitations (Ross et al. 2009; Larson 2010), an export sector that leaves too little behind (poor local multipliers: Stoeckl 2012; Stoeckl et al. 2013); an inefficient (highly centralised) public sector (Gerristen 2010); and an inefficient labour market weak in skills in demand from its export sectors, but generating little demand for the (narrow) range of available skills (Welters 2010).

We have already considered the difficulties chiefly Indigenous remote and regional communities experience in accessing benefits from development initiatives. And bifurcated societies (Gray and Lawrence 2001), with struggling rural and relatively more prosperous urban populations, are common globally. North Australia's problems are therefore not unique, but their depth, persistence and particular impacts on Indigenous people are perhaps surprising in such a rich country with a long history of dependence on rural products for its prosperity.

This study is not primarily concerned with understanding or dealing with pathways to economic or social development. But awareness of major issues, and their broad character and significance, are, we consider, important when considering the sorts of conservation and environmental management policies and practices likely to succeed in north Australia, in part because they deliver benefits to and are therefore acceptable to the local and regional population. Despite many disadvantages, the region is rich in essential human assets. In the Northern Territory in particular, significant numbers of people have tenaciously maintained a presence on their ancestral lands. With even modest but well designed support, local commitment and skill can do much to compensate for sparseness of population and lack of infrastructure.

6.5.3 Summary and conclusion

Even though northern resources have long made a substantial contribution to the national economy, residents of remote and regional north Australia in general and the Northern Territory in particular face uncertain economic futures. There is bipartisan political support for accelerated northern development federally and in all of the north's state/territory political jurisdictions. Those aspirations are articulated in government strategies (NTG 2013), regional development strategies (e.g. RDA 2013), in political manifestos (e.g. Anon 2013), and in terms of reference for the federal Parliament's Inquiry into northern development[17]. They are also integral to the Asian Century White Paper (2012) issued by the previous federal (Gillard) government. But the risk remains that benefits will flow mostly to external actors while locals contend with social and environmental costs.

Conspicuously absent from these various manifestos is serious attention to management of environmental impacts. And despite the compelling evidence for failure of large scale projects to deliver benefits to remote or regional communities that outweigh the social or environmental costs,

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[17] http://www.aph.gov.au/Parliamentary_Business/Committees/House_of_Representatives_Committees?url=jscna/tor.htm

there are no serious plans for reducing such costs and ensuring that more of the benefits of northern development stick locally.

The interests of north Australia's remote and regional residents are too often treated as issues peripheral to goals already set by others (e.g. DFAT 2012). Accordingly, NAILSMA (2014a), acting on the instructions of a diverse group of north Australian Indigenous leaders, has proposed an Indigenous "prospectus" for northern development to set out the conditions under which Indigenous landowners may seek to co-invest actively in orthodox development, including agricultural ventures on their lands.

Their challenge is to balance the obligations to secure good economic futures for themselves and their communities without excessively compromising capacity to discharge cultural and environmental obligations. Given the strength of incentives and external pressures to join the mainstream economy in one way or another, it should not be assumed that Indigenous landowners will be unwilling to take the risks revealed in the long history of failure of agricultural and other orthodox use (Woinarksi and Dawson 2002; Cook 2009). Indigenous lands will not necessarily stay in the "minimum use" category to which most are presently formally assigned (Figure 3). And the areas involved are very large (Table 2).

7 CONSERVATION PRIORITIES AND STRATEGIES

There is a considerable literature on the implications of the situation outlined above for design and delivery of improved conservation outcomes in northern Australia (e.g. Woinarski et al. 1992; Whitehead et al. 2002). The most comprehensive and coherent (Woinarski et al. 2007) proposes a model for shifting development to a pathway emphasising:

- regional planning that identifies the capacity of regions to absorb human-induced changes to the landscape;
- core areas to be managed primarily for conservation;
- constraints on activities that are directly or indirectly destructive to natural values and ecological processes;
- promotion of economic activities that are, or can be made to be, compatible with those values and processes;
- promotion of management compatible with conservation across all land tenures;
- fostering collaborative approaches to conservation and management amongst landholders; and
- facilitation of a 'conservation economy'; enterprises that yield a net positive gain for the natural environment.

Various governments have articulated plans, strategies and programs that pick up north Australian issues (e.g. NRMMC 2010; CoA 2013) but these come and go or shift focus at a pace inconsistent with the need for long term commitment. For the Northern Territory, the Territory NRM Plan (2011) picks up some of these themes, but budgets are small and highly variable. The present federal government's shift to a strong development emphasis has not been accompanied by a complementary program to manage connected environmental issues at any of the local, regional or national scales.

Those with a particular commitment to northern Australia and sound management for maintaining and (preferably) enhancing its natural and cultural heritage values need to look beyond the essential but inherently changeable role of governments to identify and commit to robust approaches to fundamental goals, like those articulated by Woinarski and colleagues. We consider that Development by Design can by a critical contributor because it embodies many of these robust ideas. If well-designed for and implemented consistently in north Australia, it can particularly advance the roles of regional planning, protection of core sites whether within the formal reservve system or outside it, promotion of compatible economic activities, fostering collaboration and facilitation of a conservation economy.

In considering the place of DbD in north Australia and the Northern Territory in particular, we therefore emphasise these important principles and practice and spend little time agonising over the failures and successes of other strategies and programs. However, we do put a good deal of effort into understanding the biophysical, social, cultural, and legal structures and processes within which DbD must be made to work. The task is neither conceptually nor operationally simple, but we consider the opportunity too important to be deterred by contemporary shifts in policy or aversion to complexity.

Above all, we are convinced that a key strategy will be to find ways to harness a portion of the effort and investment going into the development of northern Australia to not only manage the impacts of new development but to rescue systems that have been chronically degraded over decades. DbD is one of those ways.

8 THE POLICY AND LEGAL ENVIRONMENT

To complete our outline of the northern context, here we consider the policy and legal frameworks for management of natural and cultural assets in northern Australia, particularly where they may be relevant to use of offsets and to realising ambitions for northern development. We focus primarily on the Northern Territory but consider other jurisdictions where useful to illustrate shared problems or local solutions of potentially wider application. We consider explicitly the influence of federal law and policy on Territory or state activities.

We seek to examine all laws with the potential to influence the way land and waters and biodiversity are protected and managed, but confine detailed treatment to a subset which we considered have the most direct application. A list of Territory statutes and their subordinate instruments is at Attachment 2.

We also approached this task by reference to the key issues and pressures summarised above. We identify policy statements and law in planning, land use , environmental assessment, resource allocation and resource management relevant to offset design. We explore the roles that each area of policy and law might play in the need for, identification of, and opportunity to support implementation of offsets.

Development by design is inherently a land use planning system, in that it takes objectives in sustainable development and biodiversity conservation and seeks to generate optimal spatial configurations for achieving both sets of objectives. In adopting this characterisation, we particularly sought to embed our analysis within the Territory's policy and planning frameworks for either or both development and conservation.

8.1 Northern Territory policy and law

8.1.1 Planning policy

8.1.1.1 planning for economic development

Despite the strong development orientation of successive Territory governments, the NT has not framed special laws or enduring institutions to plan and then enable regional development or, less ambitiously, respond to developments or directions initiated by others. There is no equivalent of the Kimberley Development Corporation in Western Australia or State Development Areas deployed in Queensland. Whole-of-government responses to large scale development proposals or opportunities are handled by standing or *ad hoc* committees, usually convened by the Department of the Chief Minister[18].

Those committees have little in the way of formal policy positions to draw on, aside from a general awareness of a desire to accelerate economic development. Statements like the Framing the Future strategy (2013) put universal development goals like "land(ing) new local, national and international investment" and say little about priorities or pathways. Emphasis is placed on reducing obstacles to investment ("fast track", "minimise administrative requirements", "support efficient investment decision-making"). Planning by or with government is accorded a relatively minor role. For example, under the heading "Balanced Environment" the strategy packages the role of land use planning as mostly urban, with a land use agenda to:

> "deliver a land release program (for domestic dwellings); develop a Darwin Regional Land Use Plan; finalise the Knuckey and Ironstone Lagoons Area Plan and the Katherine Land Use

[18] see http://www.dcm.nt.gov.au/territory_economy/major_projects

> Plan. Investigate the potential use and development of Berrimah Farm, review the Tennant Creek Land Use Framework and previous studies pertaining to land use in the Alice Springs CBD, and develop an urban densification strategy".

This does not mean that there are no goals for more intensive use of rural or remote land: but they are pursued outside an overarching planning framework. Other Framing the Future objectives seek to:

- **"Leverage land and water resources:** grow pastoral, fisheries and agricultural businesses.
- **Build our regions:** ensure investment in the mining and petroleum sectors benefits the host regions and communities."

Matching commitments for broader long term planning for land and renewable resource use are confined to a "comprehensive Water Plan for the Territory to address .... management of water resources for the next 50 years" and "a new fisheries resource sharing framework".

Some reticence about prescribing a central role for government in regional development of north Australia is perhaps warranted by the history of misdirected effort and failure, especially in agriculture (Woinarski and Dawson 2002; Cook 2009). That longstanding failure, over at least 1/3rd of the Australian continent, is presently being addressed by a joint committee of the federal parliament. This Inquiry has been tasked to consider potential for development in a wide array of industries, remove impediments to investment and growth, and to identify and support investment in the economic and social infrastructure needed to realise potential[19].

It is likely that development directions in the Territory will be strongly influenced by the results of this inquiry, perhaps including the manner in which social and environmental issues arising from accelerated development are handled. Given extreme dependence on federal funding, how the Territory Government will be go about asserting its own priorities - particularly to deliver benefits to "host regions and communities" in the absence of a strong regional planning framework - is unclear. Many existing sectoral strategies, such as the 2011-2015 agribusiness strategy are probably disabled by changes of government and have not been replaced. A better contemporary guide to present government intent may be provided by relevant agency strategies made after the last change of government.

For example, the Department of Primary Industry and Fisheries Industry Development Plan 2013-2017, commits the agency to:

- lead whole-of-government processes to identify land and sea areas for future food production;
- facilitate expansion of the Ord Irrigation Scheme into Northern Territory lands;
- continue to facilitate the release of new blocks for horticultural development;
- develop and maintain information on Territory land and water resources to assist prospective investors in primary industries; and
- identify opportunities for primary producers to participate in the climate change and carbon economies[20].

The Department of Land Resource Management's strategy includes:

- develop a Northern Territory strategy to address use, allocation and management of water;
- determine potential for agricultural development through collection and assessment of land, soil, vegetation and water information;

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[19] See http://www.aph.gov.au/Parliamentary_Business/Committees/Joint/Northern_Australia/Inquiry_into_the_Development_of_Northern_Australia/Terms_of_Reference

[20] As will be shown later, this statement appears out of step with other NT Government treatment of offsets, but perhaps offers some scope for collaboration

- provide extension services to assist landholders in sustainable use of natural resources;
- manage the impacts of feral animals and weeds on productive and natural systems;
- build community capacity to mitigate the negative impacts of wildfire, weeds and feral animals;
- develop an integrated NT NRM information system that is accessible to internal and external clients[21]; and
- ensure that impacts on natural resources are within acceptable limits in the allocation and use of land for development purposes.

Whilst these two statements are more or less compatible with each other, It is difficult to see how some objectives, like ensuring that land and water allocation and use remain within acceptable limits, will be reached in the absence of committed rural land use planning, irrespective of the skills and capacity of individual landholders.

The Department of Mines and Energy aims to:

- implement development zones for minerals and energy resources;
- deliver an enhanced geoscience and investment attraction Initiative;
- implement case management for start up and complex projects;
- deliver contemporary minerals and energy policy that reflects the changing economic environment;
- review legislative frameworks;
- deliver a transparent and risk based approach to regulatory compliance; and
- implement a management program for legacy mines.

Again the development goals are clear, but there is no indication how the ambitions will be pursued to deal with competition among sectoral developers for land, water and infrastructure.

The most recent whole of government Northern Territory development policy is arguably its submission to the federal parliamentary inquiry (NTG 2014b). In that submission, government reiterates commitment to accelerated development in agriculture and resource extraction. But rather than treating how development paths set out in agency agendas can be joined up to optimise benefits and reduce costs, the submission's novelty arguably lies in its approach to land access.

Amendments to Indigenous land rights law are proposed to facilitate lease of land to the NT Development Land Corporation (DLC). The DLC would then sublease this land to developers. As noted earlier, the Northern Territory has an unfortunate history with this sort of intervention, notably the Agricultural Development and Marketing Authority (ADMA) of the 1980s, which encouraged private investments in cropping ventures. These failed in part due to inadequate appreciation of environmental constraints (Alford 1989, cited in DIPE 2003). This form of intervention would also appear to sit uneasily with ambitions to foster Indigenous enterprise, because it places control and responsibility for development of these private lands with external bureaucrats and investors rather than their owners and local people. Treatment of other issues (see provisions of *Territory Parks and Wildlife Conservation Act*, p. 308) suggests that such interventions would not be considered on freehold land held by non-Indigenous people. When it comes to Indigenous land, indifference to land use planning appears to be transformed to embrace extreme forms of planned intervention and centralised control.

The Territory will also seek federal support to resolve native title interests in Territory landscapes earmarked for development of irrigated agriculture, which will use water from the Ord River (Figure 12).

[21] This commitment, building on efforts already made to improve public access to information gathered at public cost, may improve opportunities for non-government actors to develop robust offsets

In addition to these propositions, additional support for research is proposed to better identify opportunities in agriculture, mining and petroleum or gas extraction. At least in regard to mining, the 2014-15 federal budget has delivered, with small explorers able to access $100m in exploration development incentives to pay as a refundable tax offset to Australian shareholders. The Territory budget also includes $15.8m for resource exploration and $8m over four years to assess the Northern Territory's shale gas potential; and $0.4m pa for administrative support for Ord Stage 3, with indications of additional funding to come. It is notable that despite its very modest financial resources, and extreme dependence on Commonwealth funding for basic services, the Territory subsidises mining more than does South Australia, and Victoria and Tasmania put together (Peel et al. 2014).

In the kinds of sectoral ambitions, overarching Northern Territory policy positions on northern development and approaches to implementation do not differ materially from the neighbouring state jurisdictions (e.g. Premier of Queensland 2014). However, there is a potentially very significant difference in the absence from the Northern Territory of schemes like royalties for regions that return incomes from resource extraction to the regions of origin. Indeed, it has been suggested that Territory financial systems operate in the opposite direction, with federal funds earmarked for investment in remote areas being redirected to major urban centres (e.g. Gerritsen 2010).

Whatever the wider policy context for development agendas, they clearly seek and require substantial land use change and, necessarily, increased pressures on environmental values. But they make no special provisions to deal with them. Even if ambitions are only partially realised, it is likely that there will be many opportunities for productive use of offsets to reduce environmental impacts or, more ambitiously, link development to environmental improvement. We now consider how existing policy and law for managing land and resources in the Northern Territory support or constrain that sort of offset use.

8.1.1.2 planning for environmental improvement

As for development, there are no general, cross-sectoral provisions in Territory law for planning land, biodiversity or resource conservation. For example, there is no equivalent of the bioregional planning provisions of the federal *Environment Protection and Biodiversity Conservation Act* 1999. Nonetheless there have been several exercises over the last decade or so to identify Territory sites supporting important natural heritage/conservation values. The Parks and Conservation Master Plan (PWCNT 2005) set out priorities for building a stronger protected lands network but was never seriously implemented. Its technical core appears to have been replaced by publications on sites of conservation significance (Harrison et al. 2009; Ward and Harrison 2009), which have been cited elsewhere in this report (Section 11.1.1.1).

Neither of these efforts had or now have status in law or whole-of government policy. Sites of conservation significance documents are treated in government citation as publications by government staff, rather than statements of government policy. To the best of our knowledge, no land use, environmental assessment or resource allocation and management laws or whole-of-government policies require that these statements be considered in decision-making. They can be most plausibly treated as the best available single-agency analysis of areas warranting special attention in conservation and land use planning. They are therefore of value for this study in providing context for sites warranting special attention and the potential to supply effective offsets: in locations that have been subject to in-depth analysis by conservation practitioners with optimal access to government-held and managed information on both values and potential threats and the skills to apply this knowledge.

To summarise, in 36 years of self-government, the Territory has not developed strong regional planning institutions or culture. Arguably, deep dependence on federal general purpose funding for basic services, and gaining access to tied grants built around national programs for discretionary spending, works against strong commitment to large scale land use planning. Leaving aside ideological reasons for de-emphasising planning, agile, *ad hoc*, response to opportunity created by shifting federal government priorities and private investment decisions may appear to offer greater immediate benefit.

But the absence of well crafted plans for Territory economic and social development and environmental management may also compromise the Territory's status as a self-governing jurisdiction with ambitions for statehood[22]. The absence of compelling, locally-developed alternatives to centralised national programs may encourage federal experiments of the sort exemplified by the Northern Territory Emergency Response (see Aboriginal and Torres Strait Islander Social Justice Commissioner 2008). The intervention required suspension of aspects of the *Racial Discrimination Act* 1975 (Cth) as well as substitution of central bureaucratic control for local-decision-making. The extraordinary land use intervention promoted by the Northern Territory government in its submission to the Joint Committee is arguably an intra-Territory equivalent: extreme measures taken to in preference to serious efforts to fill gaps in participative land use planning. A northern development push, unshaped by a genuine local narrative, positions external boosters to over-whelm regional and local perspectives, priorities and knowledge.

8.1.2 Planning Law

Notwithstanding apparent disinterest in regional planning, the Territory does have access to some of the formal institutions needed to support such work. The *Planning Act* enables the NT Planning Scheme (NTPS 2014), which purports to control land use throughout the Northern Territory. It is organised hierarchically through framework drawings and area plans that identify the expected nature of future development. An NT wide framework crudely outlines rural, pastoral, agricultural, urban and national park lands, overlaid by indications of areas of mineral prospectivity. Other, more detailed frameworks are confined to relatively small areas around the larger towns of Darwin, Katherine, Tennant Creek and Alice Springs. There are several frameworks for the Darwin area, namely Darwin, Coomalie and Finniss regions.

Zoning systems and their associated maps covering urban and local framework areas prescribe accepted uses and sets of development rules applying to those uses. But most land is unzoned and there the *Planning Act* has limited application. An important exception to this gap in application of development rules arises in regard to clearing of native vegetation, where specific provisions are made in the NTPS (Section 10.3). Assessment roles and some powers for permitting land clearing are delegated to the Department of Land Resource Management (DLRM) and the Pastoral Land Board established under the *Pastoral Land Act* 1992 to apply guidelines issued by DLRM.

This admittedly narrow application of the Act outside urban settings illustrates the potential for a larger role, namely to identify nodes and set parameters for development and complementary conservation actions at large spatial scales on unzoned land. The Planning Commission has in fact argued for a central role in supporting Territory development (Planning Commission 2014). However, despite the potential and the Planning Commission's claims, presently limited coverage of unzoned land, narrowness of the formal planning agenda in recent whole-of-government statements (NTG 2013) and precedent all indicate limited will or capacity to manage the technical issues and tradeoffs involved in planning for large scale land use change. For example, during 2004/5, a Community Reference Group on the Daly River charged with development of a land use plan to manage agricultural development while protecting natural and cultural values, was unable to secure the active engagement of planning bureaucrats. Its efforts culminated in a somewhat idiosyncratic

[22] http://newsroom.nt.gov.au/mediaRelease/8935

list of disputed recommendations of limited utility to government (PJ Whitehead, personal observation). The community group created to carry on that work has since been disbanded.

Can sector-specific land and resource management laws individually or collectively address these weaknesses?

8.1.3 Land and renewable resource management law

We begin our examination of this question by considering key laws for forms of land use that involve protection of land for intrinsic values or to maintain consumptive use of renewable resources.

8.1.3.1 Pastoral Land Act 1992

This law controls use of the very large public estate (more than 60 million ha) held under pastoral lease. Leases must be used predominantly for commercial grazing of domestic stock. Other uses are permitted provided they do not individually or cumulatively displace pastoralism as the dominant use. A Pastoral Land Board has roles in decision-making about many aspects of lease management, including approvals of major and all but irreversible change like land clearing and irrigated agriculture. Such change may place additional demands on land, forage and waters, not just on site but more widely (see Sections 6.3.1.5 and 11.1.3.3). Given the Pastoral Land Board's obligation to promote the economic viability of the pastoral industry and the nature of its membership, the Board does not appear to be well positioned to weigh offsite effects against private on-site benefits and hence to contribute to regional-scale plans that take multiple interests into account.

An important Board responsibility is to monitor condition of these public lands, held under leases that require maintenance of productivity for pastoralism and "prevention or minimisation of degradation of or other damage to the land and its indigenous plant and animal life". Recent reports (e.g. PLB undated) suggest weakness in meeting these obligations, with very few sites assessed in 2011/12 (see Figure 16 below).

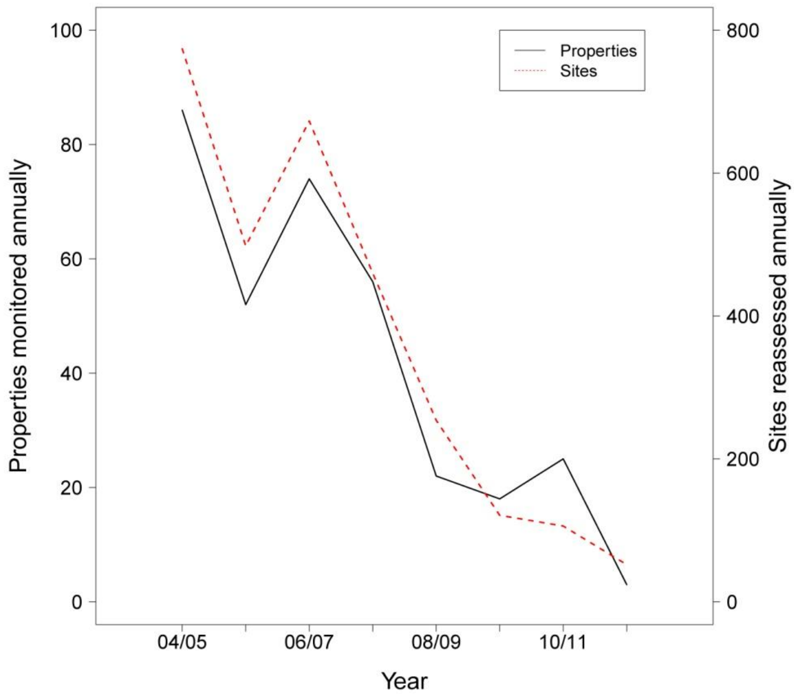

Figure 16: Acute reduction in activity of the Pastoral Land Board in monitoring condition of pastoral leases from 2004/5 to 2011/12, taken from the 2011/12 report. At the time of writing (May 2014) the 2012/13 report had not been posted to the relevant website.

This is unfortunate. Although the Board's monitoring role is constrained to consider indicators of on-site condition, many of the variables relevant to management of impacts of grazing on future production, like covers of perennial grasses and areas of bare ground, also indicate erosion risk and potentially large scale cumulative effects of sedimentation and nutrient flows offsite. Given the dominance of the pastoral estate, information on its condition is essential for sound environmental management at regional and larger scales. The present provisions of the Act and the performance of the institutions developed to apply it do not favour a productive role.

8.1.3.2 Soil Conservation and Land Utilisation Act

This Act is a very old fashioned one, providing a legal and administrative framework mostly suitable for reacting to evidence of land degradation rather than preventing it. Although the Act has some references to wider responsibilities for utilisation of land, the lens applied is mostly the suitability of soils for specified uses and associated risks of erosion. Vegetation, for example, is seen as having a role as a stabiliser of soil and landforms under pastoral or other use, rather than having independent value.

A Commissioner for Soil Conservation may declare "areas of erosion hazard", which could contribute to land use planning and effective implementation of plans. Determinations of land capability are used (through preparation of land system and land unit maps) to contribute to a range of planning activities, but the Commissioner has no other formal planning role. Guidelines have, for example, been adopted under the *Planning Act* 1999 (NTG 2013b) for application of land capability assessments, including soil issues, which must accompany subdivision applications for zoned rural or unzoned lands. A Soil Conservation Advisory Council may provide advice on land utilisation matters, which the relevant Minister could choose to promote in land use planning. But the Council, if it is populated at all, appears to have no present role in planning. The contemporary role appears to emphasise agency technical support for decisions made under other law.

8.1.3.3 Territory Parks and Wildlife Conservation Act

The title of this Act indicates its key role in declaration and management of protected lands. A companion law, the *Parks and Reserves (Framework for the Future) Act* 2004 sets a target for a comprehensive systems of parks and reserves, which it defines as:

(a) developed in partnership (with) the traditional Aboriginal owners of the parks and reserves;
(b) benefitting traditional Aboriginal owners by recognising, valuing and incorporating indigenous culture, knowledge and decision making processes;
(c) protecting biological diversity;
(d) serving the educational and recreational needs of Territorians and visitors; and
(e) enjoying widespread community support.

The present network is presumably not regarded as comprehensive because government analyses identify many areas of high conservation significance outside the protected lands network. This creates a substantial "space" for informed use of offsets. And the TPWCA, in addition to providing for formal declaration and management of conservation parks, provides other mechanisms for protecting important places and phenomena. It provides for management of populations of wild plants and animals wherever they occur, including declaration of essential habitat. It does this in part through wildlife (both plant and animal) management programs for conservation and sustainable use.

Conservation management programs provide special measures for protecting and fostering recovery of populations of threatened species, which will require consideration in any regional development proposition. And in turn can be modified to add new measures to cope with related change. Provisions are made for agreements with landholders to protect sites outside the formal reserve system, involving covenants that can be registered on title (see Fitzsimmons and Carr 2014 for a discussion of statutory covenants and their use and effectiveness in Australia). However, application has been compromised about concerns about compatibility with the *Pastoral Lands Act* and the extent to which agreements may trigger rights under the *Native Title Act* (Cwlth). Agreements with Indigenous landholders may be less problematic. For example, the Dhimurru IPA in north east Arnhem Land is subject to an agreement under the TPWCA[23] that sets out how the Territory and other parties will work together to achieve conservation objectives.

Landholder obligations and government powers to require control of invasive species that threaten natural values are also specified. These powers and prerogatives are exercised by the Parks and Wildlife Commission of the Northern Territory.

The Act also provides for managing commercial use of native plants and animals. Access is granted through permits theoretically issued in accordance with a management program approved by the Administrator (functional equivalent of a state governor). In practice permits may be issued in the absence of such programs, which, as in water management (below), are usually framed and approved when emerging levels of demand are thought to require regulation. TPWCA-established programs are usually also submitted for approval under federal law (the *EPBCA*), to cover obligations under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), when products may be exported from Australia or are similar to other endangered species subject to trade.

The Territory has approved programs including commercial use for two species of crocodile, magpie geese and cycads[24]. Part of the rationale for investing in programs for sustainable use is to provide financial incentives to landholders for protection of wildlife habitat (PWCNT 1997). Evidence that this works is relatively weak, aside from an example of crocodile harvesters on a pastoral property acting to protect nest sites.

The protected lands system enabled by the TPWCA clearly has a key role in effective regional land use planning, to protect a geographical subset of natural and cultural values of all kinds, as well as maintaining the ecosystem services that enable other land uses. The array of options for: securing conservation obligations on lands and seas; managing threatened or over-abundant species; and facilitating livelihoods based on sustainable use of wild plants and animals in preference to habitat modification, all offer useful tools for implementing large scale land use plans. The TPWCA was the principal vehicle for implementation of the now defunct Territory Ecolink program, designed to achieve a system of ecologically connected lands managed by government and private interests for conservation. Reference to the Ecolink program appears to have been expunged from relevant agency websites[25].

8.1.3.4 Heritage Act

This law protects cultural and natural heritage places and objects. For most classes of places or objects, specific nominations are made and assessed against criteria in the Act and declared by the relevant Minister. In addition all Aboriginal and Macassan archaeological places and objects are automatically declared. This offers a useful measure of protection in that developers are obliged to consider their significance and the implications of disturbing or destroying them. However, protection is not absolute and many developments proceed even when destruction or damage is dictated by the particular development, such as the location of an ore body to be extracted.

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[23] http://www.atns.net.au/agreement.asp?EntityID=1530

[24] http://lrm.nt.gov.au/plants-and-animals/information-and-publications/approved-management-plans#.U3_v1ijm4vG

[25] remnant descriptions of the scheme can be found at other non-government sites including http://www.greeningaustralia.org.au/uploads//General%20pdfs/NT_EcoLink_prospectus.pdf

Although the Act potentially deals with both natural and cultural heritage, there has clearly been a strong operational emphasis on the cultural. The few listed natural heritage places are mostly in parks or reserves already protected by other laws or cover things like historically significant individual trees rather than significant areas. A niche use may be to declare as heritage sites areas of essential habitat for wildlife on non-Indigenous freehold lands, where provisions of the *Territory Parks and Wildlife Conservation Act* do not apply. The prospects of deployment of the Act in this way being acceptable to Indigenous cultural interests would probably be increased if the monitoring and enforcement capabilities of the responsible agency were increased considerably. Penalties for damaging declared places or objects are potentially substantial (up to 2 years imprisonment).

The orientation of the Act and its application to often small sites and individual objects limits its utility as a planning instrument. Its relevance lies chiefly in establishing a class of sites that will require consideration in any planning exercise.

8.1.3.5 Northern Territory Sacred Sites Act

This law is designed to:

> *effect a practical balance between the … need to preserve and enhance Aboriginal cultural tradition … and the aspirations of the Aboriginal and all other peoples of the Territory for their economic, cultural and social advancement, by establishing a procedure for the protection and registration of sacred sites, providing for entry onto sacred sites and the conditions to which such entry is subject, establishing a procedure for the avoidance of sacred sites in the development and use of land …*[26]

Persons wishing to use or carry out work on land registered as a sacred site may apply to the AAPA for an authority certificate, which, if issued, will set out the areas in which work may or may not be done and other conditions attaching to the work. The AAPA's decision can be reviewed at the request of the applicant by the Minister who may override and issue an amending authority. Land registered as a sacred site may be acquired by government and vested in the AAPA to improve protection of sacred sites. There are substantial penalties for damaging sacred sites and there was a recent successful prosecution[27].

Many sacred sites are valued by their Indigenous custodians for a role in maintaining the health of wildlife populations. Respect for Indigenous views requires that such sites are treated as significant in a whole of society view of good practice in biodiversity conservation. Indeed, such places can play a significant role in conservation when evaluated from an orthodox scientific perspective (Joshi and Gadgil 1991; Dudley *et al.* 2009).

As with the *Heritage Act*, the relevance of this law to planning at large scales is in clearly identifying and protecting individual or sometimes linked sites that require special consideration.

8.1.3.6 Fisheries Act

This statute and associated regulations control the taking of fish and other aquatic life for commerce and recreation from fresh and marine waters. An important mechanism for implementation is the framing of management plans which have the status of legislative instruments. Measures may include specification of methods, locations and scale of take, as well as creation of reserves for protecting aquatic life. The *Fisheries Act* also regulates aquaculture.

The Act's formal objects also make some potentially important statements about the way it will be applied. Its objects refer to ecological sustainability, management at the level of ecosystems,

[26] Preamble to *Northern Territory Aboriginal Sacred Sites Act 1989*

[27] http://www.aapant.org.au/bootu-creek-site-damage.html

protection of fish habitats, and promoting "fairness, equity and access" to all groups in "stewardship" and "optimum utilisation" of aquatic resources. These ideals cannot be achieved without a strong commitment to and good tools for planning. However, the draft "fisheries resource-sharing framework" alluded to in Framing the Future (above) appears as little more than a statement of the process the relevant agency will follow in dealing with any party who seeks change in allocation processes (DPIF 2013). And the details of that process, in giving a primary role to industry-dominated fishery management advisory committees, would appear to weaken prospects of real innovation towards more equitable arrangements.

A comprehensive framework would ideally be underpinned by some sort of geographic perspective to identify those who should involved and arrangements to accommodate regional differences in issues and circumstances. Unfortunately, there is no history of fisheries management bringing a keen spatial perspective to resource management, with most licensing systems leaving choice of harvest sites to licence holders and so compromising the ability of local communities to integrate commercial fishing pressures with their own livelihoods and environmental management obligations (Whitehead and Storrs 2003; Whitehead 2012). Precedent - such as failure to clearly integrate fisheries management powers with management of the Cobourg Marine Park - also offers little prospect that the *Fisheries Act* will be used actively to support integrated planning at any scale.

8.1.3.7 Water Act

This legislation establishes the conditions under which water claimed as owned by the state may be accessed for consumptive use. It does not have a formal objects. Its description as law "to provide for the investigation, allocation, use, control, protection, management and administration of water resources" clearly outlines operational intent but give little insight to the principles that will be applied. Activities and functions potentially include water markets, although no formal sale of water under a water allocation plan appears to have occurred in the Territory yet.

Beneficial uses are defined as agriculture, aquaculture, public water supply, environment, cultural, industry (including mining or petroleum activities) and rural stock and domestic. Environmental water is to maintain the health of aquatic ecosystems and cultural to meet aesthetic, recreational and cultural needs. For non-mining industrial, agricultural and pastoral producers and water supply utilities, allocations are determined and licences are granted from a consumptive pool, determined by estimates of sustainable yield and, in systems where they have been established, through water allocation plans (WACs) approved by the relevant Minister. Where there is no WAC the consumptive pool is limited to no more than 20% of the sustainable yield.

The specification of environmental and cultural values of water along with other uses is conceptually distinct from some other resource extraction laws (below) which treat environment as a side issue, to be looked after when "practicable". However, this conceptually strong aspect of the law is lost in implementation. There is no formal allocation of water to the environment or culture and no institution with specific power to hold and deploy such water entitlements. Neither the NT nor any other Australian jurisdiction has developed explicit allocation or management arrangements for cultural water. Cultural water has tended to be confounded with environmental water in treatment of allocations (see, for example, page 15 in NRETAS 2009).

The Act provides processes for regulating construction of impoundments and discharge of pollutants to water. The pollution management powers are mostly delegated to the NTEPA (see 8.1.5 below under Environmental impact assessment).

Water allocation plans may be made at the discretion of the Minister but are not mandatory. Agency policy is to declare water control districts and establish a planning process when demand increases enough to raise concerns about competition for water and sustainability of use. It is not clear how thresholds of concern are set, but they perhaps need improvement because one of the water resources presently in the planning phase may be at risk of over-allocation (Nolan 2010). The only water allocation plan approved for the Top End - for the Katherine Tindall Limestone aquifer - makes no separate provision for cultural water. And, as mentioned elsewhere, does not make explicit provision for mining water.

Many decision-making powers are vested in the statutory office of Controller of Water Resources. This pompous nomenclature is congruent with the prerogatives that accompany it, allowing, for example, issue of licences for extraction of ground and surface waters outside formal water plans. Large proportions of the estimated consumptive pool can be issued, at no financial cost to the recipient, and without formal assessment of effects on the interests of other potential users: issues that a water allocation plan is designed to address.

Even when plans have been drafted, decision-making can appear arbitrary. In justifying issue of a very large licence from the Tindall limestone aquifer outside a water control plan, government in part justified the decision on a mis-specified water model: treated as wrong because it had drawn on all available rainfall records rather than the most recent 40 years, when rainfalls had apparently been consistently higher (Applegate 2013). There has been no detailed explanation of the decision to ignore early records of sequences of very low rainfalls, but it was apparently based on a belief that the relevant regional rainfall regime was permanently reset substantially higher with effect from the mid-1970s. Presumably this approach will be applied to other models, redefining estimates of water availability throughout the NT tropics, coincidentally at a time when expansion of broad scale irrigated agriculture is also being vigorously promoted.

The apparent confidence in higher projections of sustainable yield used to justify a very large allocation is undermined somewhat by the connected argument that the relevant draft water (Mataranka) allocation plan for the Tindall limestone aquifer does not apply because it needs recasting to secure a water supply for the town of Ngukkur. The town draws its water supply from the downstream Roper River, which is dependent on inputs from aquifers to maintain dry season flows. Such an obvious omission from the planning process indicates fundamental weaknesses. A Catchments Advisory Committee[28] has recently been established for the community to have input to Territory-wide water and land use policy. Government has argued that resource- or region specific planning committees will remain in place. However, at the time of writing (June 2014) records on the agency websites for northern committees report no activity for more than 20 months.

In its most recent report on water planning, the NWC identified the incomplete development of the water planning process and its dominance by incomplete plans, weak monitoring and reporting, fragility of non-legislated arrangements allocating water to mining and petroleum extraction and lack of transparency in such allocations as weaknesses (NWC 2014). Present arrangements and performance in water management do not match the NWC's expectations for high standards of water management in north Australia (NWC 2012).

Interestingly, the Act includes none of the language about equity of access and fairness seen in the *Fisheries Act*. Notional allocations to Indigenous people to provide for future development of Indigenous lands have been repudiated by government, despite previous inclusion in a duly approved water plan (Katherine region Tindall Limestone aquifer: NRETA 2009).

Notwithstanding these operational quirks, the *Water Act* has the potential to support much of the institutional infrastructure needed to conduct and implement effective regional land and resource use plans, especially if carefully coordinated with application of other relevant law. Recent acute changes in practice illustrate the fragility of the Territory water allocation process when uncoupled from well-developed policy and sound development and conservation planning. And they also underline the improbability of full restoration any time soon of serious, community-based planning processes that genuinely influence exercise of power.

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[28] http://newsroom.nt.gov.au/index.cfm?fuseaction=viewRelease&id=12030&d=5

8.1.3.8 Weeds Management Act

As well as controlling the movement or cultivation of invasive plants, this law sets obligations for landholders to control weeds and provides for government to frame weed management plans. In addition, government may support landholders with weed management activities where it is in the public interest to do so. Weed management plans will be important components of sound and integrated land use plans.

8.1.3.9 Bushfires Act

Unplanned or poorly managed fire is clearly damaging Territory landscapes and their conservation and cultural values (see Sections 6.4.4 and 11.1.3.8).

The *Bushfires Act* 1980 provides for use and prevention of fire in rural settings. Its orientation is strictly to protection of life and property: the word environment is not used in the statute. Although clearly not designed for managing environmental issues, it does permit landholders to use prescribed burning for any legitimate purpose, which has included environmental management. The Act also establishes some infrastructure for integrated regional approaches to fire management: through regional committees and scope to determine fire protection zones and fire danger areas influencing allowable actions, but does not otherwise provide formal recognition and support for regional plans of prescribed burning.

8.1.3.10 Other Acts

The *Emergency Management Act* is mostly concerned with response to natural and man-made disasters. Large scale or severe impacts on environments would not necessarily trigger its provisions unless those changes put human life and property (including animals and plants used in production) at risk. Its relevance to land and resource use planning arises chiefly in the potential for other plans to be over-ridden at least temporarily to deal with emergencies, including those including responses like use of biocides to control animal or plants disease. A number of other laws like the *Biological Control Act* and the *Biological Resources Act* could be relevant under exceptional circumstances but too infrequently to warrant detailed consideration here.

To summarise, the array of land and resource management and conservation law summarised above could be used collectively to provide heads of power for framing and implementing sound land use plans for securing sustainable development. Even without deployment of the *Planning Act* beyond its present land clearing provisions, a combination of the *Water Act* and *Territory Parks and Wildlife Conservation Act* could be used to engage the community in planning to foster enterprises based on renewable resources while maintaining ecosystem services and protecting other valued natural and cultural attributes. And engagement in planning will increase the capacity of local communities to frame their own development ideas and then take advantage of emerging opportunities (McGuire 1994). Deploying these laws in this integrated way would, however, be unprecedented in the Northern Territory and, based on experiences like those in the Daly River, severely challenge both political and public sector systems and personnel.

8.1.4 Managing non-renewable resource use

We now turn to laws that regulate access to land (across different forms of title or designated land use) for taking non-renewable resources: that is, for extractive industries. Do they also offer tools for delivering the landscapes that local society may want, as distinct from those that haphazard development dictates that they endure (Hamblin 2000)?

Important general features of these laws are that they: often deny land owners much influence over activity on their land; recognise that activity is often relatively short term (for a few years to decades); extraction of the resource can involve extreme levels of disturbance; and this disturbance can constrain other options for uses of land over the very long term. There is therefore a necessary emphasis on rehabilitation of sites after extraction of a non-renewable resource stops.

Their particular significance for land use planning is that they can over-ride plans made to achieve other objectives.

8.1.4.1 Mining law

Key Northern Territory statutes covering mining include the *Mining Management Act* and *Mineral Titles Act*.

The *Mineral Titles Act* establishes mechanisms for granting access to land and waters for exploration and extraction of minerals or other extractive materials like sand. Although consent is required for preliminary exploration, it may not be unreasonably withheld. And when an exploration title is issued, holders are required only to advise landowners of proposed activities. Parks and reserves are not necessarily protected from exploration or extraction, but the relevant Minister may specify conditions. Holders of mineral title have the right to use or divert water for the activities covered by the title.

The Act provides for reservation of areas from mining and cancellation or reduction in the area of a mineral title if "beneficial to the Territory". Definitions of benefit in Regulations include protection of flora and fauna. These provisions could be used to offer nominal protection of offsets from future mining, but given ministerial discretion, the security offered is relatively weak compared with other forms of land use regulation.

Mining and energy law is characterised in all Australian jurisdictions by very limited rights of landholders, emphasis on its distinctness from other forms of resource management, and in the process, "immunity" from many of the controls that apply to other components of the resource management and conservation armamentarium that governments have built. For example, the National Water Commission (Maywald 2013) has noted the anomalous treatment of water for mines, which may be taken outside normal planning processes.

Indigenous landowners have some additional rights under federal law to refuse access early in the exploration process: a right that has been exercised in a number of cases. Rights as originally recognised were relatively strong - a right of veto at all stages of the mining process under the ALRA, and a native title right to negotiate where native title had not been extinguished (e.g. pastoral lands). ALRA provisions were weakened in 1987 to allow veto only at the exploration stage (agreement to exploration could not be followed by refusal of extraction). Native title rights to negotiate were also tightened somewhat in 1997. The right for Indigenous people to withhold consent to exploration does not apply to extractive materials like sand or gravel.

In many parts of Australia, there is public dissatisfaction with the limited capacity of all landholders to protect their lands, most obviously triggered by the multiple intrusions over large areas necessary for coal seam gas extraction and associated risks to ground-waters (Windle and Rolfe 2014). In the

Territory similar concerns have been raised by both Indigenous[8] and non-Indigenous landholders[29]. As noted earlier the Northern Territory Government has in one case responded to such expressions of public concern about new modes of mining by executive *fiat* rather than formal action, and proposed an indefinite "ban" on sea-bed mining in the Groote Eylandt area[30] in an informal public statement. The Department of Mines and Energy continues to refer to a general moratorium on seabed mining pending an Inquiry begun by a statutory body that has since been abolished[31]. The ambiguity here reflects the ease with which positions could be changed. They provide at best a limited basis for comprehensive land use planning identifying values and sites that warrant long term protection from mining or other severe disturbance.

The *Mining Management Act* provides for management of mining sites for environmental protection and worker and public safety. Its objects are to:

(a) ensure the development of … mineral resources … with environmental standards consistent with best practice in the mining industry; and
(b) protect the environment by:
    i. authorisation and monitoring of mining activities; and
    ii. requiring appropriate management of mining sites; and
    iii. requiring … a management system for the site … ; and
    iv. audits, inspections, investigations, monitoring and reporting on compliance with … standards and criteria; and
    v. specifying obligations of all persons on mining sites for protecting the environment; and
(c) assist … industry to introduce programs of continuous improvement to achieve best practice environmental management; and
(d) promote … relationships between the mining industry and communities affected by mining to facilitate the provision of economic and social benefits to those communities; and
(e) minimise the liability of the Territory by requiring the payment of security … for rehabilitation of mining sites or to rectify environmental harm caused by mining activities; and
(f) require payment of a levy to provide funds for:
    i. a Mining Remediation Fund; and
    ii. effective administration … to minimise or rectify environmental harm caused by mining.

To a reader from outside the mining industry this appears as a peculiarly unambitious approach to protecting the public interest. The flow of ideas can reasonably be paraphrased as:

(1) the mining industry will set standards;
(2) government's role is to help industry meet those standards; and
(3) government will still accept some liability to fix problems caused by mining to industry standards; and
(4) it is acknowledged that industry standards have been and are expected to continue to be insufficient to protect or repair important values because an ongoing levy is required for remediation.

Complying with these obligations is compromised by the detail of Territory mining and other policy and law. For example, by repudiating biodiversity or other offsets, the Territory is inviting actions inferior to industry best practice (e.g. ICMM 2006; IUCN-ICMM 2013, MCA 2014), and weakening government's capacity to support industry to take up and succeed in applying best practice. Design

[29] http://www.abc.net.au/news/2014-03-27/nt-cattlemen-fight-for-voice-in-mining-boom/5350508
[30] http://www.abc.net.au/news/2013-06-12/groote-eylandt-seabed-mining-total-ban-nt-govt/4749576
[31] http://www.nt.gov.au/d/Minerals_Energy/index.cfm?newscat1=&newscat2=&header=Sea%20Bed%20 Mining%20Moratorium

of the Mining Remediation Fund also appears likely to set challenges for maintaining best practice in rehabilitation over the long term. Immediate access to funds through levies have been traded off against the size of rehabilitation bond required of mining companies, placing at risk capacity to deal with future problems (see Section 0 above). The suggestion that this fund may be used to ensure effective administration of the Act is also of concern, if this means that costs are to be shifted from existing agency budgets to a levy received at the expense of long term rehabilitation capacity.

There would appear to be some potential for existing laws to be used to support regional land use planning. For example, provisions of the *Mineral Titles Act* for reserving sites from exploration or extraction and reducing the size of titles could be used to "tailor" effects on other land users to optimise tradeoffs of one use for another and minimise impacts on ecosystem services. Some of the language of the administering agency in their strategy (Section 8.1.1.1 above), namely to "implement development zones for minerals and energy resources" could be taken to imply an intent to identify regions of unusually favourable prospectivity and perhaps proximity to infrastructure. This would have the virtue of identifying, for other land users with incompatible needs, sites to be avoided. More optimistically, planning for such zones would identify particular risks and include standards for environmental management to provide reassurance to the public and regulatory certainty for miners. Regionally-tailored standards could be set as conditions for exploration and extraction to promote compatibility with other uses and to avoid the cumulative impacts invited by case by case approaches.

8.1.4.2 Petroleum and gas extraction law

The *Petroleum Act* is the principal legislation for petroleum tenure, exploration and production onshore and on inland waters of the Territory. The *Petroleum (Submerged Lands) Act (NT)* covers tenure, exploration and production in NT coastal waters. Exploration activities include airborne gravity and magnetic surveys, ground-based seismic surveys and well drilling. Production may involve further well drilling, construction of gathering systems and production facilities. In regard to environmental issues, the Act requires "the reduction of risks, **so far as is reasonable and practicable** (our emphasis), of harm to the environment ...".

In 2011, the Department of Mines and Energy began a review of the suitability of current legislation with a view to accommodating unconventional gas (in the Territory mostly shale gas). The report from that review emphasised environmental matters, including better integrated management of water, and recognised the need for baseline data on groundwaters "prior to unconventional gas resource activities"[32]. The agency proposed to deal with most of the matters raised by making new Regulations under the *Petroleum Act*, but that work does not appear to have been completed.

The Government has also announced an independent Inquiry on hydraulic fracturing to be conducted during 2014. The NT EPA has said that "it expects to use the outcomes of the inquiry to develop environmental assessment guidelines or standards to assess and manage fracturing activities in the Northern Territory"[33]. The Inquiry's terms of reference (Attachment 3) are strongly operational in focus: that is, how to do unconventional extraction better. The Commissioner has not been asked to address the big issues that have been contentious elsewhere, such as conflicts between agriculture and extraction, rights to refuse access, and competition for water. They do not refer explicitly to special environmental standards that should be applied to this class of activity, or ways of protecting high value natural or cultural heritage assets from the multiple intrusions that appear to be inherent in the technology. Interpretation of the relevance of the terms of reference to cultural and social issues depend on what "environmental risks and environmental impacts" are taken to mean, but there is certainly no overt direction to consider specifically Indigenous or other

[32] http://www.nt.gov.au/d/Minerals_Energy/index.cfm?header=Legislation%20Review%20-%20Petroleum
[33] http://www.ntepa.nt.gov.au/news/2014/hydraulic-fracturing-inquiry

cultural concerns, or intangibles like loss of amenity. This narrow focus would appear to make it much more difficult to follow proposals in the 2011 report for closer integration with work on water resources.

As with mineral extraction, the option exist to reserve "blocks" from exploration or extraction and set conditions for all activity, again at Ministerial discretion. Willingness to deploy these powers in regional land use planning, including "development zones for ... energy resources" - and by implication, non-development or restricted development zones - could help reduce risk of land use conflict, especially in the development of unconventional oil and gas extraction.

8.1.4.3 Geothermal energy extraction law

Objects of the *Geothermal Energy Act* are to promote exploration for geothermal energy resources, including the right to occupy areas of land for exploration and production, and to protect the environment during these activities. The general tenor of the act is similar to Territory mining and petroleum laws in terms of environmental management, imposing a general obligation to take care of the environment. More specifically, authority holders must take all reasonable actions to prevent contamination between aquifers and hydrocarbon bearing formations or leakage from, or pollution of, aquifers or hydrocarbon bearing formations. Given apparent dismantling of NTG institutions dealing with climate change and related emissions management, it is not clear how issues like methane emissions would be handled. It may be that these sorts of issues will be picked up in the fracking management inquiry to be conducted in 2014 (see Attachment 4).

Provisions for reservation of areas from this activity are similar to those for extractive industries, again offering potential to facilitate more effective land use planning.

To summarise, laws governing extractive industries do provide some options for building protection of sites valued for natural and/or cultural attributes into decision-making processes within joined up plans for sustainable use of landscapes. Reference in agency strategies to identification of development zones could be taken to imply some interest in planning to deal with the environmental and social impacts at foci of more intensive activity in an integrated way. Optimistically, the at least rhetorical references to such options perhaps provide an opening for initiating dialogue.

We have devoted time and space to consideration of options to support planning of land use in Territory law not just because the DbD processes depend on planning, but because embedding offsets in plans for healthy landscapes improves prospects of enduringly successful offsets. We turn now to law dealing specifically with environmental assessment processes and options for deployment of offsets.

8.1.5 Environmental impact assessment

The core Northern Territory law for assessment of development proposals is the *Environmental Assessment Act* 1982. Processes are described in the *Environmental Assessment Administrative Procedures* 1984. Penalties are prescribed in the *Environmental Offences Penalties Act* 1996. These laws are predominantly reactive and procedural in focus and provide little guidance on the reasons for undertaking environmental assessment or the environmental objectives or management principles that will inform analysis and decision-making.

Enactment of the *Northern Territory Environment Protection Authority* Act 2012 created an independent authority with the role to undertake functions in environmental assessments and waste management and pollution control. That law provides more information on intent, emphasising sustainable development and effective waste management and minimisation. The NTEPA may advise the Minister on environmental matters on request or offer advice on its own initiative. The Act obliges the relevant Minister to give reasons for failure to follow advice.

The NTEPA also administers law, the *Waste Management and Pollution Control Act* and *Marine Pollution Act*, for regulating industrial and other discharges to the environment. Discharges to water (freshwater and marine) are also regulated under the *Water Act* and discharge licences issued by the NTEPA. Most discharge licences are issued for sewage, mining, aquaculture and dredging spoil.

In accordance with the statutory requirement to carry out its functions in ways that "encourage community involvement and engagement" and "ensure transparent processes and provide certainty to business", the NTEPA has embarked on a program to issue guidelines in assessment practice (NTEPA 2013b-i, 2014b-f). However, the additional detail on intent and method remains fairly sparse. For example, the NTEPA (2013c) *Policy on recommendations made in reports arising from the assessment of public environmental reports and environmental impact statements* does not mention the mitigation hierarchy and alludes only to the avoid and minimise obligations: there is no mention of restoration or compensation.

The NT environmental assessment process, including its interactions with the federal assessment systems is shown in the NTEPA-issued flowchart copied at Attachment 3. Those interactions are managed, as with all state jurisdictions, through a bilateral agreement with the federal government, a new version of which is presently under review (DoE 2014). The goal of the present federal government is to have a one stop shop for all assessments, including those that trigger the EPBCA. Both Territory and federal law require that most substantial projects are assessed. The aim to simplify without necessarily ensuring compatibility of policy detail and process raises important questions for offset deployment in the Territory.

8.1.5.1 Offsets and EIA

Arguably the most unique and distinctive feature of the linked processes summarised in the NTEPA flowchart is the anomaly created by Territory decision to reject a role for environmental offsets in local processes. The NTEPA's (2013b) guidelines on environmental offsets notes that:

> *Unlike environmental assessment legislation in other parts of Australia, the Northern Territory's* Environmental Assessment Act *makes no provision for imposition of an environmental offset, or social or other community benefit, as a part of an assessment or approval process. The NT EPA has no role in requiring, developing or managing environmental offsets or similar requirements in conditions of approval.*

But providing offsets may be set as a condition of project approval under the EPBCA (see Section 8.3.1 below), drawing on the federal government offsets policy (SEWPAC 2012). The draft bilateral agreement cited above specifies that when preparing Assessment Reports on relevant impacts under this Agreement, the NT agrees to take account of the Commonwealth Environmental Offsets Policy.

Where offsets are identified as necessary to meet these requirements, they may be separately identified in the report.

It is difficult to see how the NT can discharge this obligation when its assessment authority says it has no role and presumably seeks to develop no capacity to identify and assess offsets capable of dealing with matters of national environmental significance. More broadly, the Territory decision to eschew use of offsets can reasonably be interpreted as a willingness to allow residual damage from developments to go uncompensated. Presumably the Territory public are expected to meet those costs, at least where they cannot draw on Commonwealth processes for offsets. An obvious if unlikely alternative interpretation - that the Territory will not approve developments unless they can be designed to prevent **any** damage - makes no policy or operational sense.

But there is perhaps a third option, alluded to in a number of the NTEPA guidance documents. Guidelines on "environmental offsets and associated approval conditions" (NTEPA 2013x) imply that social benefits may compensate for environmental losses and, by invoking the role of the Indigenous land councils in negotiating social benefits, that this tradeoff is especially relevant to Indigenous people. That implication is reinforced by a statement in "guidelines for .. economic and social impact assessment" (NTEPA 2014h) that:

> *It would be time and cost effective to coordinate economic and social impact assessment with preparations for meeting the potential requirements of on* (sic) *any perceived need for environmental offsets or meeting similar approval conditions….*

This rather opaque sentence could be taken the mean that the NTEPA expects developers to "pay off" environmental damage through social benefit packages that have, for example, in the past included items like community swimming pools, which although important contributors to recreation and health in remote and impoverished townships, clearly have no connection with environmental condition. Is it being suggested that such immediate public benefits are regarded by the Northern Territory Government or the NTEPA or both as sufficient to offset longer term public costs in accepting environmental damage?

Clearly Territory law, policy and practice leave an important gap or at least idiosyncratic variation in application of the mitigation hierarchy that others might choose to fill or correct. Otherwise management of environmental quality in the Territory is likely to fall below standards applying in other jurisdictions, where there are general obligations to compensate for unavoidable residual environmental damage with at least equivalent environmental benefits. We return to this issue later in this paper.

Significantly for the implementation of the DbD process, which depends in part on capacity to influence design of projects to optimise siting, the NTEPA approach may block the opportunity to become engaged early enough in the mitigation hierarchy to influence such decisions. This issue is taken up later in proposals for a Territory-tuned process.

8.1.5.2 Assessment standards

In regard to present environmental standards, a scan of past environmental assessments indicates that a recurring feature of EIA in the Territory is treatment of uncertainties about the scope or scale of possible impacts as best resolved through monitoring (Attachment 1). The prevailing quality of monitoring, for a major facility is indicated by the conclusion of the Independent Monitor on the McArthur River mine in its first report on environmental performance:

> *Much of the monitoring has been assessed as inadequate to barely adequate in evaluating environmental performance. Furthermore, …. objectives …. (to) "assist in improving environmental management and acting as an early warning system for emerging environmental impacts", has been ignored* (EES 2007).

The mine management's proposal to adopt livestock standards for water outside the mine on the grounds that the mine lies within a pastoral lease suggests low regard for the views of the public and especially Indigenous people with customary ties to this country. Recurring concerns about management are illustrated by presently unresolved problems with spontaneous combustion of iron sulphides in rock dumps[34] (and associated emissions of sulphur dioxide), indicating the scale of risks of acid formation and suggesting that problems for management to prevent acid drainage are also likely.

The wait and see approach and regulator acceptance of proponents' proposals to monitor has been too infrequently accompanied by analysis of plausible responses if outcomes are then found by properly designed monitoring programs to be unsatisfactory. And regulators have rarely required commitments from proponents about specific responses or their funding. It is therefore unsurprising that the Territory has problems with "legacy" mines.

And use of the term legacy is arguably misleading: regulatory decisions for these "legacies" were made under laws and processes broadly similar to the existing statutes as little as 15 years ago. Environmental assessment reports suggest that many of today's legacy problems were not failures of knowledge and unawareness of substantial risk, but rather failures of bureaucratic and/or political will to deal effectively with known risks: risks identified during the assessment process. Whether the recently-created NTEPA will be able to correct such weaknesses, within a legislative framework that is broadly comparable in intent with other jurisdictions but considerably less prescriptive than some (e.g. Western Australia) remains to be seen.

Encouragingly, the NTEPA has issued public reports on two problematic existing mining developments (NTEPA 2013a, 2014a). This openness contrasts sharply with the longstanding practice of NT mining regulators to treat information on impacts as confidential; and is consequently very welcome. However, those reports also highlight the less favourable implication that "residual" impact in the Territory can be severe. There would appear to be a stockpile of candidate sites for deployment of offsets emphasising rehabilitation. However, many of these are likely to be extraordinarily difficult to repair. As a consequence, a preferred approach appears to be to keep the most difficult problems in operation (e.g. the Mount Todd and Redbank mines) so that costs of management are to at least some extent defrayed. Whether maintaining operations to include very substantial expansion of extraction ultimately leads to larger and even more intractable problems in the long run remains to be seen. The difficulty is illustrated by the NTEPA's conclusion in its assessment report that " there remain substantial unresolved risks to key receptors from the Project"[35].

As analyses presented later in this paper will demonstrate (e.g. Section 10.1.3.1), reliance on existing knowledge about presence (or apparent absence) of listed species of conservation interest, whether recognised by Territory or federal authorities, is a high risk approach in the poorly sampled environments of much of the Northern Territory. The steps taken by the NTEPA (2013f) to specify standards for biodiversity surveys to accompany environmental impact statements is therefore an important contribution to improved standards.

8.1.5.3 Strategic environmental assessment

There are many definitions of strategic environmental assessment (SEA), but most emphasise its role as a systematic process for integrating environmental considerations into key (strategic) decisions about policies, programs and plans. It works above the level of individual projects but may provide context for their assessment. Unsurprisingly, gaps in the NT's land use planning experience and

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[34] http://www.abc.net.au/news/2014-07-27/mcarthur-river-mine-gulf-of-carpentaria-anger-smoke-plume/5625484
[35] http://www.ntepa.nt.gov.au/__data/assets/pdf_file/0003/352920/mt_todd_gold_assessment_report.pdf

present practice extend to an absence of strategic environmental assessment. Important policies, plans and programmes are not usually subject to searching public examination of their environmental and social implications. Development of policy around unconventional gas may be an exception, given controversies in Australia and overseas.

But even here, policy development has so far been piecemeal, with a 2011 report on capacity of existing law to properly regulate these activities not made public but responses to its recommendations posted on the Department of Mines and Energy website[36], and a short information paper released by the former EPA in early 2012. The present inquiry into hydraulic fracturing (see Section 8.1.4.2 above and p. 312 for terms of reference) represents an important step forward. However, it is conspicuously constrained: to operational and technical issues, and will not deal with the way regulation will be integrated with other land use, community perspectives on landscape management and intrusions into or around sites of special significance, and other social impacts. The technical orientation of the terms of reference limit scope for meaningful public participation in debate about land use and the place of this activity in well-managed landscapes. Thus even in an area of demonstrated public concern, the strategic assessment gap - in the sense of a process for integrated consideration of biophysical and social concerns raised by a class of actions, to provide context and guidance for decisions on individual projects - remains.

The federal government, in contrast, does have a legislated SEA process under the EPBCA. These provisions have most recently been used to validate a decision to transfer assessment processes for offshore gas and petroleum from the Department of Environment to a sectoral regulator, subject to a program developed by that regulator (see below). This particular process is arguably different from the intent of the SEA process to foster scrutiny of the environmental credentials of important government policy and programs (like, for example, infrastructure programs that include development of major dams). Nonetheless, it may be that these SEA provisions will be used more frequently in the future to give overarching approval to certain classes of action or establish simplified ways of assessing some actions that would otherwise require individual scrutiny under the EPBCA.

In the absence of land use planning processes outside the urban setting, environmental impact assessments, whether strategic or project by project, constitute one of the few opportunities for the Territory public to influence the future of Territory landscapes. However, the particular difficulties of engaging well with remote and Indigenous communities limit effectiveness. Recent activities of the new NTEPA show an encouraging trend to greater openness.

In contrast to these positives, it is deeply troubling that Northern Territory environmental assessment law has nothing to say about offsets, and that there is an apparent commitment to keeping it that way. A 2010 proposal by the previous government to trial an offsets policy, which would have been voluntary and use agreements between government and proponents to secure offsets[37], and use the experience to inform the need for and shape of new law, has been abandoned. Guidance to developers imply that government and the NTEPA agree that it would be better to see residual biophysical environmental costs of development paid for in socio-economic currency. There is no evidence of interest in preventing net loss of biophysical environmental quality or using offsets to build community capacity to drive environmental improvement.

There is clearly an important role for other actors to fill this puzzling void in Territory policy and process.

[36] See http://www.nt.gov.au/.../Content/File/Petroleum/LegislationReviewPetroleum.docx
[37] http://newsroom.nt.gov.au/mediaRelease/560

8.2 Offsets and Territory environmental policy and law

We turn now to the characteristics of existing Territory law most relevant to offsets and their application, whether within a regional planning framework or more idiosyncratically. And whether promoted by government or other actors. We approach this task as in a few steps.

First, for all statutes that influence management of lands, waters and biodiversity (Attachment 2), we look for direct or even oblique statements regarding duty of care for environments and other reference to standards. From understanding of regulatory obligations under different law (so far as they can be discerned), we then seek to characterise actions that would clearly go beyond compliance and hence may qualify as legitimate offsets for environmental detriment. Finally we consider the dominant pressures on or threats to environmental values and ecosystem services and the way offsets to deal with them might be designed, implemented and secured under Territory law.

Broadly, in this scan of Territory law for features that might influence design and implementation of offsets (Attachment 2), we found that:

- the language used to describe environmental obligations and assumptions regarding a duty of care differ substantially among statutes
- no statute provides specifically for offsets in any aspect of design, measurement, compliance or security
- nonetheless, mechanisms capable of supporting implementation of offsets in one way or another are potentially available in a number of statutes, especially in offering mechanisms that could be contrived to offer enduring protection.

Here we pull together observations to identify patterns that relate to each of the above issues. We consider options that directly protect aspects of biodiversity as well as other options that affect the condition of land and waters and the quality of ecosystem services they provide.

8.2.1.1 Beyond a duty of care

Features common to much Territory law relating to management of natural resources and protection of environments are:

- broad definitions of environment include economic, social and cultural issues
- descriptions of environmental harm include, as well as substantial biophysical damage or economic cost, nuisance and other effects on amenity that may have no or limited direct economic or other biophysical consequences
- obligations to take measures to avoid environmental damage, when it could reasonably be expected that a person would know that damage could result from action or inaction
- references to the practicability of responses to avoid damage, including consideration of the costs of actions to avoid harm.

Differences in emphasis and hence important sources of variation among laws include:

- an obligation to ensure that benefits from actions exceed harm (e.g. *Biological Control Act*)
- emphasis in mining and petroleum legislation on optimising the value of the resource (as distinct from ensuring benefits exceed harm)
- particular emphasis on amenity in the *Planning Act*
- particular reference to equity and fairness in access to aquatic resources in the *Fisheries Act*
- requirement to prevent decline in the condition of the land (*Pastoral Land Act*), which may pick up change that would not be treated as environmental harm under other statutes
- recognition of the environment's dependence on water as a statutory class of benefit to be achieved in resource management in the *Water Act*.

More overt references to minimum (baseline) expectations are infrequent, but include:

- *Mining Management Act*: a general obligation to care for the environment and provision that observance of the Act does not displace the "common law duty of care"

- *Pastoral Land Act*: an obligation to prevent deterioration of the pastoral "asset", and a general obligation of a lessee to "improve the condition of the land" within the limits of available financing and knowledge.
- *Waste Management and Pollution Control Act*: establishes a general "environmental duty" which echoes language in other laws about taking all reasonable and practicable measures to prevent environmental harm by reducing waste and pollution from that waste
- *Weeds Management Act*: prescribes "general duties" of owners and occupiers of land which emphasises taking all reasonable measures to prevent infestations and to assist others to assert control through sharing information and preventing spread.

Under a number of statutes, observance of instructions (e.g. for use biocides) or codes of practice (e.g. for waste management) may be considered as meeting basic obligations.

Provisions for purposeful positive stewardship are few. As noted, the *Pastoral Land Ac*t (PLA) is an exception in requiring lessees to "improve the condition of the land". Given other provisions of the PLA, this requirement will be most often interpreted as referring to actions that improve pastoral production and invoke measures of condition relevant to production rather than protection of all natural or cultural assets. The *Territory Parks and Wildlife Conservation Act* positions a statutory authority (the Parks and Wildlife Commission under Ministerial direction) to achieve conservation goals and operates primarily through general restrictions on certain classes of activity in declared reserves, and requiring the public to seek permission to engage in activities affecting protected wildlife in other places.

As outlined, laws for facilitation or regulation of production activities usually proceed from the opposite direction, in that they accept that damage will occur and require actions to reduce damage so far as is reasonable and practicable. In the case of mining such provisions may take precedence over protection otherwise offered to parks and reserves.

Three of the laws considered here (Attachment 2) provide for direct government support of environmental or conservation management activities.

- The *Heritage Act* provides that the Minister may assist the owner of a Heritage place with financial, technical or other professional advice or help. While the Act itself is silent on what will attract support, guidelines for seeking related grants invoke, *inter alia*, the necessity for or urgency of the work.
- The *Territory Parks and Wildlife Conservation Act* makes provisions to support private landholders for conservation of wildlife and their habitats and control of feral animals. Actions sought will most often be specified in formal agreements with landholders. However, there is no guidance in the Act about the types or quality of actions that may warrant support or conditions that might apply. Precedent, aside from support with fencing, is limited.
- Under the *Weeds Management Act*, management plans may provide criteria for accessing assistance to carry out *obligations* under the plan and the extent of assistance. The notion of assistance to meet (presumably) well-specified regulatory obligations would appear to be at odds with provisions of other legislation and the general principle of supporting actions only when they go beyond basic expectations. An example of present support is distribution of herbicide for Gamba Grass control, but we are aware of no site specific arrangements.

In brief, Territory law to protect environmental values mostly works by proscribing certain classes of actions which vary markedly among asset classes and processes. Where options for government support of positive conservation actions are provided, criteria and practice for determining support are poorly developed. Where laws provide specifically for trading off environmental values for other benefits - using terms like practicable, reasonable, optimum - they provide no framework for determining acceptability of tradeoffs. We are aware of no substantial body of local case law establishing thresholds for failure to observe loosely specified statutory duty of care or common law to protect environmental values. It is therefore difficult to discern patterns that might inform general rules about how to recognise and reward beyond-compliance behaviour.

Given weaknesses in law and precedent, we consider that it will be necessary for interests in purchasing, promoting or providing offsets in the Northern Territory to derive *de novo* some broad criteria for recognising actions that clearly go beyond compliance. We turn now to considerations that might inform those criteria.

8.2.1.2 Recognising beyond-compliance actions

The statute to statute variation in treatment of basic obligations, ambiguity of meaning, little or no case law on relevant provisions of Territory statutes, and some apparent inconsistencies confound straightforward identification of beyond-compliance actions. The special issues created when a government chooses to vacate the offsets space are, in our view, best managed by building a framework from basic principles. Among the most fundamental of these are that (1) only actions are clearly not explicitly required under law, and (2) generate net costs (in the broadest sense) for the person(s) or organisation(s) taking them, can qualify as legitimate offsets. Working from these principles, elements of a framework matched to the Territory situation might include the following.

Actions warranting special recognition (and ultimately support) as exceeding obligations or a duty of care in regard to natural and cultural heritage must always:

- improve the condition of the biophysical environment
- produce clear and significant public benefit
- require actors to forgo rights or elements of rights and/or incur costs to deliver public benefit
- show measurable changes in the type and intensity of relevant management activities that demonstrate real shifts from business as usual practice
- substantially exceed requirements under relevant law, or subordinate statutory guidelines with the status of legislative instruments, plans or programs.

Actions are more like to satisfy these conditions when they achieve one or more of the following:

- protection of environmental values that are not integral to the profitability or sustainability of the approved or prevailing land use on the offset site
- remediation or repair of damage caused by others, including work to prevent ongoing damage
- benefits off-site that are enjoyed by interests other than the actor, including the general public
- collaboration and coordination of actions that increase effectiveness of community and government management of threats to environmental values
- enhanced public enjoyment of natural heritage
- modified traditional (Indigenous) practice or better than industry best-practice to accommodate contemporary circumstances
- risk averse approaches to management of threats when those risk-averse approaches clearly exceed prevailing standards
- direct, substantial and highly specified contributions to community or formal government conservation programs
- early adoption of superior (less damaging) land or resource management practice that demonstrably betters codes of practice or standards adopted by neighbours active in the relevant industry.

Actions are less likely to satisfy the above conditions when

- delivery of environmental benefit is incidental to or hard to separate from creation of private benefit
- benefits sought or delivered are not recognised as significant in relevant national, Territory or regional plans or strategies

- benefits are delivered entirely through application (including re-imposition following lapse) of standards of practice that are widely adopted in the relevant industry.

8.2.1.3 Evaluating beyond compliance actions

Given the huge range of potential actions and the contexts in which they can occur, it is impossible to prescribe in detail all actions that might be treated as beyond compliance. As interest and opportunities arise, it will be necessary to look at the details of the environmental change expected, the regional context, interests of offset "buyers" and providers, and all relevant legislation. The examples in Attachment 4 offer some ideas. However, it will also be useful to expand a little on application of a few of the more important attributes identified above.

8.2.1.3.1 Public benefit

Special recognition of some classes of offset action is built fundamentally on the observation that important public goods are presently under-supplied through reliance on private interest and the associated operations of markets. Recognition and support for beyond-compliance action is an attempt to supplement existing markets by creating incentives for private interests to meet that demand.

It is therefore essential that the public (environmental) benefit be clear, and interpretable in terms of the nature of the benefit and its quantum. If the public benefit cannot be described and at least crudely quantified, then it is probable that the action is too weak to warrant recognition as a valid beyond compliance offset. This should not be taken to prohibit entirely the recognition of less tangible outcomes like reduction of environmental risk. A genuine reduction in risk - especially in future demands on public resources - while maintaining the current condition of a natural asset in the face of recognised or emerging pressures may be sufficient to warrant recognition. However, even in these cases, the nature of the risk and estimate of how much the probability of occurrence (or of severity if detriment did occur) has been reduced by the offset action (risk treatment) should be clearly specified.

8.2.1.3.2 Private benefit

Actions generating substantial private benefit while also offering public benefit present some difficulty. An example might be treatment of pre-existing erosion problems that increase lands available for production on site (a private benefit) and also prevent undesirable siltation of off-site waterways (a public benefit).

Again, rather than entirely exclude consideration of actions creating private benefit, we suggest that such actions should be considered on their merits. If, for example, the costs of erosion treatment were too high to be justified by production benefits or improved capital value of land, recognition might be considered if the level of public benefits warranted, perhaps discounted to recognise the level of private benefit. As a general rule it would be expected that there would be a net cost to the provider in creating any recognised offset.

Land tenure might also be considered in determining value of offsets with, or example, benefits of remedial work being ranked higher on lands that remain in public or communal ownership or held by private non-profit organisations with an environmental purpose.

8.2.1.3.3 Site of action

In considering public versus private benefits it may also be useful to consider the balance between on-site and off-site effects[38]. Arguably, actions on private land producing exclusively or mostly on-site benefits may be biased to private benefit because they obviously protect the owners interest in his or her land and resource asset. But where there are clear off-site benefits from which the landowner extracts no or limited direct benefit, the arguments for recognition are that much stronger.

Other site-specific situations that may warrant recognition of actions that do not unambiguously exceed compliance obligations could arise:

- where a large proportion of a property is occupied by sites of special significance that prevent productive use or substantially increase management costs, especially where those values and constraints were unknown or unrecognised at the time of acquisition of a property or lease
- during transitions from one regulatory regime to another, where the new regime imposes constraints that could not reasonably have been anticipated by landholders at the time of acquisition of properties or initiation of development projects.

8.2.1.3.4 Durability

Some of the actions considered here may involve fundamental change in the design of enterprises drawing on commercial use of lands or their resources. These sorts of "permanent" actions, especially when backed by binding agreements or plans are likely to deliver more enduring benefits than shifts in practice that can be readily reversed. They should therefore attract greater recognition.

How might these issues be dealt with under compatible attributes of Territory law?

8.2.1.4 Offset options under Territory law - an exploration

The most significant pressures on environmental and cultural assets in the Northern Territory are usually addressed by multiple laws. And the array of actions that might be taken by landholders and other interests seeking relevant offsets is very large. We do not attempt to canvass every situation, but consider here some of the sorts of opportunities that are likely to arise when seeking offsets for those pressures and changes most likely to arise in the Northern Territory. We particularly emphasise ways of securing offsets to guarantee both performance in generating and maintaining them and in excluding from offset sites activities that have the potential to damage them.

8.2.1.4.1 Land clearing

Land clearing is historically one of the major drivers of biodiversity loss over much of Australia and remains a primary mechanism for change in the condition of environments (see Section 206.4.2). Most of the forms of development strongly promoted by government and industry will involve clearing of native vegetation. The way it is regulated has a major bearing on the impacts of development.

Over most of the Northern Territory, applications to clear land are assessed under land clearing guidelines (NRETAS 2010) adopted under the Northern Territory Planning Scheme. Controls cover issues such as special protection of a few vegetation types (e.g. mangroves and rainforests), buffers around drainage lines and other important natural features, and avoidance of fragile soil types and unfavourable slopes. They place no limits on total areas that may cleared except in the Daly River catchment, where limits (caps) are applied on the total amount of clearing at property, sub-

[38] Note that references to on- and off- site actions here refer to the site owned by the offset provider where the benefits are realised rather than the development site where the development impacts are felt.

catchment and catchment scales. The approach taken on the Daly has been described as potentially important (Adams and Pressey 2014), but is administratively fragile because dependent entirely on agency guidelines rather than fundamental settings in legislation. New laws to support this approach[39], which reached the point of an exposure draft bill in 2010, have been dropped by the current government.

Given apparent determination to accelerate agricultural development in particular, a substantial need will arise to offset land clearing to compensate for losses of many ecosystem services including biodiversity, landscape function, water availability and quality and the greenhouse gas emissions (Russell-Smith and Whitehead 2014). An important potential source of such offsets could be through methods to recognise avoided deforestation. In other jurisdictions (including internationally), additionality has been demonstrated by surrender of permits already issued, or reducing long term rates of loss of forested environments. Because the Northern Territory has had relatively low "background" levels of land clearing and larger bouts of clearing have occurred in sporadic bursts (Hosking 2002 and Section 6.4.2), a robust historical baseline will be hard to establish and is meaningless in regions that have yet to experience significant development.

In other parts of Australia, innovations in offset policy and practice have developed around protection of rare or threatened vegetation types from clearing, supported by quite elaborate systems for comparing sites in terms of floristic composition and condition (e.g. the Victorian Government's habitat hectares) and for appraising and generating bankable credits for suitably-managed sites (e.g. the NSW Biodiversity Banking and Offsets Scheme). Credits generated on offset sites can be sold to support management of the site. In the Territory, vegetation types of restricted extent and distribution (monsoon forests, wetlands, mangroves) are usually protected from clearing for agriculture but often approved for infrastructure development (e.g. the Darwin Liquefied Natural Gas and Inpex plants on Darwin Harbour).

Given that the bulk of vegetation most likely to be cleared in many developments will be types that are widespread and abundant, the utility of schemes built around highly depleted and rare assemblages can be seriously questioned. There may be important exceptions in the relatively restricted Bulwaddy *Macropteranthes kekwickii* and Lancewood *Acacia shirleyi* woodlands and forests in areas prospective for unconventional gas. In any event, the NT government appears unlikely to embrace any similarly complex scheme that will generate substantial costs for government.

Whilst land clearing guidelines (NRETAS 2010) made under the *Planning Act* create no requirement for or mechanisms to create offsets, the process of approval, including site visits, discussions of alternative clearing configurations and the like do offer opportunities for identification of beyond compliance actions. And although it has never been done and processes for recognition have not been developed, landholders might choose to forgo all or part of the clearing for which a permit was approved, subject to entering into binding agreement to protect the site from clearing for an extended period (e.g. the 25 years now prescribed for carbon sequestration under the federal governments proposed amendments to carbon farming law: PoA 2014).

Offsets based on direct like-for-like protection of equivalent areas of common and widely distributed vegetation are of limited utility. Arguably, it is be better to focus on actions to adjust approved clearing to minimise environmental detriment at and around the clearing site. Such actions, like matching retained vegetation across property boundaries, are not easily prescribed because their utility is so strongly context dependent, but may may provide better targets for special recognition and support (e.g. Bruggerman et al. 2005). Attachment 4 gives some examples.

[39] http://newsroom.nt.gov.au/www.newsroom.nt.gov.au/indexb54e.html?fuseaction=viewRelease&id=4897&d=5

In many cases such adjustments will involve some potential for loss of on-property production to deliver public benefits in conjunction with compatible action on neighbouring sites. Such cooperative arrangements would obviously require active coordination by a group or organisation capable of providing an overview of net benefits and then acting to secure them. Although the *Territory Parks and Wildlife Conservation Act* provides for agreements that may be registered against title (see Fitzsimmons and Carr 2014 for a discussion of statutory covenants and their use and effectiveness in Australia), application in the Territory has been compromised about concerns about compatibility with the *Pastoral Lands Act* and the extent to which they may trigger rights under the *Native Title Act* (Cwlth). Agreements with Indigenous landholders may be less problematic. For example, the Dhimurru IPA in north east Arnhem Land is subject to an agreement under the TPWCA[40] that sets out how the Territory and other parties will work together to achieve conservation objectives.

The Territory NRM Board has developed a system and guidelines for Territory Conservation Agreements, which are effectively voluntary agreements to protect specified values made between TNRM and private landholders for periods of 10 years. It is not known what penalties may apply in the event of (say) early landholder withdrawal, but it appears unlikely that loose, easily terminated agreements would satisfy either regulators or purchasers of offsets.

Given the difficulties the Territory has experienced in formalising agreements under the TPWCA, combined with apparent withdrawal from the offsets space, it may prove necessary to develop other contractual mechanisms to secure offset arrangements in ways that satisfy federal environmental regulators and offset purchasers.

8.2.1.4.2 Grazing

The *Pastoral Land Act* requires that leaseholders avoid any deterioration in the condition of the land and control feral animals. Lessees must participate in “monitoring of the environment and sustained productive health of the land”. Feral animals may be declared by the Board and lessees required to control them. This power would appear to be independent of declarations of feral animals made under the *Territory Parks and Wildlife Conservation Act*. Lessees are required to allow public access to water and features of public interest. On pastoral leasehold and other (freehold or Crown) lands, provisions of the *Soil Conservation and Land Utilisation Act* are directly relevant in linking erosion to stock densities, and potentially requiring change in stock management in reaction to actual erosion or where authorities declare areas of erosion hazard. Relevant law clearly seeks to manage interaction (tradeoffs) between production and its environmental impacts.

Taking out of production entirely areas of land of types used routinely for grazing on native pastures, where there is no evidence of land degradation, would clearly go beyond compliance. Less obviously, there may be cases where stock densities are reduced below those usually regarded as sustainable (perhaps based on carrying capacity analyses: see NTG 2009, 2013d), to protect particular values unique to a site or values of a type that are not usually considered as requiring maintenance on pastoral land. It might be argued that compliance obligations to match management tightly to local circumstances follow from the provision that “the lessee must take all reasonable measures to conserve and protect features of environmental, cultural, heritage or ecological significance” (s39(b) of *Pastoral Land Act*). It will, however, be difficult or impossible for lessees to assume responsibility and to be held to account for all such features, especially if they have not been formally identified as significant by government or other plausible authority. And this has rarely been done.

We argue that a pastoral lessee may be regarded as having exceeded the general duty of care and so gone beyond compliance and common practice where actions:

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[40] http://www.atns.net.au/agreement.asp?EntityID=1530

- reduce or could reduce production and income below levels enjoyed by peers operating to industry standards and related determinations by the Pastoral Land Board; and
- generate costs that do not produce compensating increases in production; and
- improve environmental outcomes in ways that are not confined to measures of land condition used to assess compliance with the *Pastoral Land Act;* and/or
- protect specified on-site environmental, cultural, heritage or ecological values that do not create specific legal obligations but are nonetheless recognised by community interests as warranting special consideration; or
- facilitates public access to features of interest that have not been formally recognised under the *Pastoral Land Act*.

Examples of the sorts of actions that might warrant recognition as exceeding the duty of care are given in Attachment 4. Other issues relevant to grazing are covered under land clearing (above). However, it must be acknowledged that government or Pastoral Land Board support for any arrangement that reduces orthodox commercial production is likely to be problematic. For example, in extension materials on a change to the *Pastoral Land Act* to more easily secure approval for non-pastoral use, no mention is made of carbon or other offsets or payments for ecosystem services more generally (NTG 2014).

8.2.1.4.3 Water extraction, use and water quality

Maintenance of water availability and quality is an essential ecosystem service. In theory at least, the structure of the *Water Act*, particularly the status of environmental and cultural water as beneficial uses and the potential for water markets, could provide relatively straightforward options for offsets. Water entitlements may be issued for declared beneficial uses that include production, environmental and cultural purposes. Mechanisms are not specified for determining optimal tradeoffs among beneficial uses. However, entitlement holders diverting water from the “consumptive pool” to another form of "public" beneficial use would clearly go beyond compliance. The entitlement holder would accept some private cost or at least reduction of potential private benefit to generate a public benefit in reduced pressure on a catchment's water balance.

For example, intensive use of water by a mine over a period of several years could be offset by meeting the cost of leasing a water entitlement to be held for an equivalent period by a relevant environmental organisation. This would ensure that the amount of water used consumptively did not increase during a mine's operations. And the "value" of a land offset could take account of contributions to water management.

Less abstract benefits could be demonstrated by diverting a portion of a production entitlement to the environment to enhance values otherwise suffering some detriment like, for example, an on or offsite water-dependent ecosystem under stress from locally or regionally lowered water tables. Similar actions might be taken in respect of cultural flows.

Entitlement holders just reducing use below permitted take from the consumptive pool would, in the absence of formal diversion to another beneficial use, most likely cause regulators to reduce the entitlement (the use it or lose it approach) and reallocate an equivalent amount for consumption elsewhere. More efficient use of water and reduction of actual usage below entitlement would not usually be regarded, on its own, as a beyond compliance action because all entitlements are issued on the understanding that waste will be avoided.

Securing water-based offset benefits long term will require a durable arrangement to shift water allocation from the consumptive pool to environmentally positive use. Arguably the most secure offset arrangement would be a reduction of the consumptive pool and an increase in a formal allocation to the environment under a water allocation plan approved in accordance with the *Water Act*. An alternative would be to sell the offsetting water from the consumptive pool to an environmental institution at a peppercorn (or at least below-market) valuation. Given that all trades must be approved by the regulator, government may choose to disallow such trades, particularly if there were outstanding applications for entitlements for consumptive use. It is also unclear how regulators would treat such re-deployments when it came to reviews of water allocation plans and entitlements. In the absence of established processes and given apparently negative government attitudes to offsets, attempts to redeploy water use is likely to be problematic. There is a significant risk of perverse outcomes such as reduced pressure on the consumptive pool through offsets being used to justify acceptance of (for example) increased mining usage.

8.2.1.4.4 Mining and petroleum exploration and extraction

Most extraction activities will be subject to full environmental assessment that will, through conditions on necessary approvals, formally establish obligations of developers. However, there will nearly always be some residual environmental cost not corrected by practicable (reasonable) mandatory responses which might be compensated by additional, beyond compliance, action.

Miners who have acquired the title or lease on which they operate may choose to remediate damage from prior land uses, or give special protection to values not affected by mining. They may contribute funds to environmental management work that benefits local communities who may suffer some loss of environmental quality or amenity.

To reduce ambiguity about the environmental credentials of their offset actions and to reduce risk of on-site or near site expectations of regulators and public being ratcheted upward, miners are likely to prefer offsets that are distinct from their compliance obligations. Actions taken off-site to compensate for on-site detriment will often involve land management activity unconnected to their contemporary mining activities, and so involve any of the arrays of non-mining or landscape rehabilitation actions listed in Attachment 4. In these cases, obviously the challenge shifts from identifying beyond compliance tasks by the mining operator to determining whether the off-site action done by others on the miner's behalf is sufficiently different from prevailing practice and obligations. And obviously the offset must deal effectively enough with other (non-mining) forms of pressure on environmental values to warrant recognition: including rating as equivalent (or better) in benefits compared to the environmental costs at the mining site. Comparability of mining damage and offset benefit may be less challenging when focused on rehabilitation of legacy mine-sites. And experience gained in offsets involving rehabilitation of previously damaged sites will be an important source of information for better estimation of the real costs of repairing mine sites, which have in the comparatively recent past been demonstrably inadequate.

Actions taken by miners to offset on-site detriment will most often involve some private cost to acquire environmental benefits generated off-site by others or, if the developer involved has control over lands outside the mining site, forgoing income by reducing, for example, grazing pressure on a held pastoral lease. In the latter case, it will be important to ensure that the actions taken go well beyond those specified in relevant law or prescribed by the Pastoral Land Board.

As noted elsewhere, mining law could be used to help "secure" offsets of any type by reserving their sites from future mining. This level of protection is, however, easily reversed. Greater security might be sought by setting offsets as a condition under the *Mining Management Act* (or petroleum or geothermal equivalent). However, the language of mining laws ties conditions tightly to specified activities on the particular mining site. Attempts to deploy this law to **require** offset actions in other (off-site) places may be open to challenge. Even if such arrangements were thought to remain within power, for the reasons already canvassed in regard to water, relevant regulators are unlikely to entertain such an approach. We suggest that use of mining law alone to secure offsets is unlikely to be palatable to regulators or effective.

8.2.1.4.5 Fire regimes

The condition of landscapes is strongly influenced by their fire history, and their effective long term management to protect environmental and cultural values will depend on quality of fire management in the future (see Sections 6.4.4 and 11.1.3.8). Government support in collaboration with communities has been an essential contributor to projects like WALFA through the framework provided by bushfire law (Whitehead et al. 2009). The *Bushfires Act* is presently under review with emphasis in better articulating the Bushfires Council and administration's roles in land management and emergency response. There are some concerns that placement of bushfire roles in an emergency response agency may compromise effective use of fire as a land management tool. This would in turn have implications for management of offsets where fire exclusion was not an appropriate management option.

Laws relating to fire management relate mostly to protection of life and property and make no direct provision for protection of environmental or cultural values. This might be taken to imply that any action to manage fire to protect such values could be recognised as going beyond compliance. However, it will often be difficult to separate such actions from those taken for other purposes (such as protection of pasture for production). More rigorous tests will require that actions taken differ from prevailing practice on other sites used for similar purposes in ways consistent with generation of the claimed benefit or, more directly, that present action for which recognition is sought differs from previous patterns of fire use on the same "property". Business as usual operations should not attract special recognition.

Fire management also raises issues of double counting. Credits from mitigation of greenhouse gas emissions from savanna fire are already recognised in Australian law. Fire regimes that reduce emissions may also produce biodiversity and social benefits (Whitehead et al. 2008; Russell-Smith et al. 2009a). Care will be needed in decisions to support contributions to one class of benefit where managers are already receiving financial support in respect of another. Rather than disqualifying such actions from consideration, the existence of multiple benefits and multiple sources of support may be instead used to determine the quantum of support available through offset arrangements or expectation about the scale (quantum) of delivery.

We suggest that given the ubiquity of adverse fire regimes (Section 11.1.3.8), large scale demonstrations of effectiveness and relatively well understood costs, improving fire management to achieve measureable improvements in the condition of landscapes and biodiversity values will remain a particularly rich source of offset opportunities.

There have been discussions between NAILSMA and organisations maintaining infrastructure in remote settings about opportunities to protect infrastructure through fine scale management of fire to reduce fuel loads near sensitive facilities. If agricultural and unconventional gas developments do in fact occur, these sorts of opportunities may increase. However, unless they also address biodiversity or similar issues they could not be treated as environmental offsets. Facilitating such opportunities may be more properly considered as compensation for social impacts.

8.2.1.4.6 Weeds and use of biocides

The *Weeds Management Act* is relevant to offsets mostly as an influence on the type of work on invasive plants that could be regarded as going beyond regulatory obligations and hence treated as a legitimate offset. The feral animal control provisions of the *Territory Parks and Wildlife Conservation Act* could play a similar role (see Section 8.2.1.4.7 below).

Provisions in the *Weeds Management Act* providing for support (with Ministerial approval) to comply with approved weed management plans are unusual. The intent is obscure (there is no specific mention in the second reading speech introducing the relevant Bill to Parliament) but may be intended to deal, for example, with situations in which the landowner enjoys no income from the land and lacks the means to control weeds, but there would be very substantial public benefits from promptly implementing controls. This would often be the case for Indigenous owners of lands marginal for orthodox production.

There may be circumstances in which a disproportionate effort (going beyond strict compliance) from one landowner may reduce costs for others, including government, because their property is in a critical location (e.g. traversed by a heavily used road corridor) for achieving effective regional weed control. In addition, shifts in choice of methods might attract support under some conditions. For example, use of herbicides may involve some risk to other values or human and animal health, even when used strictly in accordance with guidelines. In situations where there is particular concern about the potential for non-target effects or other unintended consequences, support to adopt methods that reduce these kinds of risks may be warranted, especially where those methods involve greater cost or effort.

The option for government support will complicate demonstrations of additionality for offsets involving better control of weeds.

8.2.1.4.7 Feral animals and use of biocides

The situation for feral animals is similar to weeds in that landholders are usually expected to meet costs if they choose to control feral animals. There is no general obligation for landowners to assert control. But when a species has been declared feral, a control area has been declared and orders to control or eradicate have been issued, control is mandatory. Feral animal management plans may be prepared which could impose particular conditions on landholders, but none have been approved so far. Sectoral legislation (e.g. the *Pastoral Land Act*) may impose more general obligations to control feral animals on pastoral leases. Erosion problems associated with feral stock could conceivably be dealt with under the *Soil Conservation and Land Utilization Act*.

In the absence of management plans, it would appear that outside pastoral lands and declared feral animal control districts, and given the long history of weak feral animal control in north Australia, any level of control could be regarded as going beyond compliance or common practice. Some landholders derive benefits from the presence of feral stock (Rathsmann 2011). Where incomes have been earned from exploitation of feral animals at levels that do not also mitigate their environmental impacts, effective control may require reduction to low densities, at which commercial exploitation is no longer tenable. In such cases, treatment of feral animal control programs as warranting recognition may be argued at levels that offset the income lost, particularly if the site does not produce other income and control produces benefits extending beyond the site. As argued in other contexts, offset projects recognised as additional would involve some loss of private benefits to deliver public benefits or reduce public costs.

Because eradication (permanent removal) of most feral animals is unlikely, assessing effectiveness of control efforts can be problematic. Focus on changes in the damage they cause is likely to provide the most relevant measure of offset value, but methods are relatively poorly developed and may be expensive to measure (Taylor et al. 2011; Bengsen et al. 2014).

8.2.1.4.8 Gaseous pollutants (chiefly greenhouse gases) and airborne particulates (from fire)

The Territory has no air quality law except to enable application of relevant Australian Government controls (e.g. on ozone). Peaks of smoke particulates measured at Darwin in September are most likely to exceed the National Environment Protection Council target for maximum mean 24-hour PM_{10} of 50 ug/m^3 and are associated with increased hospital presentations for asthma (Johnston et al. 2002). These particulates appear to originate over large areas to the south-east of Darwin and cannot be readily attributed to individual fires or particular regions. At the time of writing (July

2014) no direct link has been made to recognise human health benefits as an environmental offset generated by improved fire management.

Major pollutants like carbon dioxide and other greenhouse gases were dealt with under the federal *Clean Energy Act* and related law, which has now been partially dismantled. Carbon farming laws that have formalised eligible offsets In many areas of the land use and land use change and forestry sectors are proposed for amendment. The present federal government proposes change in the way offset products are bought and sold: through a publicly funded Emissions Reduction Fund rather than a market accessed by private buyers (Australian Government 2014). Passage of the necessary legislative amendments through the Senate is uncertain.

The Territory could choose to recognise and support some actions as contributing to local and national efforts in GHG mitigation, especially if they are not recognised in formal (compliance or voluntary) markets, but this appears improbable given dismantling of any local agency structures dealing with climate change. Unlike all other state jurisdictions, the Territory has made no legal provisions for rights in carbon to facilitate trade. Federal law and policy is likely to dominate this area of activity for the foreseeable future, even if only to set conditions for recognition of products and their sale into international markets.

Benefits in emissions abatement and carbon sequestration in vegetation can be generated by actions to improve fire management, reduce grazing pressure from both managed and feral stock and protection of sites from land clearing. The federal Government has shown particular interest in sequestration of carbon in soils through improved grazing or other agricultural management (Hunt 2012). However, the potential for increasing soil carbon and measuring change accurately has not been demonstrated in northern Australia (Russell-Smith et al. 2003; Beyer et al 2011; Pringle et al. 2011; Richards et al. 2011). Demonstrating additionality in avoided deforestation will be difficult for the reasons already given, and the relevant federal Minister has indicated disinterest in (non-Kyoto) carbon credits through better control of feral animals. The ERF will buy credits only if they are already included in Australia's national greenhouse gas inventory. Accordingly the best options for carbon-based offsets remain with fire management, for which new methodologies in abatement and sequestration are presently under development (e.g. Whitehead et al. 2014).

8.2.1.4.9 Erosion and sedimentation and other water borne pollutants

Law governing waste discharge require that polluters take all reasonable and practicable measures to prevent pollution. Consequently, beyond compliance actions would be recognised only where entities or individuals went well beyond prevailing standards and adopted unusually rigorous methods to reduce pollutants to levels at which quality of receiving waters remained well above national or local standards, or exceeded requirements of environmental management plans setting out conditions of licences or other regulatory approvals. Such on-site actions would probably be rare and it may be expected that operators seeking to compensate for residual local detriment - after practicable mitigation options had been exhausted - would look for opportunities to produce environmental benefits elsewhere.

The situation in regard to effects of movement of sediment not reflected in water quality measures is less clear, because the Territory has adopted no relevant standards for “acceptable” levels of erosion or sediment movement. However, guidelines for land clearing do cover situations of risk which should avoided, and adopting stronger and more risk averse practices may attract recognition as relevant beyond compliance action, where measurable public benefits are expected (Attachment 4). Other less formal guidance for avoiding soil and landscape degradation may also help determine what sorts of actions by landholders might be regarded as genuine, beyond compliance and environmentally positive actions.

The Commissioner for Soil Conservation may make orders under the *Soil Conservation and Land Utilization Act* for repair or reclamation of land damaged by erosion. The Act provides penalties for failure to observe soil conservation orders or reduce erosion hazard, take unauthorised actions in a restricted use area, and various administrative acts. These provisions have been invoked rarely, with much greater emphasis placed on the advisory and extension roles over enforcement or even routine regulatory functions. Nonetheless, such powers could be used to secure favourable management of offsets, including where they involve rehabilitation of damaged sites for biodiversity benefits or carbon sequestration.

8.2.1.4.10 Consumptive use of native plants and animals

Territory law requires that management of exploited species must promote the survival of the species, but does not specify in detail what goals for maintenance of population size or distribution should be. Existing programs specify maintenance of viable populations and no contraction of distribution as primary goals (PWCNT 2009, 2010). Given that approved programs usually seek to specify comprehensively the actions needed to achieve these goals, it may be difficult to identify beyond compliance actions that produce clear public benefit. Like water entitlements, in cases where a permit holder reduced the scale of take below an issued permit, it is most likely that the permit would be modified and the unused portion issued to another applicant rather than allow a reduced usage to stand long term.

Exceptions might arise where there are no management programs, as is the case with most species. There may interest in giving special protection to some exploited species that are subject to emerging threats but have yet to be classified as threatened. In these cases, a wide range of population or habitat management actions might be treated as warranting special recognition (Attachment 4). Many of these might involve Indigenous people who have rights to take wildlife for customary purposes forgoing some of those rights by modifying choice of species harvested or circumstances under which harvests are conducted. As with other "additional" actions, such users would be sacrificing private benefit for public good.

Under the *Fisheries Act* there would appear to be, at least in theory, potential to offset environmental impacts of one management plan through changes in another, or to compensate unrelated detriment (from say mining) by creation of reserves or other less comprehensive changes in fishery management plans. An example might be to protect from trawling areas of benthic habitat of the type affected by undersea mining. However, to allow pressures created in one industry to deflect commercial or recreational fishing management to reduce fishing impacts is likely to be politically difficult. Nonetheless, because this is the only law to provide for management of fish (the *Territory Parks and Wildlife Conservation Act* bizarrely defines vertebrate animals to exclude fish), it may be necessary to deploy the fisheries law in some way if the impacts to be offset logically require actions that directly affect fish populations or fish habitats.

To summarise, no Territory laws explicitly enable or set conditions for offsets, or even obliquely acknowledge their role in environmental management. They set vague and inconsistent "baselines" for duty of care for the environment and so provide limited guidance for unambiguous recognition of beyond compliance actions. Aside from carbon farming offsets, for which standards are set in federal law, it will be necessary for offset providers and buyers in the Northern Territory to agree on their own criteria for recognition and validation, perhaps drawing on existing international standards. Formal accreditation under such standards can be complex, slow and expensive.

A plausible response to this situation is for risk-averse buyers to prefer offsets that are built on strongly secured sites managed in accordance with long established procedures (e.g. in national park management) endorsed or applied by governments and so seen to require less emphasis on precise measurement of specific environmental benefits. A number of Territory laws - in particular the *Territory Parks and Wildlife Conservation Act*, *Heritage Act*, *Northern Territory Sacred Sites Act*, and

Fisheries Act - can individually and (more strongly) in combination, offer substantial security. Whether the Territory government will cooperate to deploy these instruments remains to be seen. Some recent changes in approach to environmental assessments are particularly relevant to this question.

We have canvassed a wide array of options that step outside existing offset schemes. Given all of the considerations summarised above, we suggest that realistic opportunities, ranked in approximate order of plausibility, under existing conditions are:

(a) Carbon farming under existing and emerging methodologies and law.

(b) Biodiversity benefits deploying individually or in combination:

- fire management
- reservation or other legally secured protection of favourable habitats
- pest control (weeds and ferals) tied to rehabilitation of damaged sites
- rehabilitation of sites previously cleared of native vegetation.

Despite this cautious conclusion, the withdrawal of the Territory government from the offsets space might also be interpreted positively, as an opportunity to go beyond orthodoxy unencumbered by clumsy regulation to embrace entirely new approaches. If this opportunity is taken up by organisations with technical credibility and the capacity to brand their products to appeal to corporations seeking a social licence to operate, there is potential to generate important benefits for conservation and providers.

8.3 Federal Law and Policy

We have already noted the dependence of some aspects of Territory environmental management on federal legal and policy settings. Here we set out briefly some of the most significant interactions.

The present federal government combines a strong economic development focus with a small government philosophy. Change in environmental regulation is prominent in the resultant political agenda, particularly argument that simplification and/or streamlining is required. The inescapable corollary of such an emphasis is that aspects of existing regulation are in part or whole unnecessary or poorly designed and implemented.

All jurisdictions have now agreed (April 2014) to a national review of environmental legislation which, in addition to the bilateral agreements presently under negotiation "could encompass opportunities for best practice regulation, species and heritage listing processes and simplification of land planning including Commonwealth lands". Emphasis will be put on "identifying unworkable, contradictory or incompatible regulation and seeking opportunities to harmonise and simplify regulations"[41]. The Northern Territory's idiosyncratic treatment of environmental offsets (Section 8.1.5.1 above) may be an issue in such review.

It is difficult to imagine how land use planning over most of the Territory could be simplified, considering that there is little or none now outside urban and peri-urban areas, but formal terms of reference for this inquiry have not been (July 2014) announced.

Under these circumstances it is difficult to offer confident analysis of the detail of the national policy landscape that might influence processes for application of offsets to environmental management, especially with the planning emphasis inherent in Development by Design. Nonetheless, it is improbable that more fundamental principles will alter dramatically and it will be useful to set out the key parameters of present federal law and how they intersect with Territory law.

8.3.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBCA is the federal "omnibus" law covering an array of conservation, environmental assessment, and resource management matters. Its objectives are to:

- provide for the protection of the environment, especially matters of national environmental significance
- conserve Australian biodiversity
- provide a streamlined national environmental assessment and approvals process
- enhance the protection and management of important natural and cultural places
- control the international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife
- promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources
- recognise the role of Indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity
- promote the use of Indigenous peoples' knowledge of biodiversity with the involvement of, and in cooperation with, the owners of the knowledge.

Present matters of NES are:

- world heritage properties
- national heritage places
- wetlands of international importance (listed under the Ramsar Convention)
- listed threatened species and ecological communities

[41] http://www.environment.gov.au/minister/hunt/2014/mr20140429.html

- migratory species protected under international agreements
- Commonwealth marine areas
- the Great Barrier Reef Marine Park (in Queensland)
- nuclear actions (including uranium mines)
- a water resource, in relation to coal seam gas development and large coal mining development

This rather idiosyncratic list reflects the Australian constitution's vesting of responsibility for land and resource management matters chiefly in the states. Federal legislation therefore fills gaps in state/territory obligations (e.g. in oceans), performance or capacity (e.g. in cross-boundary matters) and meets obligations set out in (multilateral) international conventions to which Australia is signatory.

Conventions of greatest direct relevance are the World Heritage Convention, Ramsar (wetlands) Convention, Convention on Biological Diversity, Bonn (migratory species) Convention and Convention on Trade in Endangered Species of Wild Flora and Fauna (CITES). The EPBCA also enables provisions of bilateral agreements such as the Japan Australia Migratory Birds Agreement and a similar agreements with China and South Korea. In the case of environmental assessment, in addition to responsibilities to protect aspects of environment covered by these conventions, federal influence also derives from corporations powers and roles in approving mineral and other exports. Water resource management as a matter of national environmental significance is a recent (2013) addition responding to public concern over effects of unconventional (especially coal seam) gas.

Where additional needs are identified, especially for issues that cross jurisdictional boundaries, other formal agreements with the states may be deployed. The best known example of this is the National Water Initiative (see McKay 2005). States and territories have incentives to sign up to such agreements in order to access federal funds.

In regard to policy change in environmental assessment, the federal government is committed to creating eight one-stop-shops for environmental assessment: one in each of the states/territories. Avoiding duplication or double handling of matters by states/territories and the federal government in environmental assessment is done through bilateral rather than multilateral agreements, reflecting variation in state/territory systems. In essence, it is now proposed that through such agreements the states will exercise federal powers in regard to matters of NES through "a single assessment and approvals process"[42,43,44]. Although the EPBCA already recognises bilateral agreements, changes in law are argued to be necessary to ensure that those agreements will operate efficiently and provide certainty to proponents: a Bill to make the changes is presently before the federal Parliament (Hunt 2014). The *EPBCA (Bilateral Agreement Implementation)* Bill proposes (*inter alia*):

- allowing States and Territories to make decisions on large coal mining and coal seam gas developments impacting on a water resource
- ensuring that all States/Territories can request advice from an Independent Expert Scientific Committee
- clarifying that proponents do not need to make referrals to the Commonwealth for actions covered by an approved bilateral agreement
- ensuring that State/Territory processes that meet EPBC Act standards can be accredited, recognising different technical approaches to give legal effect to those processes
- providing for bilateral agreements to continue to apply to accredited State or Territory management arrangement or authorisation processes, despite minor amendments.

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[42] Western Australian bilateral at http://www.environment.gov.au/minister/hunt/2014/mr20140528.html

[43] Queensland bilateral http://www.environment.gov.au/minister/hunt/2014/mr20140514a.html

[44] Northern Territory http://www.environment.gov.au/minister/hunt/2014/mr20140408.html

These changes do not in themselves directly weaken federal standards. But the incentive for the states and territories to compete with each other for major projects does invite the "regulatory creep" that Minister Hunt invokes to explain the need for change in law: but creep in the opposite direction, towards weaker controls. The existing tension between these local or regional incentives for lower standards and the willingness of the federal government to over-ride state decisions under extreme circumstances arguably provides a more robust and stable system than one based on jurisdictional competition. The draft bilateral for the Northern Territory does not cover the Commonwealth parks Kakadu and Uluru and other commonwealth lands like the Defence estate (Figure 2 above and Figure 17 below).

The EPBCA also has provisions relating to national and commonwealth heritage (below), most significantly in connecting them to environmental assessment processes.

A potentially useful set of provisions, especially in the Northern Territory context, relate to provisions for bioregional planning. Bioregional plans may cover and seek to integrate realisation of biodiversity conservation, heritage protection and economic and social values in commonwealth areas and, with state and territory governments and other partners, other sites that include non-Commonwealth areas. Use has been mostly confined to marine areas where the Commonwealth has sole jurisdiction. Bioregional plans do not have the status of legislative instruments but may provide useful foci for federal government investments in conservation and heritage protection.

Offset requirements are included as a condition of approval of proposed actions under section 134 of the EPBCA. The language describing the sorts of conditions that may be set is broad and is clearly not constrained to on-site measures and actions, provided that the condition protects matters of national environmental significance. Offsets have been required as a condition of approval in 81.6% (n=38) of Commonwealth approvals listed in the DoE website in the first 5 months of 2014. And a significant proportion of those few where offsets were not deployed were for projects where offsetting was arguably unavailable or unnecessary (e.g. rehabilitating a creek, testing interactions between grazing and fire, baiting wild dogs, upgrading a streetscape). If the Northern Territory Government and NTEPA's apparent disdain for environmental offsets is reflected in future decisions made under the bilateral, their absence would represent a major shift in Commonwealth standards.

8.3.2 *Water Act 2007*

The objects of the federal *Water Act* deal principally with the needs of the Murray-Darling Basin. Outside the Basin it provides for the collection, collation, analysis and dissemination of information about Australia's water resources; and the use and management of water in Australia. The Act is to be reviewed to terms of reference given in Attachment 5.

This review and the associated Water Recovery Strategy for the Murray-Darling Basin (CoA 2014) are relevant to this study mostly in what they may indicate about the federal government's approach to meeting environmental needs. Government proposes to recover shortfalls in environmental water by infrastructure investments rather than water buybacks and do so over a longer period than previously proposed. It is reasonable to assume that decisions about offsets will reflect a similar stance: one that emphasises maintenance or increase in production rather than contemplate trading off production for environmental benefits.

More broadly the intent to limit the Commonwealth role and funding have been signalled in the decision to axe the National Water Commission which has played the primary role in interpreting, applying and reporting progress of the National Water Initiative (CoAG 2004).

8.3.3 *Heritage Law*

The EPBCA has provisions relating to both natural and cultural heritage: specifically in establishing list of heritage places and protecting World Heritage, national heritage and commonwealth heritage places. World Heritage sites are those that have been formally listed under the World Heritage Convention.

The National Heritage List includes natural, Indigenous and historic places that are of outstanding heritage value to the nation. The Commonwealth Heritage List comprises natural, Indigenous and historic places on Commonwealth lands and waters or under Australian Government control, and identified by the Minister for the Environment as having Commonwealth Heritage values. The Australian Heritage Council, created through the *Australian Heritage Council Act* 2003 advises the Australian Government on heritage matters, including nominations for the National Heritage List and the Commonwealth Heritage List.

There are few listed national heritage sites in the Northern Territory and they often duplicate other recognition (e.g. Commonwealth parks). Listed Commonwealth heritage places are mostly built heritage but also include sites like Defence training areas nominated for their natural values (Bradshaw and Mt Bundey). The significance of listing is that it requires specific consideration of values for which the place or object was listed when actions are being taken that may affect such places.

The federal *Aboriginal and Torres Strait Islander Heritage Protection Act* 1984 and the *Protection of Movable Cultural Heritage Act 1986* also protect places and objects of significance to Indigenous people. They are designed to complement state and territory laws. However, the relevant Minister can also make declarations to protect sites or objects at risk of injury or desecration in the absence of local protection.

The application of all of these laws is likely to be reviewed as outlined in the preamble to this section. At present the Commonwealth's Offset Policy covers heritage values and properties, and may accordingly include consideration of cultural values and impacts of development actions on them.

The *Aboriginal Land Rights (Northern Territory) Act* 1976 plays an essential role in protecting Indigenous heritage through its provisions regarding recognition of sacred sites anywhere in the Territory and the particular powers it provides to control access to Aboriginal lands.

The federal government has prepared a draft strategy for Australia's heritage (DoE 2014) for public consultation. The strategy proposes no dramatic new actions but seeks greater recognition of heritage, and community involvement in its protection and management. As with other environmental issues, propositions are put about the need to reconcile different approaches and systems to provide a one stop shop for navigating heritage laws. Presumably views put in response to the consultation paper will be taken into account in the proposed Australia-wide review of state, territory and national heritage legislation.

8.3.4 Resource extraction law

The Commonwealth also has a small suite of laws to cover resource extraction outside territory and state jurisdictions, on commonwealth lands (defined to include overlying waters). Examples include the *Petroleum (Submerged Lands) Act* 1974 and the *Offshore Minerals Act* 1994. The intent of these laws is to provide powers to manage exploration and extraction in a manner similar to the states. They do this by also providing for the Commonwealth and geographically relevant state/territory to share authority and to deploy state/territory systems to manage title and the like.

The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) established under the *Offshore Petroleum and Greenhouse Gas Storage Act* 2006 is part of this infrastructure. Under recent (28 February 2014) changes to the administration of related laws, the Minister of Environment has used the strategic environmental assessment provisions of the EPBCA (Section 146) to endorse NOPSEMA's environmental management authorisation process as set out in a program (NOPSEMA 2014) . Activities done in accordance with the program will not require referral, assessment and approval under the EPBC Act. This includes all matters of NES except where activities may affect Commonwealth land, the Great Barrier Reef, or the Antarctic.

It is worth noting that the NOPSEMA program makes no mention of offsets, so it is unclear whether the Commonwealth offset policy will be applied. With EPBCA referrals no longer required, application of the offset policy may not be obligatory.

8.3.5 Greenhouse gas management

Australia has constructed a comprehensive national systems for management of greenhouse gases, including a carbon price, an emissions trading system, and law to recognise emissions abatement and carbon storage credits. Key elements of the package of clean energy and carbon farming laws included:

- *Clean Energy Act 2011 and Regulations* dealing with the carbon price and trading
- *Carbon Credits (Carbon Farming Initiative) Act 2011 and Regulations*
- *Clean Energy Regulator Act 2011*
- *Australian National Registry of Emissions Units Act 2011*

The current government is in the process (July 2014) of dismantling much of this infrastructure with the intention of removing the carbon price. The CFI law and supporting mechanisms like the ANREUA are to be retained, but modified to accommodate an Emissions Reduction Fund.

The Emissions Reduction Fund (ERF) is the centrepiece of a Direct Action Plan which abolishes the existing carbon market but still seeks to reduce national emissions by 5% by 2020. The ERF will use public funds to buy emission reductions, from individuals or corporations developing abatement or sequestration projects that are new, not required by law, and do not occur as a result of another government program. Safeguards are to be developed to inhibit big emitters from continuing to increase their emissions and cancelling out gains from the ERF, but mechanisms remain unclear. Government will seek lowest cost credits through reverse auctions (CoA 2014).

The ERF as presently framed (July 2014) creates particular challenges for offset providers in the land sector:

(f) land sector projects drawing incomes only from sale of credits will be pitted against, for example, energy efficiency projects that reduce industry costs and boost long term profitability, independent of income from credits
(g) dismissal of environmental (e.g. biodiversity) and social (e.g. remote area employment) co-benefits from consideration in auction processes reduces net public gains from ERF expenditures
(h) one contract of 5 years is insufficient to recover often substantial investments needed to establish land management projects
(i) providers unable to meet projected credit production are penalised by being forced to buy credits to make up shortfalls, disadvantaging projects like savanna burning where year to year variation is unavoidable
(j) uncertainty is increased because probability of bid success and prices may vary substantially from auction to auction, depending on the array of bidders who choose to compete.

Draft legislation to amend the *Carbon Credits (Carbon Farming Initiative) Act 2011* requires that methods (previously methodologies) themselves clarify interpretation of additionality (PoA 2014). Initiation of new methods will be under political control, with the relevant Minister setting priorities for technical working groups appointed by government. Only methods that count towards Australia's international emissions reduction targets will be considered. Priorities indicated for new methods include increasing soil carbon (despite considerable doubt about plausibility), reducing livestock emissions, expanding opportunities for environmental and carbon sink plantings, and reforestation and avoided deforestation. It is presently unclear whether the sequestration of carbon in woody vegetation through improved management of fire will be given priority, even though Kyoto-compliant activities include sequestration through "establishment or management of vegetation on land" exceeding 0.05 ha in area[45].

Until all amending legislation is enacted by the Australian Parliament, regulations promulgated and some experience gained with new advisory and regulatory arrangements, it is difficult to predict how the ERF will affect opportunities in northern Australia. However, on balance it appears most likely to discourage participation of the land sector in carbon offsetting.

8.3.6 Commonwealth relationships with states and territories

The recent steps to reduce the federal role in environmental management are elements of a larger current agenda to "(limit) Commonwealth policies and funding to core national interest matters, as typified by the matters in section 51 of the Constitution" and "the States and Territories ... sovereign in their own sphere"[46]. The only more or less direct references to natural resources and their management in section 51 relate to astronomical and meteorological observations, quarantine and fisheries in Australian waters beyond (state) territorial limits. The arguments for reducing duplication and complexity are superficially attractive, but create obvious risks of divergence in approaches, including a race to the bottom in competing for investments. The Territory, given its weak internal revenue raising capacity is likely to be particularly vulnerable to such pressures. A previous Chief Minister has celebrated the certainty offered by the Territory for developers, and the absence of ongoing issues with environmentalists[47].

There will also be more immediate effects. The loss of impetus for improved water management driven by the NWI and National Water Commission is likely to see weakening of key principles for water management in north Australia (NWC 2012). Arguably that has already happened, with apparent weakening of Territory government commitment to community participation in water allocation planning, securing Indigenous interests, and technically challenging decisions about treatment of relevant data (Section 8.1.3.7 above).

In addition to these regulatory changes, withdrawal of the Commonwealth from the large scale environmental funding programs initiated with the 1997 Natural Heritage Trust will have significant impacts. As already noted, those effects are likely to hit particularly hard in the "mendicant" Northern Territory.

In our view it would be reasonable to anticipate continued weakening of involvement of the Commonwealth government in environmental issues and hence greater dependence on Territory policy settings and financial and technical resources. Present weaknesses, especially in the area of offsets, clearly require considered response if the DbD program is to be rolled out in the Northern Territory.

8.3.7 Summary

This short treatment does not cover all potentially relevant Commonwealth law and associated policy but identifies those statutes that intersect most directly with Territory law and process. By far the most significant in terms of its influence is the *Environment Protection and Biodiversity Conservation Act* 1999. The EPBCA covers, in one way or another, management of most classes of natural and cultural values and threats to them, including opportunities to use offsets to improve environmental outcomes. The way in which these laws are deployed to manage relations between

[45] Norton Rose Fulbright (2013) CFI legal and contracts guide. Norton Rose Fulbright, Melbourne. 143 pp.
[46] http://www.pm.gov.au/media/2014-06-28/white-paper-reform-federation
[47] http://newsroom.nt.gov.au/mediaRelease/6533

Commonwealth and Territory objectives and processes is presently in flux, but on balance Commonwealth involvement appears likely to be weakened over the short to mid-term by both directly relevant policy change and fiscal tightening.

The treatment of offsets is particularly problematic given the Territory's apparent determination to avoid their use so far as possible, despite potential and actual significance in dealing effectively with matters of national environmental significance. Other processes of divestment of EPBCA obligations to sectoral bodies like NOPSEMA through strategic assessment provisions create further ambiguity in regard to offsets. More generally, divestment of responsibilities to sectorally-oriented bodies, and states and territories competing for investments, increases risks of regulator capture and invites emergence of divergent approaches in all areas of environmental regulation, with the weakest arrangements becoming the *de facto* standard. The treatment of the land sector in design of the ERF appears likely to reduce options for involvement.

Delivery of DbD in close collaboration with government may be challenging under contemporary policy and fiscal settings. Potential to attract private and industry funding may, however, encourage some useful if relatively passive support from government, especially in access to mechanisms for securing offsets over the long term. In its justification of the need for fundamental change in Commonwealth and State/Territory relations, the federal government has invoked the notion of subsidiarity. The Queensland Government has taken a related step in repealing aspects of the *Wild Rivers Act* and placing development decisions in the hands of local authorities under the *Regional Planning Interests Act 2014*, which covers areas of regional planning interest, including Priority Agricultural Areas (PAAs), Priority Living Areas (PLAs), Strategic Environmental Areas (SEAs) and Strategic Cropping Areas.

Confoundingly, the present turmoil in environmental policy settings could open spaces for useful innovation by non-government actors in systems of support and governance for environmental management at regional scales, which Agrawal and Ostrom (2006) have identified as perhaps the greatest challenge for conservation in the 21st Century. Some options relevant to DbD are explored in the succeeding discussion.

8.4 New approaches to environmental management and the role of offsets

The full effects of contemporary retreat of government from serious engagement with the environmental challenges posed by sustainable development of northern Australia will take some time to be felt. And the significance of contemporary weakening of focus on environments should not be exaggerated: even before this shift in rhetoric and policy detail, performance was already compromised by many other factors, some reasonably attributable to policy weaknesses in and others due to sheer intractability of problems and the constraints imposed by sparse populations and lean budgets.

In the past, some of the pressures on environments summarised in preceding sections of this report have been actively addressed, but too often in a piecemeal, under-funded and inadequate way through various time-bound public programs offered chiefly by the national government. Because public funds are most often disbursed roughly in proportion to human population, adjusted to account for the greater costs of delivering basic human services (e.g. health and education) to remote and disadvantaged populations (see below), north Australia's vast landscapes struggle to attract a fraction of the resources needed to address widespread management problems that have no single solution. Recognition that early intervention and preventative treatment are more cost-effective than seeking cures for deeply entrenched problems has not been sufficient to attract resources matched to the scale of need (Robin and Dovers 2007; Blanch 2008) to arrest environmental decline, despite a North Australia subprogram (again time-limited) within the most recent national Caring for Our Country program (Commonwealth of Australia 2008). It appears unlikely that the like of even these modest programs will be seen again soon.

More optimistically, one of the most important contemporary successes in management genuinely matched to need is been the West Arnhem Land Fire Abatement (WALFA) project. Here a sequence of publicly funded research and government conservation projects facilitated by a committed group of senior Indigenous land owners and managers built the foundations for a substantial, long-term investment from a global energy producer seeking offsets for greenhouse gas emissions. Research coordinated by NAILSMA led to declaration of new methodologies (see Russell-Smith et al. 2009). Support from philanthropic and environmental NGOs, including TNC, and funding for Indigenous rangers followed, allowing the range of conservation activity to widen. Gains sustained for a decade have been made in emissions reductions, and protection of fire sensitive vegetation, including habitats used by threatened and endemic wildlife. Fire regimes are now more favourable than in the adjoining federally funded Kakadu National Park (Figure 5 above). Arguably, the unique combination of long term private and public sector support has facilitated durable institutions capable of producing long-term conservation and social benefits (Burgess et al. 2005; Garnett et al. 2009; Russell-Smith et al. 2009; Campbell et al. 2011).

Many more successes will be needed. New pressures are set to add acutely to chronic running down of ecological integrity. Accelerating developments in mining, petroleum and gas extraction (both conventional and unconventional), irrigated and rain-fed agriculture, forestry, and intensification of grazing will add a layer of large-scale structural change. As well as associated increases in clearing of native vegetation and much greater water use, intrusions into previously undisturbed regions will push along the chronic and incrementally increasing problems in weed control, fire management and invasive animal management to affect even larger areas.

Acute changes and the chronic commonplace will come together test the resilience of natural systems and the commitment of those who seek to look after them. One possible response to this coupling is to see private and public investments in the new as an opportunity to redress the old and intractable. Directing a small part of projected investment to offsets that deliver net environmental benefit is the most obvious mechanism for realising that opportunity. Although regrettable, apparent withdrawal of the Northern Territory government from this space may open up additional options for creative and credible programs based on collaborations among industry, conservation and philanthropic NGOs, and land owners and managers. And Development by Design provides a well-established vehicle for designing and presenting ambitious projects and negotiating the necessary partnerships to achieve them.

8.4.1 New roles for non-government actors

To some extent offsetting disengagement of government is a trend to increasing third sector involvement in acquiring sites with high conservation values and actively managing them to secure those values (e.g. Wongalara[48]: Australian Wildlife Conservancy), or supporting others to do so (Fish River[49,50], Warddeken[51] IPAs: The Nature Conservancy).

Invoking patterns of land use change seen in other nations, Holmes (1990, 1992, 2002, 2008, and 2010) has over a period of several decades tracked a shift in Australian savannas away from orthodox production. A "post-productivist" status has been postulated, designating a shift from management regimes for production of orthodox (agricultural) products to other environmental and consumer benefits. This trend is said to be in part exemplified by Indigenous land rights shifting land use to Indigenous customary purposes. There is debate about the full array of drivers and significance of such shifts, but there is no doubt that landowners face a different set of options and demands than applied a generation ago.

Transfer of land to Indigenous people (Table 2 above)has greatly outpaced access to the resources needed to plan and support use or management, or even to take up residence, so adverse impacts from fire, weeds and feral animals, too often go unmanaged. Entrenched socioeconomic disadvantage demands urgent attention, so landowners feel obligated to extract incomes from their land. Acting together, these factors place great pressure on traditional landowners to make important decisions about the future use of their lands; and now rather than later (see NAIEF 2013).

At present they face starkly contrasting options. One class of options involves formal inclusion (declaration) of lands in the state or national protected lands system. Joint management systems under which lands are formally declared as reserves and often held by the state under long term leases place the greatest constraints on future land use. In exchange traditional owners may get accelerated recognition of land claims and long term commitments to employment of community members in park management. Indigenous protected areas (IPAs) place fewer restrictions on use and have proved highly attractive to landowners, even though government financial support is usually modest relative to declared, jointly-managed areas. Sites under both of these forms of management are shown in Figure 17 below and details of areas under such management given in Table 3. Both of these sorts of arrangements appear unlikely to be significantly expanded in the Northern Territory in the near future.

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[48] http://www.australianwildlife.org/sanctuaries/wongalara-sanctuary.aspx

[49] http://www.fishriver.com.au/

[50] http://www.nature.org/ourinitiatives/regions/australia/explore/fish-river-station.xml

[51] http://www.natureaustralia.org.au/news/indigenous-australians-protect-the-past.xml

Table 3 :Areas in the protected lands system in the NT study area.

Protected area class	Area (ha)	Percentage of study area	Principal parks/IPAs
Indigenous protected areas	2,989,692	4.6	Djelk, Warddeken, Anindilyakwa, Dhimurru, Laynhapuy, Marri-Jabin, Yanyuwa
Jointly-managed formally declared reserves	3,999,024	6.2	Kakadu, Nitmiluk, Garig, Gregory National Parks
Other protected areas	1,767,633	2.7	Litchfield, Keep River, Limmen, Wongalara
TOTAL	8,756,349	13.6%	

Partnerships with conservation NGOs like those alluded to above may also be proposed and funding from non-government sources is increasingly common.

Another distinct class of options - embracing orthodox production - derives from access by external actors to large areas of relatively cheap land rather than other specific "fit for purpose" advantage. Such arrangements may involve marginal uses that depend for their commercial viability on attribution of low or no value to the land on which they take place, but which may generate some employment attractive to communities. For example, a valuer put an annual rental of \$3 $ha^{-1}.y^{-1}$ on Tiwi lands (cited in SECARC 2009) for a forestry venture which required clearing of 30,000 ha native of forest. The project collapsed after a few years. Based on the Tiwi experience, the Northern Territory Government proposes to institutionalise additional transfer of Indigenous land to agricultural developers under leases arranged through the Development Land Corporation (see Section 8.1.1.1 above).

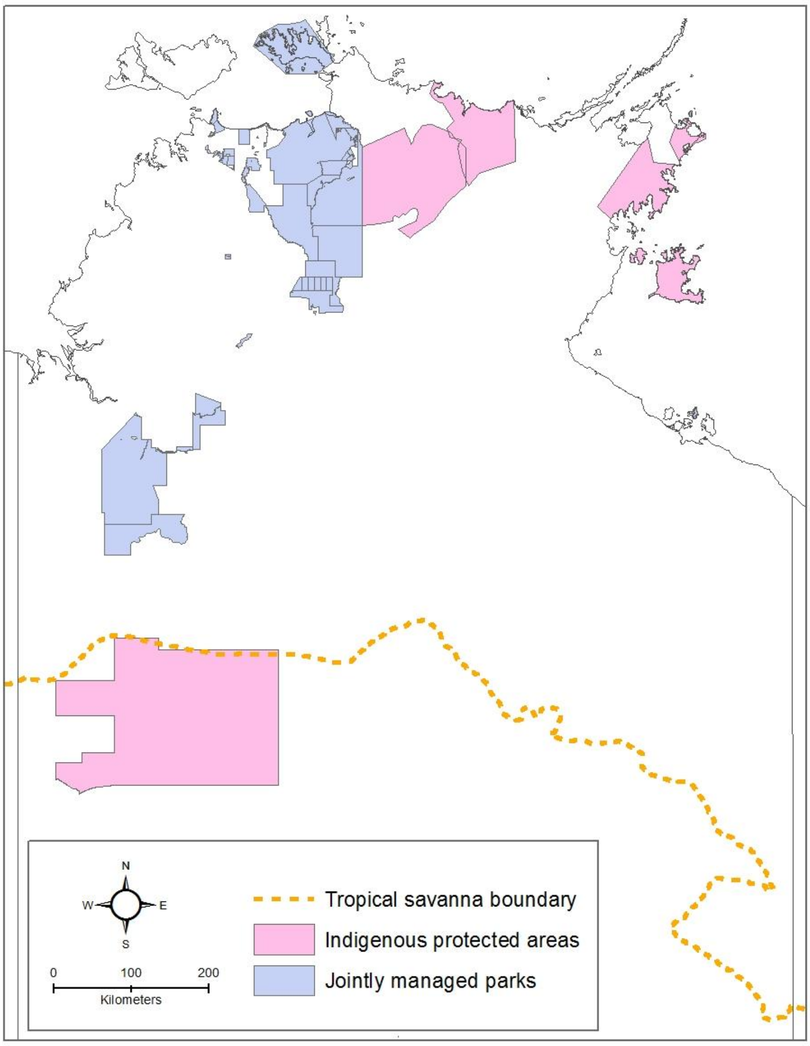

Figure 17: Conservation areas on Indigenous land formally declared as reserves and managed jointly with Indigenous people under specific laws (e.g. Nitmiluk and Garig National Parks) or under agreements with the federal government (Indigenous Protected Areas).

Landowners facing stark individual choices or, potentially, seeking appropriate reactions to interventions of the sort proposed by the NT government, require high quality, unbiased, non-ideological, advice that weighs up costs and benefits and openly acknowledges risks of land use change. Arguably, Indigenous land owners and others have not always had access to advice of the necessary comprehensiveness and quality, despite the need demonstrated by regular failures, especially in agriculture. Consultations for formal approvals of external, context-free proposals can be complex and costly and too often require that landowners consider options in isolation from properly analysed alternatives.

Formal land use planning processes in Australia are not well-matched to Indigenous interests and approaches (Hibbard et al. 2008). In the Territory, such interest as there was in improving the fit seems to be waning, with innovations for involving Indigenous people in water planning (e.g. Hoverman et al. 2012) being wound back (see Section 8.1.3.7 above). Supporting Indigenous landowners and communities to develop land use plans encompassing both economic development and conservation as a framework for decision-making - rather than treating plans as a response to decisions already made by external interests - may be productive investments for NGOs and

Indigenous organisations. The use of scenario planning as developed as part of the recent TRaCK research program (e.g. Pantus et al. 2011) coupled with simple models capable of incorporating local knowledge (Collier et al. 2011) offer useful approaches. Karjala and Dewhurst (2003) report that such methods can help reveal the complexity of Indigenous views of sustainable resource use in ways that permit meaningful planning responses. And they will also help Indigenous decision-making about partnerships with private for-profit or not-for profit organisations for any purpose.

NAILSMA and the North Australia Indigenous Experts Forum[52] has embraced the notion that Indigenous livelihoods based on land use can be advanced by appropriate planning at a range of scales (NAILSMA 2014a). But planning without reasonable expectation of adequate resources to implement ideas is worse than useless because it squanders time, money and energy. Given the weakness inherent in formal NT government land use planning and retreat from resource use planning exemplified by changes in water management, government support appears likely to be at best indirect, by providing better access to publicly funded data archives. There is clearly a gap to be filled here, going beyond the role of offsets to include the wider sustainable development and conservation plans within which they will necessarily be embedded.

Roles for planning at the different scales relevant to DbD can be summarised as:

> **Regional:** Planning at the regional scale provides for identification of powerful external influences on opportunities and challenges and broad understanding of community interests and capabilities. Through participation and formal endorsement of such plans, all parties, including governments, can indicate their commitment to directions in regional development, as well as understand specific issues that have strong community support and may warrant investment. Regional development plans provide context for more localised planning.
>
> **Country-based planning:** Cadastral boundaries rarely coincide with ecological boundaries or Indigenous estates and interests. Indigenous people in many parts of northern Australia have adopted tenure-blind, country-based planning in which they identify issues of interest or concern across all of their traditional country. These plans can then be used to create partnerships for achieving shared goals (Smyth 2012). If well-managed, such processes can provide essential community-based statements of both aspiration and capability: to inform regional plans and influence decisions on investment by other interests. And communities can consider where and how they will access the resources to advance their ideas. Indigenous resource management organisations often operate at this level as well as making contributions to regional plans facilitated by others.
>
> **Estate or property-level planning:** When plausible livelihood goals have been set and tested, then individual landowning groups can plan for their on-ground achievement, taking advantage of partnerships and supportive policy and investment commitments, and identifying the investments and actions they and their local organisations must also take to succeed.

Support is required for country-based planning and preparation of the equivalent of property management plans for Indigenous land holdings where these are not already covered by other arrangements (e.g. IPA plans). These could be an important focus for investment by philanthropic and environmental NGOs to secure both social and conservation benefits.

One of the options considered in all Indigenous land use planning should be the option to engage in commercial delivery of environmental services, which has already started with carbon offsets and in which Indigenous organisations have shown much interest. Biodiversity and other offsets are

[52] See http://www.nailsma.org.au/programs/north-australian-indigenous-experts-forum-sustainable-economic-development

additional options. It makes sense to deploy the already substantial national investments in a strong cohort of skilled Indigenous land managers - with access to the two toolkits - to also address social benefits in enterprise development suited to regional and remote areas and goals which are often compatible with the goals of non-government environmental and philanthropic organisations.

8.4.2 A TNC role for planning and offset deployment in the Northern Territory

The Northern Territory's lack of legislative or policy infrastructure designed specifically to support offsets obviously complicates their use in this jurisdiction, no matter who seeks to deploy them.

The NTEPA dismissal of offsets is obviously a considered decision, involving as it does at least two separate statements of guidance. Those statements offer no coherent explanation of the decision, but imply that offsets may be seen as an unnecessary impost on industry that the NTEPA has no capacity nor power to deploy. But the Commonwealth's EPBCA Offsets Policy for matters of national environmental significance (NES) may leave no option but to engage in offsets work in one way or another, despite government disinterest or incapacity. The NTEPA's apparent solution - to link environmental offsets to social and economic impact assessment (NTEPA 2013h, p. 2) - is confused and confusing. Whilst we agree that the manner in which offsets are deployed can have important social and economic effects, we regard overt uncoupling of offsets from considerations of environmental quality through the environmental assessment process as misguided and potentially damaging.

Despite the difficulties the NTEPA has created for itself and the NT government, the consistency of presentation of the no offsets policy suggests that this stance will not be easily abandoned and will flow through to other areas of Northern Territory government activity. Using the mechanisms available in law administered by other agencies to specify and secure offsets, no matter how well suited to the task, may prove problematic. It is unclear how the anomalous Territory position will be managed within a proposed national review of environmental regulation[53]. It is likely to require some time to complete such a review.

Until these anomalies are resolved, TNC may choose to focus its promotion of offsets in the Northern Territory on matters of NES, pursued directly through interactions with developers and the Commonwealth Government. This is not to suggest that documented priorities of the Northern Territory Government in biodiversity conservation and other environmental issues should be ignored but active government support to realise them through offsets should not be anticipated. This conclusion is important, because resistance to the application of offsets to environmental management, whether passive or active, may constrain the options available to ensure their security and durability.

Approaches to dealing with these challenges are explored in other parts of this paper which propose a conceptual and practical approach to offsets matched to the Territory's present situation, while remaining consistent with DbD principles. Given the significance of planning to the DbD approach, important questions arise for TNC in the extent to which it is equipped or prepared to embrace a role in land use planning that goes beyond the direct achievement of conservation goals to deal with some of the messier preliminaries.

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[53] http://www.environment.gov.au/minister/hunt/2014/pubs/mr20140429.pdf

9 MATCHING OFFSET THEORY AND PRACTICE TO NORTHERN TERRITORY CONDITIONS

We have shown that Territory land and seascapes are mostly "natural". Away from a few major settlements, environments are structurally unmodified and occupied by predominantly native plant and animal assemblages. Expression of cultural heritage are widespread (indeed ubiquitous) but mostly embedded in natural features. Major developments almost always cause significant and conspicuous loss of natural and cultural values. Effects may be localised to the development site or, more commonly, also entrain varying levels of off-site change through, for example, the movement of gases or water bearing pollutants from the development site. In the extreme climatic conditions of the northern seasonal tropics, confining effects to development sites is always uncertain. Indigenous views of the connectedness of landscapes also mean that impacts on cultural heritage and well-being are felt outside the development site. New infrastructure demanded by an increased human presence and entirely new activities adds to impacts. Effects may be short term, but are more likely to continue for decades, or effectively be permanent.

A widely accepted high level principle for compensation for such damage through offsets is to seek no net loss and, preferably, a net gain (ten Kate and Pilgrim 2014) in environmental quality. Clearly such a goal requires that environmental values at an offset site be improved. And ongoing application of offsets at any significant scale requires that there is a "supply" of degraded sites offering plausible opportunities for rehabilitation of attributes commensurable with those lost. This presents some conceptually and operationally important issues for a jurisdiction like the Territory. On the one hand, acutely degraded sites that warrant and are amenable to repair at costs that can reasonably be accommodated within a plausible offset project are relatively few, so precise matches among impact, site characteristics, and remediation opportunities may be difficult to find. Alternatively, merely protecting (as distinct from repairing) a site of equivalent pre-development quality, in a widespread and abundant environment type may achieve no or little immediate benefit and yet generate substantial costs.

There are, however, very many sites suffering diffuse degradation of values important to Indigenous and non-Indigenous society, some of which can be repaired over large areas by relatively modest increase in management resources. Treating such areas as sources of offsets, whilst potentially critical for achieving the positive change necessary to reach a target of no net loss, raises difficulties in demonstrating equivalence and securing benefits over very large areas. Such large scale improvements require robust institutions that will prove durable and capable of operating over the long term at acceptable cost.

Related conceptual and practical challenges also arise at a political level. In an undeveloped region targeted by national and regional governments for rapid acceleration of development of the sort (e.g. broad scale agriculture) that can produce major, effectively irreversible change over large areas, the very notion of no net environmental loss may be questioned: as naïve utopianism and a recipe for unreasonable denial of opportunities to improve socioeconomic conditions. Neither the Northern Territory government nor the independent NTEPA have explained coherently their rejection of offsets or the expectation that they can be rolled into assessment of social and economic impacts. But their apparently shared stance may in part reflect unwillingness to adopt a prevailing offset model that they see as pursuing unreasonable expectations, irrespective of prevailing national and international best practice.

There are also issues in definition of environmental values that require offsetting. Appraisals of the residual damage of developments are most often couched in terms of direct physical or chemical change and orthodox conservation biology, with its bias to more conspicuous and better understood or charismatic fauna and flora. These are essential components of the assessment process and offset design, but given the predominantly Indigenous society occupying most of the Territory landscape, they surely should be complemented by Indigenous views of values that require protection or compensation. These will not always align with conventional treatments (Whitehead et al. 2000). Indigenous participation in the environmental assessment process is often weak (BIITE 2009) because it depends on the (inherently variable) skills and commitment of the development proponents. Environmental assessment bureaucracies arguably lack both the resources and skills to ensure that the Indigenous groups who will be most affected are properly engaged.

In this section we address these and other issues by developing an offset model that, while maintaining the aspiration of no net loss, adds a focus on building capacity to manage change and secure better management of large areas, as well as more orthodox, smaller-scale offsets. Notwithstanding our earlier exploration of some unusual options for offsets, we do not attempt a re-analysis of the well-established fundamentals of offset design, but rather a tuning of attributes to the Territory situation and the particular demands of Development by Design.

9.1.1 Environmental and social costs and benefits

The NTEPA proposes that environmental offsets should be considered during social and economic impact assessment (NTEPA 2013h). We are unsure what this means, and note that in recent draft terms of reference for preparation of an environmental impact statement made after the issue of the social and economic assessment guidance (e.g. for the Jervois base metals project[54]), the NTEPA provides no publicly available clarification to the proponent. There is no mention of offsets except to refer to the separate guidance on offsets: guidance that dismisses them (NTEPA 2013b) and confuses them with social benefits packages that may be negotiated, for example, with traditional owners on Aboriginal land. In its presently weakly articulated form, it is hard to interpret this approach to offsets as anything but a departure from widely accepted (e.g. by the Minerals Council of Australia) obligations to compensate for impacts on the non-human biophysical environment with at least equivalent benefits measured in similar biophysical currency.

In raising this muddling, we do not argue that there is no connection between the condition of biophysical environments and human well-being. Or that delivery of biophysical offsets cannot be designed to produce socio-economic benefits. Indeed, we take the view that social benefits can and often should be delivered without compromising the quality or scale of the biophysical compensation for unmitigated/residual damage. In-keeping with this position, we suggest that key attributes for framing a Development by Design Offsets model matched to the Territory situation must be considered in two conceptually distinct but functionally overlapping categories. One set covers features for creating biophysical products that are credible in national and international forums and with buyers, whether in compliance or voluntary markets. The second set addresses features to match the needs and preferences of offset providers, including Indigenous landholders. The goal with this second, social overlay is not to trade environmental benefit off against social credentials, but to ensure that commitment and capability to deliver environmental benefits are reinforced.

We deal first with the features needed to assure offset buyers that they are accessing robust, credible products that offer genuine compensation for biophysical detriment in Territory environments.

9.1.1.1 Essential features of biophysically robust offsets

Acceptability of impact: The environmental detriment for which offset is sought must be acceptable in type and magnitude to the local, regional and wider communities.

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54 http://www.ntepa.nt.gov.au/__data/assets/pdf_file/0006/351915/terms_reference_jervois_base_metal.pdf

> Offsets, no matter how attractive, cannot be used to weaken or be perceived as a threat to the rigour and quality of environmental assessment or lead to special treatment of projects that would otherwise be rejected because of the nature of their impacts or the importance of the sites they affect. This may mean, for example, that projects with extreme impacts that distress many in the community and hence may be seen as incapable of relevant compensation, like the diversion of the McArthur River, would not be considered for DbD treatment, even though they receive formal approval. This framing differs from established approaches in seeking a more inclusive approach to determining acceptability to explicitly accommodate Indigenous views.

Additionality: The proposed offset must be clearly additional to on-site environmental protection measures expected from the developer under existing legislation or common law duty of care. And the offset project must make a distinct and substantial improvement in environmental quality at the offset site, again going beyond regulatory obligations.

Quantifiability (of impacts and offsets): Levels of residual detriment and offset benefits should be quantified using the best available data and methods. Where quantification presents unusual difficulties, including complexities associated with incorporation of Indigenous and other local values, they should be ranked against other examples of impacts and their offsets to inhibit slippage of standards.

Equivalence: The environmental improvement available at the offset site must be at least equivalent in quantum to the residual damage at the development site over all significant attributes identified as impacted.

> Additionality, quantifiability and equivalence in combination set a minimum requirement for biophysical benefits from an acceptable offset. That minimum threshold should not be traded off for other non-environmental benefits. The features outlined here follow well-established policy, and restatement mostly constitutes a rejection of the NTEPA's linkage of biophysical offsets to socio-economic impact assessment.

> Environmental values are difficult to measure in ways that facilitate comparisons of different sites. In many situations, management of risk of weak quantification has been sought primarily in ratios of area of offsetting sites to impacted equalling or exceeding 1.0. Ratios must be much greater when uncertainties are high (Moilanen et al. 2009).This proposition is again consistent with established principles but acknowledges that some views of impact, including Indigenous perspectives, will present particular difficulties for quantification. This is not necessarily because they are unusually intractable, but have had much less study

Location: Offsets should be established in landscapes as similar as possible to development sites but other factors should also influence choices.

> Site selection should be based so far as possible on biophysical similarity, including topography, floristics and vegetation structure and the presence of key attributes affected by the development. Sites close together are more likely to be similar, allowing greater confidence that offsets will achieve equivalence. But if too close they may be subject to unwelcome spill-over of impacts. Location may also determine which human communities enjoy the benefits of the offset arrangement. If poorly located, offsets may exacerbate inequities in distribution of costs and benefits. Except in the case of rare or otherwise unique attributes, site selection should weight likelihood of successful implementation ahead of precise like-for-like substitution. This framing differs from orthodox treatments in putting issues of practicality and probability of producing real net environmental benefits ahead of precise like-for-like biophysical matches which, given the state of scientific knowledge of Territory landscapes, are problematic anyway. Acceptance of this approach positions offset

designers to consider a wide array of options to take advantage of large areas of structurally intact and readily repairable lands.

Sustainability / durability: Offsets must be guaranteed for at least the expected duration of the development impact and in many cases permanently. Design and implementation should address explicitly their role in strengthening local institutions capable of covering gaps and weaknesses in regulatory institutions and related developer commitment.

Because full rehabilitation of severely altered sites is improbable, there will in almost all cases be some effectively irreversible change, creating a preference for permanent protection of the offset site. This demands not just offsets of the right type, but also enduring institutional arrangements to support them. Again the framing is fundamentally conventional in requiring durability but differs in emphasising positive steps to build institutional and related capability to secure longevity despite weak government systems, rather than assuming dependence on government.

Cost-effectiveness: Offsets should be established at reasonable initial and recurring cost, so that no plausible alternative investments would produce greater benefits at equivalent cost.

Judgments about the level of costs that developers might reasonably be expected to meet are difficult, but will become clearer with well-documented experience. Providing information on costs and quantified benefits will be an essential component of a durable offset scheme, especially in the Territory where experience is limited. Analysis of cost-effectiveness should take account of the contribution made to community and landholder commitment and capacity to secure long term protection.

Regional priority: The offset regime should contribute positively to local and regional conservation and development priorities or, if this proves impossible, at least be compatible with them.

The problematic treatment of offsets by the Northern Territory government and NTEPA may be ameliorated if offset providers and developers can show that they make substantial contributions to realisation of local, regional or Territory-wide conservation goals. This provision is similar in intent to requirements in Australia's CFI to show compatibility with regional NRM plans. Regulatory agencies may be encouraged to support offset security if it can be shown that, in doing this, they contribute to larger jurisdictional goals.

Accountability: Arrangements must include obligations for regular open public reporting of outcomes in both levels of detriment at the development site and benefits at the offset site.

Systems for monitoring and open reporting of the effects of development are often poorly developed. But they are essential if offsets are to be seen as making genuine contributions to improved environmental outcomes rather than superficially improving relationships among industry, the public and regulators. Meeting costs of providing such information should be explicitly built into offset funding arrangements. Work will be needed to increase relevance to audiences other than orthodox conservation interests, including Indigenous communities. Recent NT improvements in openness of reporting impacts at development sites must be maintained as a critical component of offset validation.

Timeliness: Offsets must be identifiable and implementable without undue delay and realise benefits within a reasonable time.

Time lags in establishing offsets and in achieving benefits challenge achievement of equivalence. Whilst we have emphasised a critical role for Indigenous lands and land managers, we have also acknowledged institutional and other gaps in contemporary capacity. Dealing with these site by site will slow offset development. It is therefore important, in the absence of government commitment, that non-government interests help build a framework for developing potential offsets somewhat in advance of new development. Development directions and impacts are to some extent predictable (Section 11.2 below) so populating a framework with offset options and potential sites is plausible, as part of a wider strategy to reduce delays.

Active management: All offset arrangements must include financial and other provisions for ongoing active management onsite - and where necessary offsite - fostering improvement in the environmental attributes being compensated, for the life of the offset.

Passive protection of offsets based primarily on attempts to exclude new forms of disturbance is unlikely to be enough in the non-equilibrium systems of the wet-dry tropics. Prevailing pressures relate to fire, grazing by feral and managed stock, and invasive plants, all of which demand active intervention rather than passive protection. The relatively undeveloped state of most Territory lands is also associated with relatively low land values. The capital cost of acquiring lands for conservation offsets may therefore be relatively small compared with recurring costs of active management, reducing (for example) the value of handovers of minor additions to the reserve system, unless there is also commitment to long term maintenance and clarity about how to sustain management inputs. The awful fire regimes prevailing in three of the Top End's major parks (Russell-Smith et al. 2009x) illustrates the folly of relying on formal protection alone. De-emphasis of passive measures is not an unusual framing, but our intention is to go somewhat further than recognising that lock it and leave it doesn't work. People active on country in meaningful employment is so fundamental to the building of human and social capital and the institutions they deploy to meet any land management objective, that it warrants special emphasis in both biophysical and social features of good offsets.

This set of attributes differs from accepted wisdom mostly in acknowledging that like for like offsets may not be the best option, even where they are practically achievable. The second, socially-oriented set of attributes presents greater challenges to orthodox approaches to offsets. Before they are laid out, it will be useful to explore further the connection between delivering biophysical benefits and the social conditions prevailing in the Territory.

9.1.2 Opportunities

Whilst the peculiarities of the Territory situation complicate identification and design of offsets, they also offer unusual positives. Structural integrity of Territory landscapes means that sites with most of the pieces in place are many, offering more choices than in more densely-settled regions. And dealing with diffuse impacts provides options to improve management of large areas at relatively modest recurring cost (Whitehead et al. 2009; Whitehead 2012). Further, regional populations, although sparse, are dominated by Indigenous people with a particular interest and well-developed skills in management of pervasive impacts like fire and feral animals. At least potentially, more people in more places are positioned to contribute - and interested in contributing - to offset delivery.

The social disadvantage suffered by many regional populations is an important *caveat*, because it affects capacity to take on the stewardship roles that both cultural norms and sound offsets require. In under-developed, socio-economically marginalised parts of the Territory (Whitehead 2000; Whitehead et al. 2009) with much Indigenous land suitable for generating offsets, landowners often have difficulties accessing the financial resources needed to manage their lands as they would like. Chronically limited options to intervene to protect lands from direct and indirect impacts of development exacerbate local and regional concerns about development benefits flowing mostly to distant interests (Stoeckl 2012; Stoeckl et al. 2013). Investments designed to support management of lands and in so doing also improve the social conditions of local people are therefore likely to be particularly welcome (e.g. WLM 2012).

We have in this paper criticised the apparent muddling of socio-economic and biophysical compensation inherent in the NTEPA guidance on offsets. In doing so, we are acknowledging that direct connection of social benefits to environmental offsets may be controversial. An important concern is that delivery of some local social benefits may be treated as payoff for permission to damage the biophysical environment in ways that would otherwise be unacceptable. Those paying for offsets may also see as double dipping the addition of social benefits to the compensation to which they are expected to contribute. It may be argued that social obligations have been met through payment of taxes and royalties levied by governments, even if governments make no effort to direct those royalties back to the places of origin (see Section 6.5.2 above).

However, we consider that well designed offsets offering biophysical equivalence but using available funding to secure those environmental benefits in socially positive ways are immune to either of these criticisms. We consider that offset quality (especially their security) is best achieved by building local capacity, and that this is in turn best done and done cost-effectively through local employment. At a cost of about 50 cents per hectare, ConocoPhillips and its local subsidiary Darwin Liquefied Natural Gas have demonstrated, in the WALFA project (Whitehead et al. 2009), delivery of high quality biophysical environmental benefits and social benefits through the one set of actions: by employing and otherwise supporting groups of local land managers to deliver agreed environmental benefits.

The conjunction of many options for low cost, large scale interventions and the potential to draw on local skills to increase remote area employment that delivers numerous social benefits (e.g. Burgess et al. 2005; Campbell et al. 2011), is surely an extraordinarily valuable asset for any offset system.

In the Territory situation, there are no conceptual or insurmountable practical difficulties in offset purchasers biasing their decisions to high quality products that also deliver social benefits and, in favourable circumstances, additional (multiple) conservation benefits. Indeed, in carbon market systems, products that also demonstrate social and biophysical (especially biodiversity) benefits are regarded as essential to avoid a "race to the bottom" (GSF 2013) and described as premium products (e.g. Kolmuss et al. 2008). In the absence of offset standards set by regulation, as in the Territory, there is a compelling case for those who fill this void to aim for maximum total returns from the investments of developers and offset providers. The benefits/costs hyperspace within which decisions will be made about project design are illustrated in Figure 18 below.

Several features of this simple graphic warrant comment. There is a considerable area (yellow) where uncertainty levels and hence risks of under-delivery are high. There are several inter-related ways of reducing such risk.

First, by simplifying and narrowing choice of offsets. This may be approached by seeking strongly like-for-like offset sites, implemented without community or other engagement extending much beyond the offset manager. Indeed local people may be actively excluded to minimise risk of disturbance. In this situation (left side of yellow sector), risks are created by uncertain or even hostile landscape context. The probability of producing net benefits at a single discrete site is potentially greater if initial site condition is well below potential, but full restoration will take longer and risk of failure is higher. Less degraded sites may be more reliably restored, but the total quantum of benefit from a given area is reduced. Consequently, at both ends of the condition spectrum, confident delivery of net benefit from sites isolated from their context will require an area much larger than the area of the known impact, in the first case to account for greater risk of failure and the second to account for the lower density of benefits.

Another important step is to improve credibility of methods for assessing and comparing development detriment and offset benefit. Technically robust and well accepted systems for quantifying impacts and benefits would allow greater flexibility in choice of offset sites and methods. Confidence in offset calculus may also reduce the scale of area multipliers necessary to reduce risk of under-delivery and satisfy regulators and the public about equivalence.

Third, and in our view most importantly, the offset obligation can be designed to deliver social benefits, particularly employment, that increase local incentives and capacity to manage lands and resources. Improved technical and operational competence will in turn reduce risk of under-delivery. Where those investments go entirely to the offset provider, on-site offset quality and reliability is likely to be improved. Where that provider has legal and/or cultural obligations for surrounding areas, as will most often be the case for Indigenous providers, the security of the offsite is likely to be optimised by driving enhanced and sympathetic management of adjoining areas. Based on experience at sites like WALFA and Indigenous Protected Areas, we consider that additional costs of socially positive engagement will, with good design, be offset by improved effectiveness (Whitehead et al. 2009; Gilligan 2006).

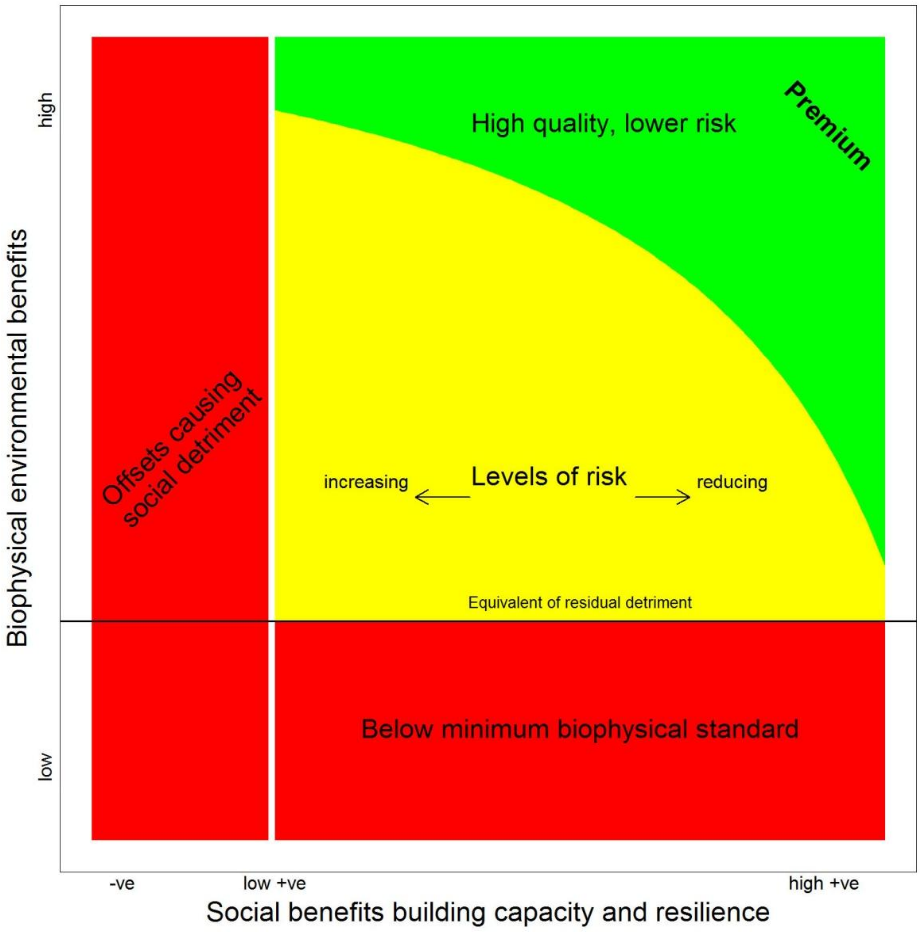

Figure 18: Hypothetical relationships among biophysical environmental and social benefits for offset design. Offsets that fail biophysical equivalence tests are not considered irrespective of social benefits. Offsets so poorly designed as to cause social detriment (e.g. damaging native title rights and customary economies) are rejected (also shown in red). In the yellow area, all offsets ostensibly meet minimum standards but are high risk because of uncertain measurement and/or capacity of providers to deliver, especially if local communities have not been successfully engaged and/or context is actually or potentially unfavourable. If no or low social benefits of a type that improve land and resource management capacity and social capital are delivered then environmental benefits sought would be a substantial multiple of detriment to manage risk (upper left of yellow sector). Multiples may be reduced where social capital enhance local management commitment and capability (right of green sector). In general, design to offer both strong environmental benefits and substantial local social benefits - to build capacity and resilience at the offset site and beyond - should be favoured (top right).

We turn now to the set of attributes needed for offset design to encompass social benefits as a key driver of robust biophysical benefits: in terms of our simple model, to position offsets in the top right of the green sector of Figure 18.

9.1.3 Designing socially positive offsets

In a recent technical review of issues in biodiversity offsets (ten Kate and Pilgrim 2014), intended to inform proposed IUCN guidance, Indigenous interests are invoked once to propose "(s)pecial consideration" (p. 10) of nationally and internationally affirmed rights. Such treatment constitutes no more than a recognition of basic obligation to act reasonably and in accordance with law. More broadly, social issues are dismissed on the grounds that "equity among stakeholders and their participation in planning and decision-making should provide an overarching social safeguard" (p. 8).

This facile proposition can be disputed on many grounds, including problems in identification of stakeholders, arbitrary differentials in weighting stakeholder input, prospects of equitable treatment given systemic variation in capacity to participate, and weakness or absence of planning and decision-making frameworks to facilitate genuine and productive participation. Guidance is, however, proposed to identify "societal values of biodiversity" for incorporation into offset goals. Simplistically, a complex set of issues is reduced to debate about whether utilitarian use or cultural values should be compensated or recognition of detriment to be offset confined to "intrinsic" or existence values. The crudeness of their caricature of such issues illustrates the difficulties of reconciling, in a diverse society, very different views of relationships with and obligations to nature. If directions taken in the ten Kate and Pilgrim (2014) paper are followed, the IUCN guidance will contribute only to accounting standards rather than integrated assessment standards that deal with all of the issues important for effective offset implementation.

In contrast, a number of standards and associated guidance for carbon offsets seek to grapple directly with social issues. They go well beyond basic obligation to do no damage to the interests of local people: to require demonstration of social benefits. Standards such as CCBA, REDD+, Gold Standard, and Social Carbon embrace an obligation to show that credits improve long term livelihood security and well-being of Indigenous peoples and local communities (Robinson et al. in preparation). Whilst such standards are applied mostly in developing countries, we regard the principles of equity and social justice on which they are based as just as relevant to disadvantaged, un-developed regions of nations like Australia.

We do not seek to enter debates about definitions of biodiversity or other environmental values here, or to develop further the moral argument for seeking socially-beneficial offsets in northern Australia. Instead we focus on attributes of design and implementation most likely to contribute to Indigenous well-being: and so help to build interest, commitment and capability to provide robust high quality offsets that are secure over the very long term. We draw on work by Robinson et al. (2011), James (2012, 2013) and Robinson et al. (in preparation) summarising issues identified by Indigenous people as necessary for full participation in offset (specifically carbon) markets.

9.1.3.1 Contributions to well-being

A number of studies have shown that engagement of Indigenous people with external conservation and other programs is often motivated by a desire to regain access to traditional lands and get resources to reassert customary land management practice (Russell-Smith et al. 2009; Smyth and Whitehead 2012). It is unsurprising that descriptions of benefits sought from offsets reflect similar motivations.

In thinking about attributes that should be reflected in measures of benefits - specifically through savanna burning projects (DCCEE 2013) - Indigenous informants have emphasised "right country, right people, right time, right fire". NAILSMA (James 2013) has abstracted the non-exclusive features requiring attention as: connection; identity; knowledge and skill; seasonality; and power and empowerment. Robinson et al. (2011) summarised views of co-benefits from carbon markets in two principles : "support (Indigenous) peoples' interests, values and assets" and "build … adaptive capacity to supply (carbon offsets)". Criteria for observance of these principles included: increased opportunities to work on country and/or maintain connections with traditional lands and waters; net positive impacts on livelihood security and well-being; equitable distribution of benefits; recognition and application of Indigenous knowledge; and respectful partnerships. This focus on processes and the relationships they depend on is strikingly similar to that observed in identifying indicators of success in joint management of reserves. Early in the joint management experience, Indigenous participants put quality of relationships with joint management partners ahead of biophysical or cultural indicators of performance (e.g. Stacey et al. 2013).

Such emphasis is unsurprising among landholders who have, in generational terms, only recently recovered ownership of lands and are searching for the means to reoccupy. As emphasised by Murphree (2009, p. 2554-2555), in assessing successes and failures in CBNRM:

> *It is the perception of people that is important, not value as measured by some extraneous yardstick ….. The criteria used by a communal entity to determine benefit may well differ from those of facilitators, but those who have had the experience of observing a community determine benefit will know that the exercise is not taken lightly. A variety of institutional and distributional factors will be considered and negotiation is likely to be involved.*

In designing and specifying types and levels of support needed to ensure effectiveness it would be unwise to diminish significance of the divergence between Indigenous motivations and the very different drivers of offset purchasers. In terms of the conceptual model described here (Figure 18), the challenge can be described by asking, given what we know of Indigenous perspectives, what features must be added to biophysical criteria for robust and well-designed offsets to move them from the red or yellow, deeply into the green? We consider those features within the conceptual frameworks offered by NAILSMA (James 2013) and Robinson et al. (2011).

9.1.3.1.1 connection

Connection is about relationships of people with each other and with lands, waters and living things. Those connections are expressed through family, kinship, skin system, and Indigenous law and commitment to specific homelands. No site will lack well-recognised cultural links with other sites; and those linkages may extend over long distances. Failure to meet obligations in one area will affect neighbouring and sometimes distant sites and people. The implications of this recognition of connectedness are no different in principle from the obligation of biophysical scientists to take account of physical flows and ecological connectedness in offset design, but may involve differences in detail and in the relative emphasis on the significance of maintaining connections in different contexts.

Designs or implementation strategies that explicitly recognise and reinforce such connections will attract stronger commitment and have the potential to increase the aggregate resources brought to bear in support. On the other hand, designs that threaten recognition of connections and can be seen to isolate sites - like exclusion of people with real connections with country or prohibition of aspects of customary practice or ceremony - may be actively resisted, damage social cohesion and so place offset sites and community well-being at risk.

9.1.3.1.2 identity

In NAILSMA's (James 2013) treatment, identity equates with authority and obligation. A person who is recognised as holding a cultural legacy from their country accepts obligations and is assigned authority. They are the right people to negotiate with and carry out the wishes of traditional owners. It is essential that would-be offset designers or buyers know that they are dealing with those with full authority, not just to allow access to the land but also to take the right actions with full customary authority.

Offset selection and delivery mechanisms that work through the wrong people - who consequently lack customary authority - will, irrespective of other forms of formal authority those individuals might hold, attract both formal (legal) and informal (community) challenge, damage social capital and put both offsets and community well-being at risk.

9.1.3.1.3 knowledge and skill

Offsets will be most robust if designed to use effectively both formal scientific and local (situational) knowledge. Local knowledge may be codified in traditional theory and practice and based on individual experience. Design and management regimes that do not accommodate local knowledge and engage local skills are likely to attract weaker commitment and inferior performance. Modes of delivery denying local knowledge and dismissing opportunities to exercise local skills will not support the building of social capital needed to increase capacity and commitment.

Indigenous groups emphasise the obligation to transfer detailed socio-ecological knowledge to younger generations, especially through direct experience on country. Offset design and delivery practices that respect local and traditional knowledge enough to build in opportunities for inter-generational transfer of customary knowledge, as well as incorporation in formal education systems to enhance their attractiveness (Fogarty and Schwab 2012) will not only contribute to Indigenous well-being but also to the improved management and long term stability of offsets.

9.1.3.1.4 seasonality

Much Indigenous knowledge is built around seasonality, related understanding of social and ecological cycles and the importance of their relationships in land, water and resource management. It is such a fundamental component of Indigenous knowledge and practice that it warrants separate emphasis.

Offset design and management that gives priority to timing actions for compatibility with biophysical and social dynamics will be important in most natural heritage and resource-based offsets. Skilled and culturally informed application of seasonally-attuned activity in offset management will engender a greater sense of continuity and compatibility with community and customary life, reinforcing social cohesion and well-being. But interpretation and application of seasonal thinking and action must be done by those to whom it has real meaning.

Arrangements that fail to take account of beliefs and practices regarding temporal and well as spatial linkages of places and events - and peoples' seasonal social commitments - are likely to be fragile. This sort of risk is exemplified by the substitution of crude understanding and non-Indigenous application of seasonality in fire use and consequent institutionalisation of destructive fire regimes in Kakadu (Petty et al. in review), that appal both Indigenous and non-Indigenous interests.

9.1.3.1.5 power and empowerment

Showing proper respect for Indigenous and local values, skills and obligations requires serious consideration of all of these issues in offset design. And respect is essential in any genuine partnership: in which both parties understand and accept their obligations and entitlements and have the means and confidence to deliver and receive them respectively. A measure of local empowerment is a pre-requisite for entering partnership in the first place, but would be expected to be reinforced and to grow through positive experiences. Improving ability to reconcile customary law and practice with effective and productive partnerships will underpin better planning and more robust institutions for good decision-making. Such positive feedbacks are necessary to build individual agency, social cohesion and, ultimately, enhanced community well-being.

Arrangements that over-prescribe method, or assign authority to others from outside the community and so disempower local people and institutions, damage local authority and compromise both short term performance and longer term capability. Murphree (2009) concludes that "when economic benefit is linked with authority and responsibility, large increments in social capital can result". The reverse is also true: when empowerment is not attempted or fails, social cohesion and hence the capacity to deliver on any agreement is weakened.

9.1.3.2 Important features of socially robust offsets

Based on these syntheses and interpretations of Indigenous statements regarding the benefits expected from participating in offset delivery, we suggest that credible biophysical offsets that also seek strong social credentials for their own sake and/or to drive ongoing improvements in offset quality, security and durability, will incorporate features like these:

connectedness

- of people to country
- of culturally-linked sites to each other
- of customary Indigenous roles in accordance with kinship
- of mainstream and customary institutions

adaptability

- to make use of evolving and growing capability and interests
- to incorporate new skills
- to increase scope, scale and opportunity

integrability

- with other work
- with customary activities
- with formal education and training
- with preferred pathways to employment and enterprise

flexibility

- by avoiding over-prescription
- to accommodate different methods including support for customary activity like ceremony that has no recognised orthodox analogue
- to respond to dictates of seasonal conditions and obligations
- by supporting activities and building capacities applicable in multiple locations and situations

reinforcement

- of existing customary and mainstream activities, institutions and capabilities
- of formal training
- of enterprise building

adequacy

- to make a meaningful contribution to on country obligations
- to meet all important costs, including measurement of outputs and outcomes

on-country action

- generating activity on country rather than payments for access by others

- emphasising customary, usually labour-intensive methods
- combined with contemporary technology when compatible

building capability

- by workforce development
- by providing the resources and experience needed to plan land use and so position offsets within a well understood context
- by generating awareness and encouraging creativity

equitability

- by actively involving multiple within-community interests
- by sharing rewards in proportion to contribution
- by formal agreement on benefit distribution and conflict resolution

demonstrating respect

- for different perspectives on causality, obligation and method
- for Indigenous institutions, including roles of traditional custodians of knowledge, sites and resources

knowledge-richness

- drawing strongly on Indigenous and situational knowledge as well as science
- amenable to on the job and formal training
- contributing to primary and secondary school curricula

relative autonomy

- to take agreed actions without unnecessary external intervention

accountability

- to purchaser or regulators
- to regional communities and their aspirations
- to local and Indigenous institutions and authority
- for outcomes reflecting Indigenous priorities.

Some of these attributes we regard as essential for any offset agreement, and others as important for recognition of the criteria Indigenous offset providers will apply to assessment of opportunities and preferred approaches and hence the array of offset types they may be willing to supply. It is highly desirable that offset designers and buyers understand these preferences and enablers. To facilitate comparison and awareness of overlap we now summarise these observations in equivalent language and style to statements outlining biophysically acceptable offsets.

9.1.3.2.1 Essential features of socially robust offsets

Acceptability: Offsets that involve or create plausible risk of loss or reduction of local social capital or damage local customary or orthodox economies should not be considered.

> This proposition should be uncontroversial because it reflects basic obligations and is already included in many offset standards, including Australia's CFI. Its strict observance is necessary to maintain offset quality and enduring community support. It invokes principles of equity and respect. For example, arrangements that provide for lease of land but use external managers exclusively for on-site work would not be considered.

Location: In general, offsets should be located to maximise net environmental benefit. However, if relevant offsets are available in a timely way from the individuals, group or close affiliates who most directly suffer environmental detriment, they should be selected ahead of equivalents available at similar prices from other providers.

In a perfect system, communities most likely to experience social and environmental detriment would enjoy a level of social and environmental benefit that they assess as at least equivalent to the detriment, irrespective of benefits delivered elsewhere. This preference qualifies the search for the most cost-effective way to deliver optimal environmental benefits to ensure that communities suffering the most direct detriment have first opportunity to benefit from its treatment. It is arguably the social equivalent of like-for-like biophysical offsets, and invokes issues of equity.

Cost-effectiveness: Socially-responsible offsets should not make significant cost-based tradeoffs of environmental benefits for social benefits.

We base our argument for considering social benefits in offset design on the premise that good design for downstream enhancement of biophysical benefits can be done at little or no additional cost. This provision formalises that argument. However, we also note that some buyers may wish to claim contributions to multiple benefits, including social improvements, and make correspondingly larger investments.

Regional priorities: Where regional groups have prepared or endorsed local conservation or development plans, whether or not formally endorsed by government, offset arrangements should at least be compatible with, and preferably support implementation of, those plans where they are compatible with good environmental outcomes.

As noted above, this framing echoes provisions in the CFI requiring compatibility with NRM plans. However, some NRM plan regions are very large: the NT has only one for the whole 135 million ha. Positive feedbacks between aspirations, experience, capacity improvement, and offset quality will operate at much smaller scales, so design must be sensitive to local plans as well as the more formal large scale statements. Observance will demonstrate respect for local aspirations and make important contributions to local empowerment.

Sustainability/durability: Offsets should be designed to draw on existing or build new institutions and skills capable of supporting active management over the long term.

This capacity-building role is at the core of the proposed model for low cost but robust offsets, supported by reliable institutions and an Indigenous workforce growing in skill and confidence.

Accountability (and quantifiability): Offset providers should keep records and agree to make public statements of social benefits derived from offset provision, using metrics or surrogates based on statements of community aspirations for socio-economic development.

Offset providers should always be positioned to provide evidence of performance in all relevant areas. Discriminating buyers will wish to see evidence of social benefits, especially if they pay a premium price. All buyers will wish to avoid entanglement in suggestions of inequitable or otherwise unsatisfactory access to benefits, and so welcome open public reporting.

Additionality: Social benefits realised through engagement in offsets provision should not be the same as or counted towards benefits specified in social compensation packages agreed under relevant law or otherwise to compensate for negative social impacts of developments. If social benefit packages developed outside environmental offsets frameworks include direct or indirect support for land or resource management, then there should be no requirement to generate biophysical environmental offsets sought by the developer with regulators or other groups.

If biophysical offsets are to be credible and avoid being seen as a form of environmental blackmail, they must avoid any suggestion of double dipping. By the same logic, funding for social benefits packages should not be accompanied by demands to deliver free biophysical offsets.

Equivalence: Socially-responsible offsets should generate equivalent environmental benefits at costs similar to more routine offsets. If a purchaser seeks formal recognition of additional biophysical benefits and/or social benefits, a premium may be paid.

> Uncertainty in specifying both the level of residual environmental detriment or the corrective available in particular offsets will often be addressed by requiring an offset potentially offering a multiple of assessed biophysical detriment, usually by increasing the area of the offset site. And benefits should substantially exceed detriment to warrant investments of time and other transaction costs met by participants. Social benefits should not enter directly into this calculus. However, offsets that demonstrably contribute to community commitment and capacity as well as providing for ongoing measurement of performance can reduce uncertainty about probability of effective delivery, which can be reasonably factored into decisions to reduce the scale of the multiple needed to account for uncertainty (Figure 18 above). Offset provision is not mandatory under Territory law and policy. It follows that offsets will be formalised through voluntary agreements (binding once entered) between provider and funder that will specify products. Providers will seek to negotiate higher prices if buyers seek recognition of additional benefits.

Timeliness: All offsetting actions should begin as soon as practicable after residual environmental detriment is known. Search for socially optimal offsets should not unduly delay identification and implementation when alternatives satisfying other criteria are available.

> Achieving environmental equivalence depends in part on avoiding delays in offset implementation and lags in effectiveness. In many locations, institutions needed to support commercial activity of any sort and socially positive offsets in particular are likely to require strengthening. In order to avoid delays, advance development of offset options matched to likely development pathways will be necessary. This is plausible because directions and locations of development are in some measure predictable and very large projects spend several years in the planning phases. Non-government interests in delivery of environmental services and protection of ecosystem services should consider creation of appropriate frameworks for developing capability in favourable locations. Where advance workforce development is proposed by developers or governments, then offset arrangements, including institutions for training and employment should accompany those activities.

Active management: Offsets requiring active engagement of community members are more likely to produce enduring social benefits and secure offsets more strongly than passive offsets.

> Direction of part of a development investment into land and resource management offsets, positions local people and communities to take on important roles in sustainable development which would otherwise be unavailable to them. This may happen because there has been no opportunity or incentive to develop skills directly required for the particular development type or developers rely on fly-in, fly-out practices irrespective of the local workforce. Active employment delivers benefits more directly and arguably more equitably than lease or other payments solely to traditional landowners. The land and resource roles that local people are best placed to take on will often be labour intensive because such tasks are not amenable to substitution of machines or other technology for human knowledge and capability.

Monitoring and evaluation: All offset projects are subject to monitoring to verify delivery of biophysical benefits. Agreed monitoring and reporting frameworks should include indicators of social impacts on local communities, especially measures of capacity to sustain inputs.

> Validation of claims for benefits is an essential feature of offsets under all voluntary and compliance standards. Ideally those systems should index key social attributes influencing performance and prospects of sustaining inputs and quality of outputs. For the reasons

already given, offset design will almost always include elements for managing risk. Social influences on performance are key risks.

9.1.3.2.2 Desirable features of socially robust credits

Optimal offsets will achieve a tight fit between the nature and quality of products and the methods, preferences and capabilities of local providers. The features outlined above are those necessary to give enough weight to social issues to avoid obviously fragile arrangements, and make useful contributions to growth in capacity. In this second list, we highlight features with the potential to make additional contributions to robustness of offsets and additional growth of capacity and commitment, because they give extra weight to social issues and contribute positively to Indigenous well-being.

Connectedness: Design of offsets that are vulnerable to management context, as most will be, should show how management will be matched to compatible actions in neighbouring sites, how Indigenous practice will contribute to improved security, and how social cohesion will be improved by strengthening cultural links.

> The argument that socially responsible offsets improve security and durability by careful matching to regional context and exercise of reciprocal responsibility depends on real action to maintain and deploy cultural links. It will be incumbent on groups claiming capacity to deliver this advantage to show how they will go about it.

Empowerment: All offset agreements will be designed to empower local people by facilitating informed decisions about participation, tailored approaches to delivery and the structure and management of supporting institutions. Obligations, benefits and authority should be established unambiguously.

> Empowerment is a pre-requisite for strengthening the social capital and cohesion needed for any successful enterprise, including offset delivery. A particular benefit of exposure to commerce through the more accessible and engaging land management pathway is to provide important training for commercial negotiation of any sort, frequently the only opportunity of this type accessible to local groups (Murphree 2009).

Flexibility: Offset agreements should so far as practicable focus on specifying the outputs required by the purchaser rather than the specific methods adopted to achieve them which should, so far as practicable, be left to the provider.

> Taking responsibility for meeting both cultural and contractual obligations in interactions with markets is an essential ingredient for growing capacity to offer more and better products.

Equitability: Agreements for offset provision should include acceptance of provider obligations for equitable distribution of benefits among participants, in line with effort to assure purchasers that their investments will indeed generate social capital.

> An important part of the argument for seeking approaches to offset design that deliver social benefits is that this will ultimately underpin durable, high quality offsets because commitment and capability will be enhanced. If this claim is to be accepted, it will be necessary to take genuine actions to limit risks of failure through weak institutions or inequitable arrangements that cause community tensions.

Respecting local knowledge and skills: Delivery of agreed offset products should draw on real strengths in relevant Indigenous knowledge, skills and experience.

> Deployment of existing local and traditional knowledge and skills is important to increase prospects of success as well as reinforce the cultural and other social value of participation in offset design and delivery. Timeliness and quality of delivery can be enhanced by drawing

on strong local capabilities. Recognition should extend beyond the traditional to include demonstrated capacity to deploy contemporary science and tools complying with legislated or voluntary technical standards

Integrability: Offset activities should fit comfortably with other social and work obligations of key individuals and groups and draw on institutions supporting other activity.

Offset provision will rarely - on its own - sustain a local economy. It is essential that new tasks taken on in offset delivery can be handled by existing institutions and/or institutions created or modified to handle multiple roles. They should be capable of working in tandem with existing or emerging roles and customary activity. And where possible, activities should be compatible with preferred pathways to other employment and enterprise identified by the community.

9.1.4 Processes for a non-government offsets regime

Given disarray of Territory offset policy, it is necessary to make a number of assumptions about how non-government organisations, including industry, can operate in the space vacated by government. The processes to follow are based on several key assumptions about the present and future government role and the intent of non-government interests:

- while not necessarily supporting particular developments or high rates of development in general, non-government actors will none-the-less encourage capture of economic and social benefits from development by local people in the regions;
- mining and energy and other major development companies (e.g. horticulture and other intensive agriculture, forestry, secondary industry) will in general adopt policies and practices sympathetic to offsetting of significant impacts and recognise the desirability of local people enjoying a significant share of the benefits flowing from major developments;
- standards for effectiveness of offsets will require no net loss or net gain in biophysical values and hence full or better compensation for residual damage felt on and beyond development sites;
- the NTEPA, based on its written guidance, will not participate directly in negotiations regarding offsets, but will as a matter of routine provide sufficient detail in assessment reports to permit at least semi-quantitative statements about the level of detriment (including acceptance of risk) likely to flow from individual developments;
- despite some present ambiguity, the Cwlth DoE and any other federal regulatory agencies setting conditions for environmental approvals (e.g. NOPSEMA) will continue to apply the federal offsets policy;
- the Territory government is unlikely to change its policy settings and law to engage actively in offset design and delivery in the near to mid-term future;
- nonetheless, where offsets are sought by developers and/or required under federal approvals, relevant territory agencies will be prepared to support security of offsets by using relevant powers under Territory law, especially where there is no direct cost to the Territory government; and
- Territory agencies will not actively compromise the utility of offsets for maintaining environmental management standards and their potential role in regional and community development.

In sum, they assume a passive but potentially positive role for government, with active promotion of offset use taken on by non-government actors. We turn now to the possible shape of that non-government role, consistent with these assumptions.

9.1.4.1 Outline of a suggested process

A serious role in fostering optimal use of offsets in the Territory will require a considerable investment. A minimum set of activities will be to:

(a) adopt standards and other components of an offsets framework compatible with the features outlined in Sections 9.1.1.1, 9.1.3.2.1 and 9.1.3.2.2 above;
(b) promote that framework to potential Indigenous and other offset providers and refine its detail in response to feedback;
(c) maintain a watching brief on statements from governments and industry on development directions and about individual development proposals;
(d) scan NTEPA and DoE (Cwlth) websites for notice of intent (NoI) and referrals or their equivalent under the EPBCA or other relevant federal legislation;
(e) track EIA processes through the same websites, identifying potential impacts for which offsets may provide a useful response;
(f) initiate exploration of opportunities to generate new offset projects or apply existing projects to particular developments;
(g) maintain a database of offset options, opportunities, providers and projects underway;
(h) alert development proponents to opportunities to apply offsets to their project(s) and invite dialogue on standards and potential providers;
(i) alert potential offset providers to emerging or actual opportunities;
(j) on expressions of interest from industry or other developers, facilitate initial design of relevant offsets by relevant providers or refine existing projects, including details of institutional support and other essential features;
(k) prepare written outlines of potential offset projects, including details of the type and level of residual biophysical detriment being compensated, type of compatible offsets potentially available, and other important features including duration, uncertainty and risk and where plausible, an estimate of cost;
(l) as EIA processes unfold, refine or archive offset proposals as appropriate;
(m) where offsets appear to be required by regulators (Commonwealth) or seen as desirable and sought by industry, make formal proposals to potential buyers to initiate serious negotiations on supply;
(n) relate development and offset proposals to formal and informal regional or local land use and conservation plans or programs;
(o) support both providers and buyers to draft related agreements and facilitate related consultations with landowners and their legal representatives; and
(p) advise relevant regulators and government agencies of proposals and seek their engagement to secure protection of offset sites from future incompatible development under relevant law.

In sum, the role proposed is to frame the intellectual and procedural core for a working system, drawing so far as possible on existing standards and to engage directly with developers and offset providers to match need with capability. Inherent in the features outlined here for high quality offsets, there will also be a role in building local community capability to meet the needs of an offset and environmental services industry. And because the NT EIA process does not provide for early dialogue on offsets, it will also be necessary to establish relationships with industry and processes for early awareness of proposals under development. Otherwise it will be impossible to introduce consideration of siting alternatives that are fundamental to the DbD approach.

9.1.5 Options for non-government actors in offset development

Under the carbon farming initiative, numerous private offset developers and/or brokers have emerged. The list of entities registered to provide financial advice in relation to emission units issued by the Clean Energy Regulator (ACCUs) under carbon faming law, maintained by the Australian Securities and Investment Commission[55], indicates the scale of interest. And many other entities not registered to provide financial advice offer other technical advice and services. Some also claim to be positioned to offer non-carbon offsets or environmental services.

But non-carbon offsets sought in response to individual development projects in northern Australia are not directly comparable to carbon offsets:

- there are no established markets in biodiversity or other values of the types canvassed in this report in northern Australia;
- there is no established (fungible) currency for non-carbon offsets like biodiversity or water quality;
- there are no "banks" of offsets for off-the-shelf purchase like Australian National Register of Emissions Units or of the sort established by governments in New South Wales and Victoria for "bankable" vegetation types;
- even where formal markets are proposed, as for water, there are no systems for government or non-government agencies to hold values like water on behalf of the environment (or culture);
- north Australian experience in offsetting is quite limited, arguably too limited to support a review of examples of success and indicate relative costs of different offset types; and
- many potential Indigenous and non-Indigenous providers have yet to demonstrate capability in consistent delivery of high quality products.

It follows that there are three distinct sets of tasks facing non-government organisations seeking to take individually or collectively a substantial role in a substantial Territory offsets regime.

One is the day-to-day challenge to identify and support potential providers to respond promptly to opportunity, as individual development projects roll out or proposed development precincts are announced. This function requires knowledge of and careful matching of the few providers with demonstrated capability to specific developments, plus the knowledge and skills to fill gaps in capability, especially weaknesses in the institutions needed to support long term commitment and performance.

The second is to go beyond *ad hoc* responses to individual opportunities, to foster new and improved capacity across an expanding range of services. This requires an appreciation of likely demands for particular offset types in different areas of the Territory, awareness of interest and capability among potential providers, and the credibility and resources to develop and help implement training programs, including engagement of new providers in projects run by others or local acceptance of less demanding projects that provide, with appropriate support, good training and testing options.

The third is to build, document and oversee application of an offsets framework robust enough to accrue credibility, despite working with at best tacit (as distinct from financial and technical) support of government, and capable of working at modest ongoing cost. What might an effective institution look like, and what would be its essential features?

We suggest that the list of attributes will necessarily include:

- independence (of government, industry, and landowners)
- relevant technical credentials
- understanding of offset principles and standards
- record of performance in land and/or natural resource management
- moral authority (demonstrably high ethical standards)
- commitment to sustainability of development

[55] See http://www.asic.gov.au/asic/ASIC.NSF/byHeadline/Register%20of%20carbon%20registrants

- knowledge of and long term commitment to NT/northern Australia
- understanding of Indigenous culture and land management obligations
- understanding of and interest in local livelihoods and regional development
- no inherent or direct financial or other conflicts of interest with role(s) in offsets design and implementation
- additional durable sources of funding and financial strength
- compatible existing role(s)
- clear view of place of offsets in conservation and sustainable livelihoods and other roles
- credibility with landholders
- credibility with government
- knowledge of and good relationships with relevant industry (mining, oil and gas, agriculture)
- productive relationships with research groups (Universities, CSIRO, etc)

Most commercial carbon offset project managers or developers and environmental assessment companies would fail to meet many of these criteria. They are not structured to perform these roles at the sort of costs that emerging providers are likely to be able to meet. In any event, a for-profit commercial operator taking on a key role normally accepted by government would create obvious conflicts of interest. We consider that such a government-replacement role is best taken on by not-for-profit organisations.

However, this large set of features appears likely to exceed the reach of any individual non-government or not-for profit organisation. However, many are capable of making important contributions to part of a comprehensive package (Table 4). We therefore suggest that the most plausible substitute for an active government role is a collective effort by some of the bodies listed in the table. Key roles will be to frame the concept and present it to others, and to craft an agreement (or memorandum of understanding) about how parties will work together and the sorts of contributions each party will make. We develop this proposition later in this paper, using a regional case study to illustrate the approach.

Table 4 : An incomplete and haphazard list of organisations active and apparently successful in land management roles in north Australia and that may have an interest and roles in promoting application of offsets to environmental management and/or livelihoods. None of these bodies were contacted to verify impressions summarised here, which are mostly interpreted from statements on websites.

Organisation	**present role**	**potential offset role**	**strengths**	**constraints**
TNC - NFP NGO	supporting selection and management of private and public protected lands; innovation in conservation strategies	identifying options; technical and financial support for implementation; negotiation with government and industry	strong funding base technical skills in site selection relationships with government and industry	not engaged in on-ground management
AWC - NFP NGO	managing private protected areas	acquiring and managing offset sites	active land management; on ground conservation actions; technical skills including wildlife monitoring	model emphasises site ownership / control; disinterest in Indigenous knowledge and land management practices
NAILSMA - NFP NGO	land and natural-resource based livelihoods; related policy	identifying culturally appropriate options; choosing and developing standards; training and mentoring	familiarity with relevant policy; knowledge of offset law and policy; relationships with Indigenous groups;	limited technical capability; uncertain funding; chiefly enabler through partnerships
Land Councils - statutory authority	land claims and management of interests in land	obtaining landholder authority; negotiating contracts; supporting Indigenous enterprise development	compatibility with statutory role to optimise benefit; legal expertise especially on aspects of land access	limited technical expertise in conservation management; historical emphasis on royalties over employment-generating activity; no particular conservation interest;
Territory NRM - NFP NGO	promoting sustainable use and conservation of natural resources	identifying opportunities; choosing or developing standards; integrating offsets with other relevant plans and programs	planning role; relationship with government; relationships with landholders; awareness of other funding programs	uncertain funding base; limited technical expertise; no on-ground presence
Aboriginal Carbon Fund - NFP NGO	promoting Indigenous participation in carbon farming	developing carbon offset methods; supporting development of carbon offset projects	knowledge of carbon farming policy; knowledge of offset law and policy	narrow role; chiefly enabler; uncertain funding base
Warddeken Land Management Ltd - NFP NGO	land management for conservation and livelihoods	managing offsets; supporting other Indigenous groups; training and mentoring	direct experience in offset provision; strong governance; Indigenous authority; monitoring and evaluation experience	uncertain funding base; geographic definition; conflict of wider role with local demands and obligations

Organisation	present role	potential offset role	strengths	constraints
Savanna Alliance Ltd	Indigenous enterprises providing environmental services	management of offset sites	network of experienced Indigenous land managers	limited technical expertise
Dhimurru Aboriginal Corporation	To manage natural and cultural management priorities, emphasising designated recreation areas	identification of offset sites management of offset sites		uncertain funding base; geographic limitations; conflict of wider role with local demands and obligations
Northern Territory Cattlemen's Association	to advance and protect the interests of cattle producers	identifying options for offsets on pastoral lands policy development compatible with pastoral interests	knowledge of industry strong local commitment land stewardship role	antipathy to removing lands from pastoral production
Minerals Council of Australia - NT Division	promoting a regulatory environment for profitable and effective business while maintaining community expectations in regard to social, environmental and social obligations	support to determine an NT-appropriate offsets framework	knowledge of mining industry; understanding of offsets in other jurisdictions	interest in minimising additional costs for industry; limited understanding of conservation biology
Charles Darwin University	research emphasising tropical desert and Indigenous knowledge teaching matched to regional needs and aspirations	developing offsets framework; technical support; developing relevant training and educational programs; training and education	technical skills; training role;	outside statutory and business roles
Indigenous Land Corporation	statutory body with roles to acquire lands and to promote enterprise dependent on land ownership	developing offsets framework; promoting commercial offsets on Indigenous lands; supporting Indigenous enterprises active in offset provision	strong governance; experience in Indigenous business; business and industry contacts; understanding of compatible government programs	commitment chiefly to orthodox enterprise types; preference for projects viable in themselves rather than more complex integrated (hybrid projects)
Indigenous Business Australia	statutory body with roles to support Indigenous Australians to create wealth and accumulate assets, take up investment opportunities, create business enterprises	development of Indigenous businesses in environmental services	experience in Indigenous business;	no understanding of land management' preference for the highly orthodox

The Nature Conservancy — Protecting nature. Preserving life.

Establishment phase
- develop framework
- select standards
- negotiate agreement with other parties
- execute agreement
- join TOP Board

Operational phase
- provide technical support
- support establishment and development of offset-capable groups
- develop biodiversity offset options
- promote offset opportunities with potential buyers
- support individuals and groups to develop proposals and projects
- develop monitoring systems
- market products with industry associates

NORTHERN LAND COUNCIL

Establishment phase
- develop framework with partners
- include offset provision among active enterprise support activities
- approve policies to require environmental offsets in all major developments
- develop a process for decision-making and offset approval
- join TOP Board

Operational phase
- identify offset capable groups
- support landholders to negotiate offset arrangements
- support individuals and groups to develop proposals and projects

The Territory Offsets Program (TOP)

Establishment phase
- revise existing NIES structures
- establish not-for-profit company
- appoint Board members

Operational phase
- maintain registers of proposals and projects
- identify potential providers
- promote offset opportunities with potential providers
- support individuals and groups to develop proposals and projects
- market products

NAILSMA — NORTH AUSTRALIAN INDIGENOUS LAND AND SEA MANAGEMENT ALLIANCE

Establishment phase
- develop framework with partners
- negotiate agreement with partners

Operational phase
- review and refine framework
- promote awareness of opportunity
- support individuals and groups to develop proposals and projects
- support groups in negotiation with developers

Territory Natural Resource Management

Establishment phase
- consultation
- include offset role in plans

Operational phase
- support individuals and groups to develop proposals and projects
- promote projects with members and government
- assess offset role in plans

Figure 19: Potential participants in a non-government program for environmental offset design and implementation in the Northern Territory. The TOPNT program would when established be operated by a not for profit company built on the constitution and structures already established for carbon farming.

10 EXPLORING FEASIBILITY

In the preceding sections, we considered existing descriptions, analyses and conclusions about biophysical, socio-economic and cultural environments, and broad trends in northern development and conservation policy. We turn now to the way in which databases of formal existing information and statements of intent can be accessed and used to:

(1) describe and present values at risk and important aspects of their spatial distribution;
(2) infer likely directions of land use and resource use change and their probability from observed trends and statements of intent;
(3) deduce from these changes, the pressures on values at risk and their relative significance; and
(4) propose plausible responses to maintain or improve net environmental quality, especially through the use of offsets.

Source of data are summarised in Attachment 7.

10.1 Methods

In this working report we examine capacity to apply DbD approaches with the information and techniques available to us. We do not claim comprehensiveness. We regard this contribution as a significant one, but also see opportunity to continue development of the ideas to foster applications of offsets to environmental issues in northern Australia, especially where delivered by Indigenous people.

In setting down what we have done, we often provide some background to explain the choices made.

10.1.1Unit of analysis

For most purposes we have chosen to use sub-catchments constructed and maintained by the Bureau of Meteorology, as an element of the Australian Hydrological Geospatial Fabric[56]. The products draw on an international standard conceptual model (Atkinson et al. 2012). Given this robust base and the central role of the Bureau for maintaining national datasets related to rainfall and water in the landscape, we regard this as durable basis for future analysis. The units are also scalable up and down in area to a consistent methodology. Use of reasonably fine scale sub-catchments is particularly relevant to likely directions of land use change and the particular challenges they pose to aquatic systems (see Sections 6.4.2, 6.4.5 and 6.4.6 above).

A total of 1787 sub-catchments fall within the Northern Territory study area. Average area is 361.5 km^2, but size distribution is highly skewed (median=33.0 km^2; range 0.03 to 24818.7 km^2) to smaller units. Many of the smaller units reflect short localised coastal discharges disconnected from inland drainage systems.

In some analyses we confined analysis to a pre-determined proportion of non-zero values for indices (e.g. the top decile or highest 10% of values). We adopted this procedure despite awareness that for some variables, values may be expected to vary with sub-catchment area. In some cases where effect of sub-catchment size appears likely to be decisive regarding likelihood of sampling or other biases, we excluded very small catchments or catchments with zero observations for a given variable from further analysis. In other cases we expressed values as a density (index or other variable value divided by sub-catchment area).

[56] see http://www.bom.gov.au/water/geofabric/index.shtml

10.1.2 Environmental variables

For each catchment we determined a suite of biophysical variables by intersection with other coverages described in Attachment 7. The minimum set was:

MeanRain: Mean annual rainfall at the centroid of each catchment determined from a surface of monthly rainfalls provided by the Bureau of Meteorology (Jones and Weymouth 1997; Jones et al. 2006)

RDQ: Mean rainfall in the driest quarter (the driest continuous 3 months) determined using the same surface.

roughness: with unit variation in elevation determined as described by Russell-Smith et al. (2012)

divveg: Within sub-catchment diversity of vegetation types mapped as NVIS Level IV: the number of different types with any area present

domveg: The vegetation type with the largest area within the subcatchment.

divuse: The number of different land uses from the suite shown in Figure 3.

domuse: The single largest type of use by area in the subcatchment.

AvFF: The area-weighted average fire frequency for the subcatchment from mapping described in more detail in Section 11.1.3.8 below.

We examine relationships among these variables and heritage values, most using generalised linear models. Model selection uses the Akaike Information Criterion implemented as described by Burnham and Anderson (2002). We used R (R Development Core Team 2012) for all data management, summaries, graphics and statistical analysis.

10.1.3 Values at risk

In this component of the study, we assemble the best available data on natural and cultural values. We make use of information gathered, aggregated and analysed at a number of spatial scales. We assign relative rankings to sub-catchments based on these values.

10.1.3.1 Natural Heritage

We have aggregated information from a large number of sources, using material developed for different purposes and analysed in different ways. For example, we have identified sub-catchments falling all or partly within the boundaries of the Northern Territory Government's sites of conservation significance.

Methods used to delineate these sites are described in Ward and Harrison (2009). Briefly, sites were rated against five sets of conservation values: Threatened Species, Wildlife Aggregations, Wetlands, Endemic Species, and Botanical significance through a combination of novel analyses based on NT records, or assignments made by other authorities. In some cases rankings for regional, national or international significance were based on explicit scoring systems and in others were influenced by expert opinion. Clearly there will be variable levels of overlap among the various sets of conservation values (e.g. wetlands and threatened waterbirds).

We effectively repeat elements of their analyses but at the sub-catchment scale. We consider separately, in order to make use of the most up to date records available, the frequency with which records of threatened and endemic species occur within sub-catchments. We have also taken account of Kennard (2011) indices for High Conservation Value Aquatic Ecosystems.

We treat formal government rankings, including those used by the Northern Territory Government for SoCS, mostly as an informal "policy weighting", indicating local and national commitment to resolving conservation conflicts with other policy objectives. The Northern Territory's own rankings are tenure blind (Ward and Harrison2009), while federal law imposes particular obligations on managers of commonwealth lands, as defined in the *EPBCA* 1999, in respect of matters of national environmental significance. We do not directly consider tenure in our presentations of natural heritage significance, but instead take it into account in summaries of existing and projected pressures from land use change. The derivation of indices for these orthodox conservation value of sub-catchments is summarised in Table 5 to Table 7.

At Table 8 we also show an approach to incorporating Indigenous valuations of natural values in analysis of conservation priorities. Garibaldi and Turner (2004) describe what they call cultural keystone species as plants or animals that play such a central role in Indigenous or other traditional communities that those societies would be fundamentally different without them.

The index we use here is based solely on the number of records of a suite of fauna known to be important in the customary economy and hence in Indigenous relationships with land and living resources. We acknowledge that this treatment is very crude, but it perhaps provides an example of the sort of issues that may need to considered in detailed local case studies and application of Development by Design principles to conservation and development planning.

Table 5 : Ranking of sub-catchments on relative proportion falling within boundaries of Northern Territory identified sites of conservation significance.

Criterion	Score	Aggregation Treatment
Position relative to NTG sites of conservation significance		
- entirely outside	0	none
- any portion within	1	none
- substantially within (20-50%)	2	none
- majority within (50-75%)	3	none
- mostly within (75-99.9%)	4	none
- entirely within (100%)	5	none

Table 6 : Ranking criteria relating to presence of vascular plant and vertebrate animal species of particular interest (endemics and threatened species) and the number of records of those species in sub-catchments, and used to derive compound indices for ranking subcatchments by conservation significance.

Criterion	**Score**	**Aggregation Treatment**	**Comment**
Number of species of conservation concern or interest (endemics); NT designations			
- vulnerable	2.0 for each species	each subset relative to maximum raw index for that subset in any sub-catchment	flora and fauna weighted equally
- endangered	3.0 for each species		
- critically endangered	5.0 for each species		
- endemic	1.0 for each species		
Index of threatened and endemic species (IN)	sum of all of above	score for each sub-catchment	
Number of species of conservation concern or interest (endemics); national designations			
- vulnerable	2.0 for each species	each subset relative to maximum raw index for that subset in any sub-catchment	flora and fauna weighted equally
- endangered	3.0 for each species		
- critically endangered	5.0 for each species		
- endemic	1.0 for each species		
Index of threatened and migratory species (IE)	sum of all of above	score for each sub-catchment	
Number of records of NT-listed threatened species (RN_i) where *i*=individual subcatchment	raw numbers	flora and fauna separately and combined	endemic, vulnerable, endangered and critical pooled
Number of records of EPBCA-listed threatened species (RE_i)	raw numbers	flora and fauna separately and combined	migratory, vulnerable, endangered and critical pooled
Record weighted index of threatened and endemic species (RWIN)	IN weighted by $(1+\log(RN_i)/\log(\max(RN))$	flora and fauna separately and combined summed	logging to reduce influence of extreme observations
Record weighted index of threatened and migratory species (RWIE)	IE weighted by $(1+\log(RE_i)/\log(\max(RE))$	flora and fauna separately and combined (summed)	
Density index of threatened and endemic species (DRWIN)	$RWIN_i/A_i$	flora and fauna separately and combined (summed)	A_i = area of subcatchment *i*
Density index of threatened and migratory species (DRWIE)	$RWIE_i/A_i$	flora and fauna separately and combined (summed)	

Table 7 : Application of indices develop by Kennard (2011) for high conservation value aquatic ecosystems to sub-catchment planning units. The area covered by the Kennard (2011) analyses do not cover the whole of the NT study area. Where more than one Kennard site fell partially within a sub-catchment, an area-weighted mean was taken.

Criterion	Score	Aggregation Treatment	Comment
Indices for - diversity - distinctiveness - vital habitat - evolutionary history - naturalness - representativeness	for each index, average of values (range >0 to <1) for their units falling within study sub-catchments, weighted by relative area of the Kennard units	generally none in one analysis summed for sub-catchments with no weighting of individual indices	used in comparisons only in regions of overlap of study sub-catchments and Kennard et al sub-catchments

Table 8 : Framing of indices for significance of individual species of fauna to Indigenous people, based chiefly on species known to be important in the customary economy (Altman 2003; J. Morrison and AJ Griffiths, unpublished data).

Species	Attribute	Index
Macropods	number of species from nominated array in sub-catchment shown in NTG fauna database number of records of nominated macropod species	no index developed
Bustard	number of records	
Emu	number of records	
Magpie Goose	number of records	
Freshwater turtle	number of species in sub-catchment shown in NTG fauna database number of records for all species	
Marine turtles	number of species in sub-catchment shown in NTG fauna database number of records for all species	
Dugong	number of records in neighbouring seas	

10.1.3.2 Cultural Heritage

One of the most significant features of northern Australia is the continuity of connection of first nations people with northern landscapes and the plants and animals they support. Connections to specific places and responsibilities for protecting those places and their character are deeply embedded in Indigenous identity. In this tight connection to place Indigenous commitment to maintain natural heritage goes well beyond the more abstract sense of obligation to care for the natural world characterising the mainstream conservation ethic. It also differs in kind from the otherwise comparable mix of spiritual reverence and utilitarian respect in the land ethic articulated by Aldo Leopold (1949).

O'Faircheallaigh (2008) provides a useful summary.

> *"... Aboriginal cultural heritage can be seen as having two dimensions. The first involves material manifestations of Aboriginal occupation during earlier periods of time, including burial sites, middens created by discarded shells and other food debris, rock and cave paintings and scatters of stone tools. These manifestations can be up to 50,000 years old, or only a generation or two removed from the present. The second may be lacking in material manifestations and involves places, sites, areas or landscapes that are of spiritual significance to living Aboriginal people. .... Sites or areas that are of special significance are often association with the actions of mythological beings during the creative period of the Dreaming, ... when these beings moved across the landscape and created not only the forms the land now takes, but also the law that governs people's interactions with the land and each other and the languages and ceremonies that constitute key elements of their culture. Certain sites are the resting places of powerful creation spirits. Sites or areas may also be important because they are breeding grounds for key food species, are associated with initiation, mortuary or other ceremonies, or because they were the location of important historical events ....."*

Legal recognition of enduring connection and obligation has been slow to evolve, and the process still has some way to run (e.g. O'Donnell 2011). The most significant change has occurred in land rights and native title law, but some important ancillary regulations have been made. These offer options for Indigenous people also to use long-established forms of protection of non-Indigenous cultural heritage, like those applied buildings and associated artefacts. The details of those laws are set out in Sections 8.1.3.4 and 8.3.3 above.

Here we use two classes of records recognised in law and a third (recorded sites) maintained by AAPA on advice from Indigenous custodians.

10.1.3.2.1 Place-based values

The strongest and specifically Indigenous of those protections is the *Northern Territory Aboriginal Sacred Sites Act* 1989. It authorises the Aboriginal Areas Protection Authority (AAPA) to register sites that traditional owners have identified as requiring formal protection. The AAPA also records other sites on behalf of traditional owners. The process of site identification and recording by non-Indigenous institutions is inherently problematic. To quote O'Faircheallaigh (2008) again:

> *... (S)acred or significant sites may have substantial and even dramatic effects on people and these effects can be positive or negative depending on the nature of the site, the people concerned and their behaviour. Sites may be gendered, and safe for one sex but dangerous to the other. Some may be safely visited by any male, others only by initiated men of a particular group. ... (K)nowledge regarding the existence, location and significance of sites is often not public. Knowledge may be secret and sacred and if transferred inappropriately may be dangerous to both giver and receiver..... Knowledge is shared and transmitted in the context of relationships among people and between people and land.... While relevant*

knowledge regarding sites may be carefully controlled and often withheld from non-Aboriginal people, the dangers associated with damage to sites or inappropriate release of knowledge concerning them is not confined to Aboriginal people. Indeed the consequences of damage to or destruction of particular sites can be catastrophic for non-Aboriginal people as well as for the sites' custodians …..

It follows that formal records of sacred sites and in particular registered sites are a small subset of the totality of sites that are highly significant to people, often revealed only when they came under direct and immediate threat. The approach used here to protect confidentiality has been to provide aggregated counts of registered and recorded sites within mostly quite large planning units (sub-catchments) that bear no relationship to language or other groupings. Thus sites within a sub-catchment may or may not have strong cultural linkages.

In addition to these often intangible attributes of sites, we have also accessed records of archaeological sites held by the Heritage Branch of the Department of Lands Planning and Environment, all of which are automatically protected under the Northern Territory *Heritage Act* 2012. These may not have been identified by Indigenous people and consequently are not expected to show consistent relationships with recorded or registered sacred sites.

We assume, for our case study analyses, that registered sacred sites will not be developed. Consequently a high density of sacred sites, all else being equal, will reduce the attractiveness of such areas for development. We make no assumptions about denial of approval to disturb archaeological sites which are not listed under Territory or federal law. Further we take no account of non-Indigenous heritage sites because they are so few and mostly urban.

For ranking units on their cultural heritage values, we have aggregated all record from both of these sources and assigned weight to records as set out in Table 9.

Table 9 : Approach to assigning an index of Indigenous cultural value to sub-catchments based on numbers of and size of registered sacred sites, recorded sacred sites and archaeological sites.

Type of site	**Attribute**	**Ranking system**	**Comment**
Registered sacred site	Number of individual sites	assign score of 4 for each site	significance based on level of custodian concern motivating registration
Registered or recorded sacred site	Area of registered or recorded sites	double score for AAPA sites in planning unit if average area / site exceeds 500 ha	additional significance of larger areas based on need for buffer or linkage
Recorded sacred site	Number of individual sites	assign score of 2 for each site	significance based on custodian concern
NTG recorded archaeological site	Number of archaeological sites	assign 1 for each site	not necessarily of special contemporary significance

We also have access to sites formally registered for other Indigenous or non-Indigenous heritage values, comprising mostly built and hence non-Indigenous heritage. These are too sparse to be useful for jurisdiction-wide assessments, but may be applicable to finer-scale case study work.

10.1.3.2.2 Organism-focused values

Particular relationships with wild plants and animals play important roles in Indigenous cosmology and livelihoods. Whilst fragments of such relationships and associated obligations have been documented, data permitting ranking of relative significance for different groups and hence a geography of variation in importance is unavailable and meaningful generalisation is implausible. There is no Indigenous Red Book. Analysis of the significance of impacts of development for local people in the form attempted for orthodox conservation values is impracticable.

However, we consider it essential to recognise and respond to culturally-informed variation in values in design of offsets for the Northern Territory, even if those values are not sought by buyers. At the very least Indigenous offset providers would be expected to design their offerings to avoid compromising and preferably enhancing such values, and non-Indigenous providers on lands where native title rights have been recognised to avoid actions that compromise those values.

We have therefore sought to identify a "space" in the framework for such values by considering species that are known to make important contributions to customary economies throughout the northern savannas (Table 8). Some of these fauna groups (emu, macropods and magpie geese) are also of interest because they will create conflicts with some forms of agricultural development when abundant.

This issue warrants further work.

10.1.3.3 Aggregated natural and cultural values

To aggregate biodiversity and cultural values, we combined indices for natural heritage values (Table 6) and cultural values (Table 9) by simple addition, after normalising each index by dividing by its maximum to give a range between 0 and 1. The process effectively weighted biodiversity and cultural values equally.

To date we have not attempted to incorporate observations relating to fauna of particular Indigenous interest because most of the species on our arbitrary list were widespread and datasets appeared spatially biased (see Section 10).

This aspect warrants further work, but will probably be most useful in finer scale studies where interests can be better focused on clan-level interests.

10.1.4 Existing pressures and impacts on assets

We considered existing pressures in several categories: grazing of domestic stock, grazing and other impacts of feral stock, weeds, fire, agricultural development and mineral and petroleum extraction. Details of data assembled are in Attachment 7.

We have made no attempt to use these datasets quantitatively to rank sub-catchments on their suitability for offsets based on existing condition or the tractability of dealing with existing pressures to derive environmental benefit.

These issues are to be taken into account in identification and analysis of case study site(s).

10.2 Northern development: anticipated directions of change

Key features of the present Coalition government's (2030) vision for north Australia are:

- a food bowl offering premium produce, doubling Australia's agricultural output
- two million tourists per annum, an increase of 33%
- an energy export industry of $150 billion, an increase of about 50%
- enhanced infrastructure to service these changes, including water infrastructure.

These sorts of views are echoed in the Green Paper on northern development (CoA 2014a) and the interim report from the Joint Select Committee inquiry (JSCND 2014). Increased rates of mineral extraction are assumed, based on better access to land and improved infrastructure to reduce costs. Beef features strongly among mention of premium products although no specific targets are set. All of north Australia's state/territory jurisdictions echo the "open for business" ethos and the associated commitments to reduce "green and red tape" to allow accelerated development.

These and related statements, even allowing for substantial hyperbole, indicate that a DbD strategy may need to consider:

(1) substantial increases in areas of the savannas used for irrigated agriculture, rain-fed agriculture, forestry and more intensive beef production;
(2) increases in both onshore and offshore gas extraction and processing, including unconventional oil and gas;
(3) ongoing increase in the number and diversity of active mineral extraction and processing sites;
(4) large numbers of tourists seeking increased access to presently unvisited or little visited sites; and
(5) more and larger built infrastructure in both remote sites for all targeted land uses, and in major centres.

Rates and total extent of change are inherently difficult to predict due to both uncertainty of commodities to be grown, demand and price, and uncertainty of supply imposed by biophysical constraints and willingness and capacity of major land holding groups (Indigenous and pastoral) to participate. We make no attempt to estimate likely rates of development but focus instead on identifying those areas that appear most favourable for development. We confine our analysis to terrestrial sites.

We have accessed information on roads and other infrastructure and done some preliminary work on "travel costs" and verified the plausibility of incorporating such information in rankings of the favourability of sites, but not taken it far enough to warrant reporting here.

10.2.1Agriculture

The Northern Australia Land and Water Taskforce was commissioned by the Rudd Government to report on options for northern development and particularly to consider how apparently abundant water resources might contribute to sustainable development. Their work was supported by CSIRO and research conducted in parallel by the Tropical Rivers and Coastal Knowledge consortium (TRaCK)[57]. The Taskforce investigations and additional detailed studies by TRaCK debunked the notion of large volumes of "excess" or "wasted" water as a driver of northern development.

The Northern Australian Sustainable Futures program (NASF) grew out of that report[58]. Its major program, the North Queensland Irrigated Agriculture Strategy, resulted in a CSIRO report (Petheram et al. 2013) which argued that up to 30,000 ha might be developed for irrigated agriculture given

[57] http://www.track.org.au/
[58] http://www.regional.gov.au/regional/ona/nasf.aspx

limits on water availability. A private consortium proposes about double the area[59] and 3 times the water, more in line with apparent government ambitions. The proponents repeat the arguments for scale necessary to make such projects work - by providing sufficient product for the necessary "processing architecture"[60] - that have encouraged northern over-reach in the past.

With this mix of conflicting information and ambition, it is difficult to come up with defensible scenarios for likely development trajectories. We propose, for the Northern Territory, to specify no limits or targets for total areas of development. Rather we use data from Pascoe-Bell et al. (2011) to identify sites regarded as suitable for agricultural development based on a match of soil suitability and water availability. An example of their products is in Figure 20.

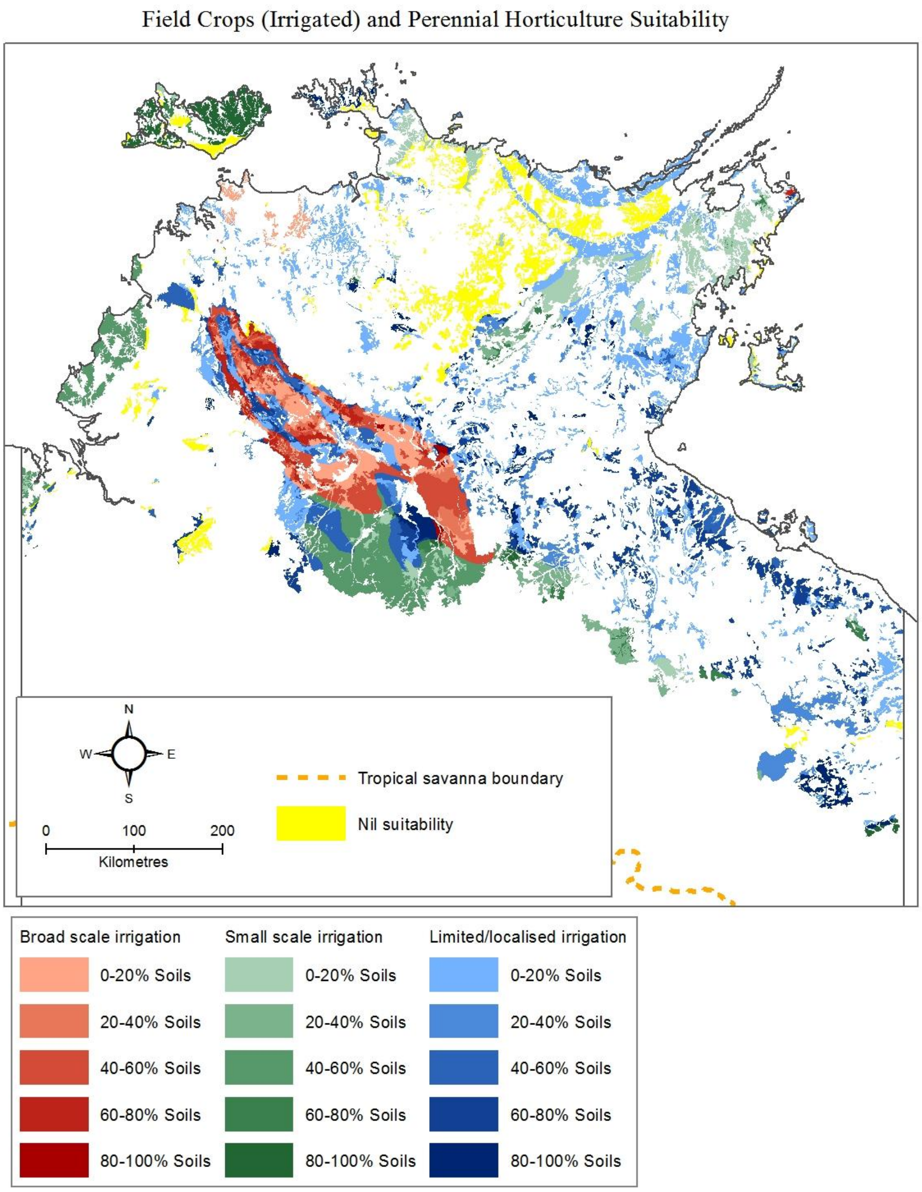

Figure 20: Example of the assignments of suitability for various agricultural uses made by Pascoe-Bell et al. (2011).

59 http://i-fed.com.au/project/

60 http://www.abc.net.au/news/2014-04-06/5369388

It should be noted that their analyses exclude sites subject to seasonal or longer term flooding. However, floodplains associated with large northern rivers have a long history of exploitation through improved pastures like Para Grass *Brachiaria mutica* and Olive Hymenachne *Hymenachne amplexicaulis*, which damage habitat suitability for wildlife (Ferdinands et al. 2005), and for rice growing (see Mollah 1982). Large scale rice growing schemes collapsed decades ago but in the contemporary northern development mindset, rice boosterism has re-emerged[61], and should be taken into account in assessing likely development-conservation conflicts.

We assume that no agricultural development will occur in national parks and declared reserves. We assume that agricultural development may proceed in up to 25% of the area of an Indigenous protected area without the IPA status being revoked. We further assume that Indigenous landholders with IPAa will seek to retain IPA status.

To summarise, we:

- use Pascoe-Bell et al.'s (2011) assignments of suitability to identify potential agricultural development sites
- rank economic value of irrigated agriculture in the sequence (Table 10)
    - broad scale irrigated annual row crops
    - smaller scale irrigated annual row crops
    - broad scale irrigated field crops and perennial horticulture
    - small scale irrigated field crops and perennial horticulture
    - rainfed field crops and perennial horticulture
    - localised irrigated annual row crops
    - localised field crops and perennial horticulture

Development of improved pastures is included in the field crop categories.

We assign notional ranks to prospects of development to planning units (sub-catchments) based on the scale (area) of land with combinations of suitable soils and favourable notional water availability within the planning unit. In applying the Pascoe-Bell et al. (2011) mapping we took the midpoint of their categories for proportions of suitable soils (e.g. 0.3 for 21-40%) and then summed these "effective areas" separately for each of the farming system classes (e.g. rain-fed field crops). Because the mapping in Pascoe-Bell et al. (2011) showed considerable overlap (e.g. areas suitable for rain-fed agriculture were also suitable for irrigated agriculture). We then multiplied this effective area by the appropriate index value shown in Table 10. For most analyses we took the highest ranked use for each sub-catchment as the raw prospectivity score (raw in the sense of taking no account of access, infrastructure, competition for water or other constraints).

Although not expressed quantitatively, we also considered the following factors in looking at prospects for development:

(a) significant existing operations of a relevant type demonstrating plausibility within the planning unit or within similar planning units in the same landscape types

    To be considered at the case study level if appropriate.

(b) presence of multiple opportunity types within the same planning unit or ecologically and hydrologically-linked planning units;

    Multiple adjacent planning units favouring agriculture are arguably more likely to undergo development because infrastructure can be more efficiently located, and impacts can be expected to be increased if adjoining units all undergo development. We take account of spatial

[61] http://www.abc.net.au/news/2014-05-23/rice-seedlings-key-to-future-of-norther-australia-cattle-farms/5474354?WT.ac=statenews_nt

and functional linkages in identification of potential development nodes. Considered in case stuy.

(c) extent of prior allocation of water resources necessary to sustain the opportunity type(s);

Pascoe-Bell et al (2011) identify sites available for agriculture on known availability of surface or (more usually) groundwater. In some areas, regulators have now allocated a significant proportion of available reserves. We take account of what is known of allocations at the case study level

(d) apparently serious and considered proposals already made for development of the opportunity type(s) in the planning unit;

Development is obviously more likely in sites which have already attracted serious proposals for new or expanded agricultural development. We seek to take account of known proposals to at the case study level.

(e) proximity of the opportunity type(s) to relevant storage, processing infrastructure; and

Ready access to facilities like mills, silos or other storage, abattoirs may influence likelihood of development. Considered at the case study level.

(f) distance and other topographical constraints to transport infrastructure

A comprehensive analysis of access and related infrastructure constraints is outside the scope of this study. However, as noted earlier we have done sufficient work to show feasibility where the array options warrants finer discrimination. There remain difficulties in incorporating flood proneness of river crossings and the like. We consider potential impact of such constraints on sites identified as favourable on other grounds at the case study level.

Table 10 : Farming systems and an index for agricultural prospectivity for sites in the Northern Territory. Categories are dictated by soil quality and spatial configuration of good soils and, for irrigated sites, water availability (Pascoe-Bell et al. 2011).

Crop(s)	**Scale**	**Water source**	**Relative density**	**Index value**	**Source and comments**
Field crops and perennial horticulture	broad	rainfall		1.0	map 12 Pascoe-Bell et al (2011) examples: sorghum
Field crops and perennial horticulture	broad	irrigated		2.0	map 13 examples: sugar, cotton, irrigated pasture
Field crops and perennial horticulture	smaller scale	irrigated	half of broad	1.0	map 14 examples: irrigated pasture
Field crops and perennial horticulture	localised	irrigated	1/4 broad	0.5	map 15 examples: small orchards
annual horticulture	broad	irrigated		4.0	map 16 examples: row crops - vegetables, flowers, herbs
annual horticulture	smaller scale	irrigated	half broad	2.0	map 17 examples: as above
annual horticulture	localised	irrigated	1/4 broad	1.0	map 18: examples: as above

10.2.2Forestry

Boosters of northern development rarely invoke forestry except as an example of economic diversification inhibited by pastoral lease conditions. However, experience in the Northern Territory has seen large areas of land considered favourable for agricultural development (e.g. in the Douglas-Daly region) go to forestry, most recently for production of sandalwood. We consider forestry as one of the suite of agricultural opportunities taken into account in ranking likely pressures for change in planning units based on soil attributes and water availability.

10.2.3Mining

The history of mining development in north Australia is that most commercially viable proposals will proceed, even where they pose obvious and considerable environmental risks. The relatively recent decision to change Territory law to permit expansion of the McArthur River Mine and permit diversion of major rivers illustrates the priority given to mining by successive governments.

We therefore base selection of sites likely to attract proposals for mining development entirely on prospectivity as indicated by the relevant government agency. We consider site-specific factors influencing commercial viability at the case study level. In considering mining prospectivity we assume that mining will be permitted on national parks and reserves, and make no assumptions about likelihood of agreement to exploration (and ultimately mining) by Indigenous landholders.

10.2.4Petroleum (oil and gas), including unconventional gas

We consider conventional oil and gas exploration and extraction and unconventional sources (in the Territory case exclusively shale) together. Large parts of the Northern Territory are thought to offer opportunities for extraction of natural gas from shale (Figure 56 below) and in exploring these possibilities some conventional plays may be encountered. No coal seam gas resource has been reported[62].

Seismic studies and a few exploratory wells have been drilled at a number of sites (Table 12), but the scale and prospects for commercial exploitation of the inferred resource will not be known for several years. We therefore treat all sites within basins identified as having favourable geology as equally likely to be developed over the long term, but rank sites (exploration leases) for early development in the sequence indicated in Table 11 below.

We assign prospectivity to sub-catchments by:

(a) assigning an area weighted ranking based on the index in Table 11 using categories from a Territory-wide coverage produced by Department of Mines and Energy .

Areas of sub-catchments falling into each category were multiplied by the ranking index and the products summed over the sub-catchment. If there was known to have been recent exploration activity, including test wells in a exploration licence overlapping with the sub-catchment, then 1 was added to the ranking in Table 11 for that area.

It should be noted that the agency would not provide a digital version and the GIS coverage used was recovered by on-screen digitisation from a publicly available presentation made by agency personnel. Clearly the errors inherent in this approach limit application to broad scale assessments of relative ranking.

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[62] http://www.nt.gov.au/d/Minerals_Energy/?header=Unconventional%20Oil%20and%20Gas

(b) adding 1 to the index from Table 11 if active exploration was known to be occurring within the sub-catchment

Information was gained from DME summaries of NT activity and search of websites of companies known to be active in this field (see Table 12).

(c) discounting to take account of topographic roughness

A topographic roughness score was derived as described by Russell-Smith et al. (2012). Areas of the sub-catchment falling into each prospectivity category were discounted by an amount proportional to the maximum of the roughness index for the study area (72.3). The discount was uncapped (i.e. sites at the maximum roughness were treated as entirely unsuitable).

Table 11 : Rankings for prospectivity for unconventional gas in the Northern Territory.

Category	**ranking**	**other variables**
demonstrated high potential	5	recent activity, topography
high potential untested	4	recent activity, topography
moderate to high potential	3	recent activity, topography
moderate untested potential	2	recent activity, topography
low to moderate potential	1	recent activity,topography
not considered prospective	0	none

We assume that regulatory authorities will permit drilling for conventional oil and gas on national parks and reserves, including Indigenous protected areas.

We assume that approvals to explore for resources that may require fracking are less likely on parks and reserves because of the potentially greater levels of surface disturbance required in both exploration and extraction phases. Rather than assuming total exclusion we regard parks and reserves as less prospective because constraints increase costs[63]. We implemented no discount in our initial scan but consider implications in the case study region.

We make no assumptions about regulator exclusion of fracking on Indigenous land. We also note that DME proposes release of additional acreage during 2014/15[64]

[63] Interestingly, planning guidance issued by the UK government would permit such activity in World Heritage and similar high value areas if proponents can demonstrate that development is in the public interest. Considerations include "the cost of, and scope for, developing elsewhere outside the designated area, or meeting the need for it in some other way". See http://planningguidance.planningportal.gov.uk/blog/policy/achieving-sustainable-development/delivering-sustainable-development/11-conserving-and-enhancing-the-natural-environment/#paragraph_116.

[64] http://www.nt.gov.au/d/Minerals_Energy/index.cfm?header=Petroleum%20New%20Acreage

Table 12 : Exploration leases known to be active in the terms summarised above in July 2014. Pointers to activity were garnered from NT DME reports and details usually taken from company reports to shareholders.

Lease numbers	Basin	Activity	Company
EP76, EP98, EP99, EP117	Beetaloo sub-basin	seismic surveys 2012 and 2013 (adjacent to pipelines)	Falcon Oil and Gas and partners
EP(A) 167, 168 and 169 EP(A)198	Beetaloo sub-basin	airborne geophysical (gravity) survey seismic data	Pangaea Resources
EP126, EP135, EP138	Bonaparte Basin	airborne geophysical survey	Beach Energy
EP171, EP176, EP190, EPA193A	McArthur Basin (Barney Creek Formation)	AMAC 2D seismic survey exploratory wells	Armour Energy
EP386 RL1	Bonaparte Basin	reprocessing existing seismic data	Advent Energy

10.2.5Tourism

Despite additional demands likely to made on transport and other infrastructure and the probability of demands for increased access to new sites, we do not treat tourism of a significant stimulus for land use change for good or ill. However, we recognise that tourism as an important industry and employer (e.g. more than twice the contribution to gross state product as agriculture forestry and fisheries combined in the Northern Territory (NTG 2014)) may positively influence the treatment of natural and cultural heritage as key tourism assets.

10.3 Integrated assessment of prospects of land use change

Integration has been confined to identifying sub-catchments falling into the top decile of prospectivity for both unconventional oil and gas and agriculture, both of which have the potential to generate disturbance over large areas.

10.4 Integrated estimates of land use change impacts

Numerous approaches have been used to assess the environmental impacts of various forms of land use change. These range from measures or indicators of on-site immediate and direct physical impacts to "whole of life cycle" effects that take account of even the most indirect impacts, including such things as effects of emissions created in the manufacture of equipment used in change (e.g. van der Werf 2002). We have assumed that the DbD approach is most concerned with direct impacts on the condition of natural heritage and, in the north Australian situation, cultural heritage strongly associated with natural heritage.

We had originally proposed to develop a system for ranking impacts from each sort of land use and linking these to prospectivity as a measure of relative probability of development to derive landscape vulnerability indices. For each form of land use change, namely mining, petroleum extraction (liquid and gas), irrigated agriculture, rain-fed agriculture, and grazing intensification through improved pastures, we proposed to identify the array of both on-site and offsite impacts resulting directly from the on-site activities. Treatment of greenhouse gas emissions would have included only emissions generated directly on site and not extend to energy or emissions costs of manufacturing equipment, fuels or chemicals used on site.

On examining the data available to us, we considered that this sort of approach was over-elaborate and unnecessary in this scoping study at large spatial scales. Nonetheless we consider that such approaches will be valuable at finer spatial scales and as improved data become available. We retain the conceptual and analytical work partly complete with a view to future application.

10.5 Choosing case study sites

The path we followed in identifying sites or regions where focused application of DbD processes might be productive is illustrated in Figure 21 below. As alluded to in the section preceding, we had planned to reach decisions based on quantitative rankings based on landscape vulnerability, but concluded that the available data did not support such an approach and have reverted to a qualitative assessment based on a wider range of considerations.

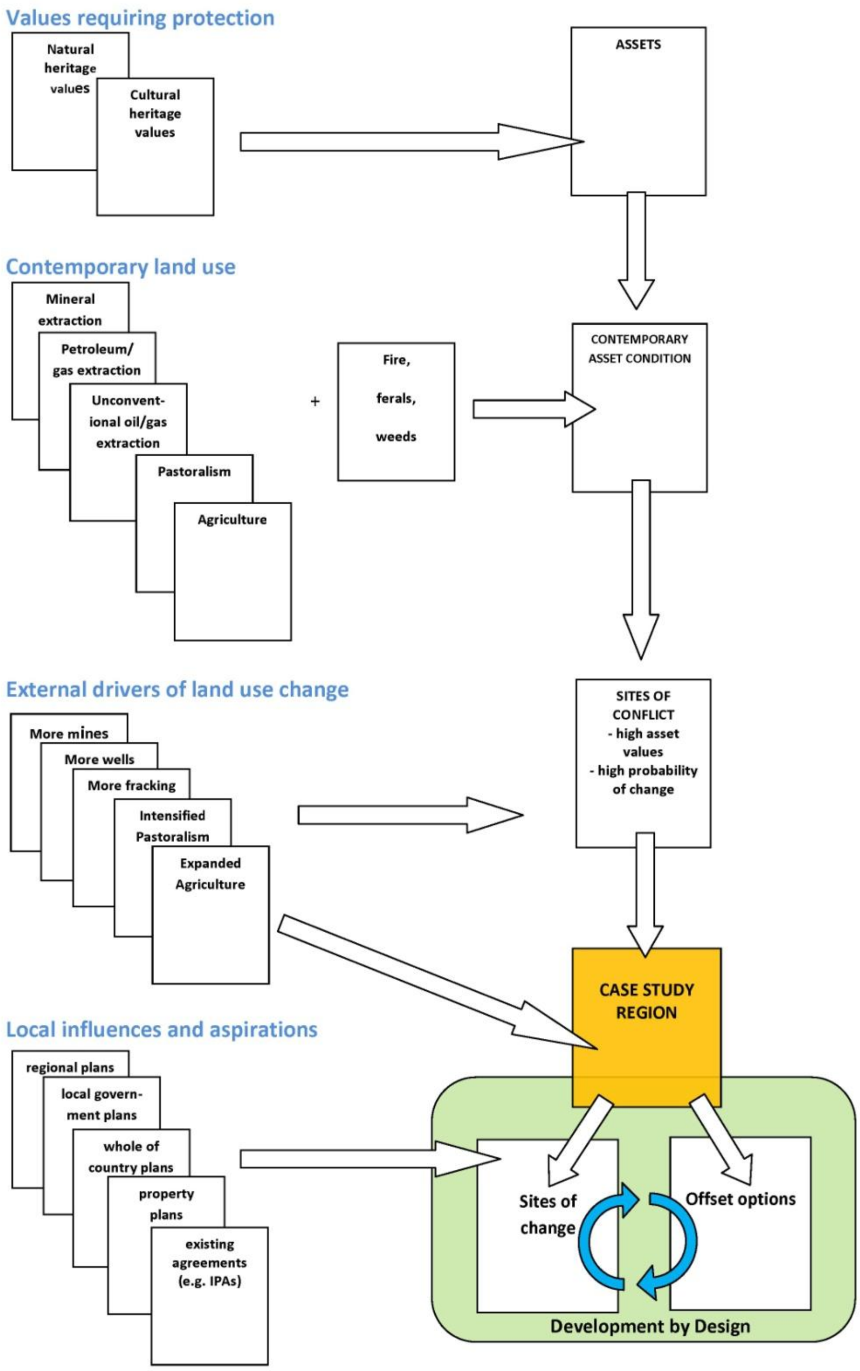


Figure 21: Data and issues considered in selecting sites for case studies and, once selected, the additional regional and local issues that should be considered in deploying the DbD process (bottom left). In essence case study areas are those supporting high values assets where prospects of land use change are considered higher than average, and values are susceptible to impacts from the changes thought likely.

11 RESULTS

11.1 Values at risk

The study area in the Northern Territory encompasses an annual rainfall gradient spanning more than 1.5 meters from the wettest parts of the north (1771 mm) to the drier inland (259 mm). Topographic variation is relatively minor and so does little to ameliorate locally the effects of the steep rainfall gradient from coast to inland. But even in the wettest areas, seasonality of rainfall is intense, with often heavy rainfalls alternating with intense seasonal droughts of several months, during which no rain falls. Throughout the study area, annual evaporation exceeds rainfall and most rivers cease to flow and may dry entirely over much of their inland length. Here we summarise some of the variation in ecology and human use of landscapes that is influenced by those primary drivers.

11.1.1 Natural heritage

11.1.1.1 Vegetation pattern

Vegetation mapping for the Territory is relatively coarse. Very little of the region is mapped at scales of 1:250,000 or less and often this mapping is in the form of land systems or land units. We have chosen to use the National Vegetation Information System for mapping primary because its offers a consistent approach to structural and floristic variation and so facilitates broad scale comparisons. We use NVIS level IV.

At this scale diversity of vegetation types varied markedly among sub-catchments, ranging from zero (1 coastal site) to 17 of the mapping units (described in the data descriptions in Attachment 7). Unsurprisingly, diversity declined inland (e.g. latitude and mean annual rainfall were negatively correlated with diversity despite the general increase in inland catchment sizes). A simple linear model of log(area) and rainfall in the driest quarter (RDQ) explained more than half the variance in NVIS vegetation diversity (r^2=0.630, P<<0.0001, n=1787), with RDQ adding 2.3% to explained variance (P=0.004). A variable for topographic roughness was not a significant entry.

11.1.1.2 Patterns of species richness

Analyses to follow are based on point data from the Northern Territory Flora and Fauna Atlas. It contains records of 846 species of vertebrate fauna recorded from the Northern Territory and 4479 species of vascular plants.

11.1.1.2.1 Fauna

The aggregated databases maintained by the Northern Territory Government comprised 563,216 records showing total numbers of species of vertebrate fauna in our sub-catchment units ranging from 0 to 522 (mean=39.1, sd=68.4). Broad scale variation in number of species recorded in sub-catchments is illustrated in Figure 24. There was wide variation in the number of records for sub-catchments (range 0-99071). The median number of records from sub-catchments was a remarkably low 3, due largely to the fact that there were no records from 732 (41.0%). Many sub-catchments without records were small (mean area=3511 ha, range 8-141,200 ha). However, the number of sizeable sub-catchments without fauna records (0 class in Figure 24 below) indicates the patchiness of sampling in the Northern Territory, which obviously compromises robustness of any interpretation of apparent spatial patterns.

To illustrate the level of sampling bias, the mean number of records from sub-catchments with centroids within 1^{o} of coastal latitude (12-13^{o}S) was 2089 and in an inland 1^{o} span (17-18^{o}S) was 138 records, even though the sampled inland catchments were on average more than 50% larger than the coastal. The relationship of apparent species richness with the number of records is illustrated in Figure 22 below.

Nonetheless, in an attempt to extract as much as possible from the data, we did attempt some multivariate modelling. A simple exercise demonstrated the futility. First we looked at a set of candidate models with apparent species richness (for sub-catchments with at least one species recorded) as dependent and all possible additive combinations (no interaction terms) of mean annual rainfall, rainfall in the driest quarter, topographic roughness, vegetation diversity and dominant vegetation. The best generalised linear model based on AIC difference included all of these variables. But there were statistical difficulties with severe over-dispersion of data which compromised some approaches to modelling (e.g. on raw counts with Poisson errors), so we switched to simple linear models using transformations.

The best model is summarised in Attachment 9. Superficially, features of potential interest are that, after taking account of the influence of sub-catchment area on apparent species richness (ASR) (Figure 23), coefficients of model parameters suggest:

- increase in ASR with increasing annual rainfall
- increase in ASR with increasing mapped vegetation diversity
- a decrease in ASR with increasing fire frequency.

Whilst the congruence of these features of the model with basic ecology and expectations regarding fire impacts is reassuring, it should not be over-interpreted. All of the explanatory variables are to some extent correlated. This can have powerful effects on value and even sign of coefficients in such statistical models. It is therefore difficult to assign particular significance to the relative contribution of different variables to fitted values. The flaws are illustrated when log(records) is substituted for log (area) in the multivariate analysis. When this is done, the model is a better fit (r^2=0.93 versus 0.42) and arguably a better predictive tool, but the coefficients for annual rainfall (MeanRain) and vegetation diversity (divveg) switch signs and fire frequency (AvFF) drops out of the model. The simplest message from the combined analyses is that the sample is inadequate to support either meaningful testing of hypotheses or construction of useful predictive models.

Although it is self evident that there will be a strong association between number of records and number of species recorded in building a comprehensive record, it would also be expected that this relationship would break down as the number of species detected approached the number of species present. In the great majority of sub-catchments, we appear to be well short of this point, with ASR increasing rapidly and linearly with more numerous records. Most catchments remain in a sampling space where additional effort would add substantially to recording of species apparently new to the region. Exceptions may arise in a few very well sampled catchments in the northern Top End with more than about 5000 records (Figure 22). Those 11 sites with more than 5000 records are in the adjoining Finniss (3), Adelaide (2), Mary (1), South (2), East Alligator (1) and Daly (2) River catchments surrounding Darwin.

Despite these constraints on conclusions about much more than the impacts of variable sampling on apparent patterns in vertebrate fauna richness, we identify very tentatively (Figure 24 and Figure 25):

- apparently species-rich sub-catchments in a Finniss River-Darwin-Kakadu coastal and sub-coastal strip
- a less marked but arguably noteworthy concentration in the Daly River catchment
- a much more diffuse set of moderate to high richness sites in the Roper River catchment
- an arc of moderately rich sub-catchments from the WA border in the Keep and Ord River catchments through the Timber Creek region into the Victoria River catchment
- some clumping of moderate to high species richness sub-catchments in the McArthur and Robinson River catchments in the Gulf of Carpentaria.

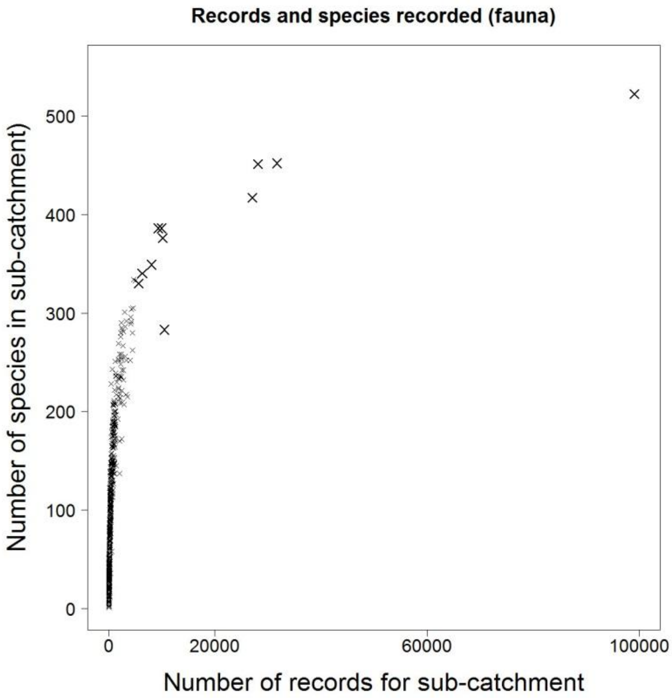


Figure 22 : Increase in number of species of vertebrate fauna recorded in sub-catchments with number of records. The relationship can be described by a simple linear regression of the form log(species) = 0.27 + 0.74log(records) (r^2=0.93 , $F_{1,1053}$= 13420, P<<0.0001).

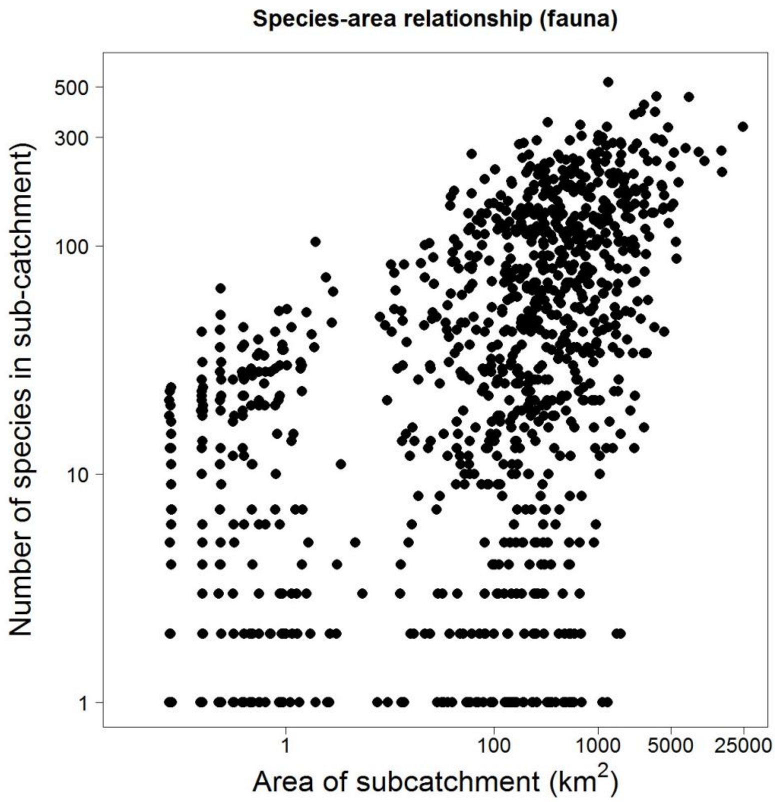


Figure 23: Relationship between fauna species richness and area of sub-catchments in which at least one species was recorded. The substantial number of units, including large ones, with 1 species recorded illustrates the sparseness of sampling even in sites that have not been entirely missed.

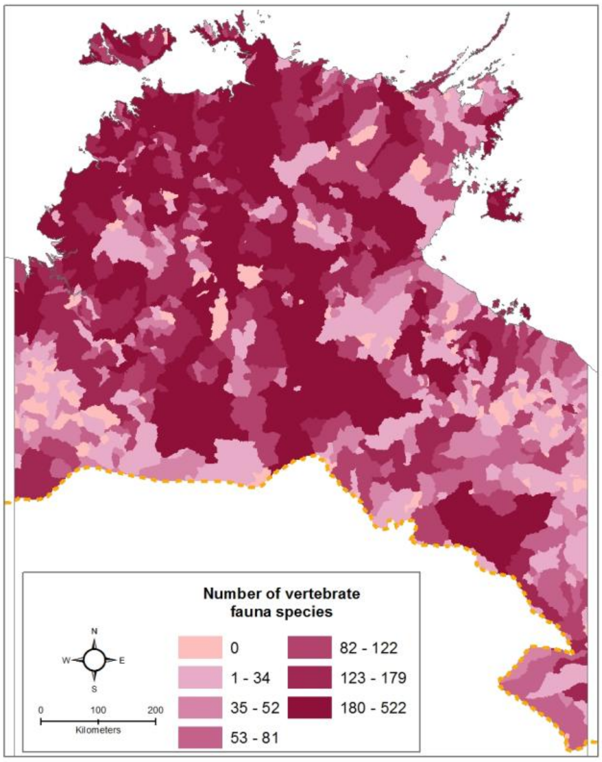


Figure 24: Variation in apparent species richness of vertebrate fauna in subcatchments. Classes are 5 deciles above the median and a single class for observations below the median. A zero class where there were no fauna recorded is also given. The substantial size of some of the subcatchments with no samples at all is a good illustration of the patchiness of records.

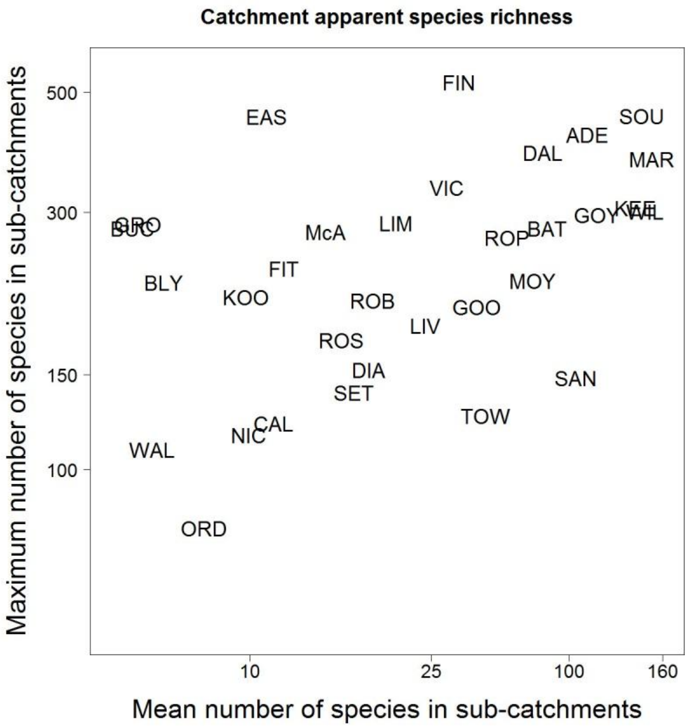


Figure 25: Position of regions (major catchments) in space defined by mean and maximum apparent fauna richness. The Darwin/Kakadu arc sits in the upper right (FIN=Finniss, ADE=Adelaide River, MAR=Mary River etc). The only non-northern coastal site in this space is the Keep River (KEE). The Roper River (ROP) sits close to these more heavily sampled sites.

11.1.1.2.2 Flora

As with fauna records, there were many sub-catchments (n=767) without records, despite the apparently large sample (*n*=629,118). Again many smaller sub-catchments appeared to have been un-sampled (*n*=767: mean area without records= 1583 ha, range 3-52,040). Species recorded in sub-catchments sampled ranged up to 1769 (mean=85.9, sd=175.1). The disparity between apparently high richness sub-catchments and others appears even greater than for fauna. Higher values for the Darwin-Kakadu-western Arnhem Land sub-catchments are particularly striking and reflected in Figure 26. Because many flora records are based on voucher specimens lodged with the Northern Territory herbarium they are arguably less subject to methodological variation, which for fauna may include information gathered in rapid sighting (e.g. aerial) surveys over large areas. Nonetheless, the bias to coastal sites remains marked, with numbers of records varying 6-fold between the same coastal and inland bands as we compared for fauna (above).

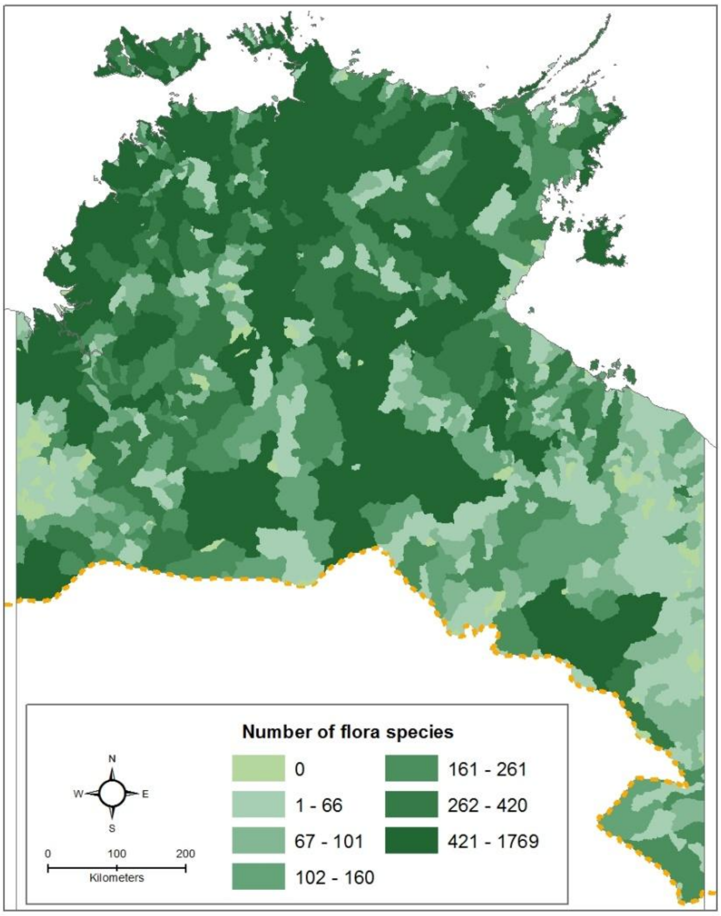


Figure 26: Variation in number of species of vascular plants among sub-catchments. As with fauna there are substantial areas with no records. Classes were derived as described for fauna observations.

As with fauna there was a strong statistical relationship between the number of records and apparent richness of flora (for both variables logged, r^2=0.97, $F_{1,1018}$=30900, P<<0.0001). In this case introducing area to the regression added slightly but statistically significantly to explained variance (addition to r^2=0.0004), but the coefficient was negative (P=0.0005), so that for a given number of records, larger sub-catchments had slightly smaller species counts. We attach no particular significance to this result for the reasons given earlier, but interpret it as an artefact of relatively strong positive correlation of the "independent" variables (r=0.36, P<0.0001).

In a separate regression, the relationship between total species richness and sub-catchment area for sub-catchments in which there was at least 1 record is summarised by log(number of species)=0.39+0.37(log(area) [r^2=0.29, df=1,1018, P<0.0001].

11.1.1.2.3 Summary and conclusions

Geo-coded records of flora and fauna routinely available from the Northern Territory Government show strong geographic bias to northern coastal and sub-coastal regions. There is also a great deal of other spatial patchiness with many large sub-catchments having no or few records (for fauna 54.6% with 10 or fewer). Including zeros as valid observations, median density of fauna records was 0.051 records.km^{-2} and of flora records 0.060 records.km^{-2}, much lower than the respective means (9.22 and 5.39), indicating the right skew to a few very heavily sampled sites in the Darwin to Kakadu regions in particular. Beyond broad generalisations, such as relationships of species richness with position in the rainfall gradient, interpretation of spatial patterns therefore needs to be approached with caution.

Capacity to substitute modelling of species associations with environmental features for direct empirical observations is also compromised by relatively low resolution of relevant thematic mapping with wide coverage and the non-hierarchical structure and other limitations of finer scale mapping such as land systems and land units. We return to this issue in consideration of the case study region.

We suggest that capacity to make comparisons among sites at spatial scales relevant to Development by Design is compromised by both weak vegetation and other biophysical mapping and the patchiness of point records of species occurrence. Inferences regarding variation in the presence/absence, absolute or relative abundance of individual species cannot be readily drawn from such records.

11.1.1.3 Notable (threatened, endemic and migratory) species

We turn now to species that have been recognised as warranting special attention in setting conservation priorities. Specifically we consider threatened species listed under both Territory and federal law, migratory species as listed in federal law, and species of restricted distribution, loosely categorised as endemics. Woinarski et al. (2007) provide a comprehensive listing of threatened species, with updates available on the NT Department of Land Resources Management website[65]. Migratory species are listed on the federal Department of Environment website[66]. There is some ambiguity regarding categorisation of NT endemic species in the flora and fauna database but we applied categorisations used there without review.

11.1.1.3.1 Fauna

11.1.1.3.1.1 Richness

[65] http://lrm.nt.gov.au/plants-and-animals/threatened-species/specieslist#.VApdxGPisTA
[66] http://www.environment.gov.au/cgi-bin/sprat/public/publicshowmigratory.pl

Most sub-catchments (71.8% for NT and 74.3% for EPBCA categories) had no notable fauna recorded in databases (Table 13 and Table 14). There was a weak trend for larger sub-catchments to report more notable fauna (e.g. Figure 27: number of species and area both logged, r^2=0.098, P<0.0001, n=504). Significant numbers of notable species were found in some very small (mostly coastal) sub-catchments.

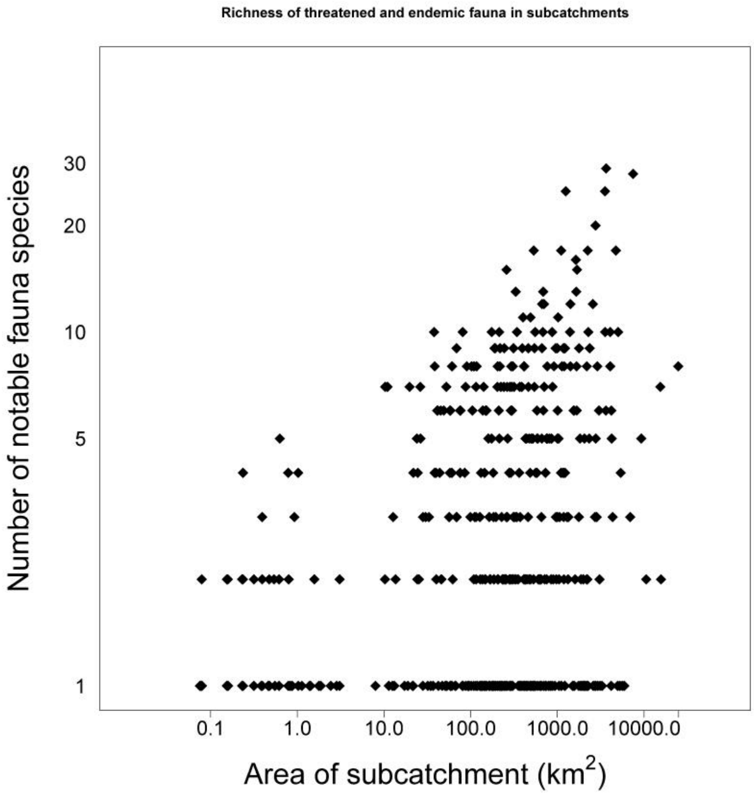


Figure 27: Relationship between richness of notable fauna in sub-catchments in the Northern Territory savannas, based on NT categories of vulnerable, endangered, critically endangered and endemic. Near threatened species are not included.

Patterns were broadly similar for fauna listed under the EPBCA (all classes vulnerable, endangered, critically endangered, and migratory) although they were present in many fewer sub-catchments and numbers of species were generally lower (Table 14).

We used a process similar to that described for all flora and fauna to examine relationships between numbers of notable fauna species (NT classifications) and broad environmental descriptors. WE do not report the results here because we consider that the geographical biases render them uninterpretable. In any event there is some conceptual difficulty in seeking to relate the distributions of rare or restricted range species to broad scale environmental variables. These analyses are unlikely to capture influences on contemporary conservation status.

11.1.1.3.1.2 Number of reports

Most units recording notable fauna had multiple reports in datasets, sometimes including very large numbers (maximum of 2389 for the period January 1803 to 31 Match 2012). However the distribution was highly skewed to lower values (median=5). Records of EPBCA listed species were fewer than for NTG listed species (Table 13 and Table 14).

11.1.1.3.2 Flora

11.1.1.3.2.1 Richness

Fewer sub-catchments were recorded as supporting threatened and endemic vascular plants, and the average number of species present in occupied sub-catchments was lower at 3.3 per unit (Table 13). In the sample of sub-catchments that supported at least one notable plants species, there was no trend for number of species to increase with sub-catchment size (r^2=-0.001, *P*=0.95, *n*=103). Most strikingly, notable plant species were never reported in the very small sub-catchments in which notable fauna were sometimes recorded (Figure 28). The smallest catchment with at least one notable plant species recorded was 31.6 km^2, compared with 0.08 km^2 for fauna.

The reason for these differences may be associated with occurrence of threatened marine fauna like nesting turtles and migratory birds in un-vegetated or sparsely vegetated coastal (tidal) environments and intensive sampling of small near coastal islands.

EPBCA listed plant species were reported from only 31 sub-catchments (1.7%) and again mostly from larger units (minimum 45.1 km^2). Sub-catchments with reports of at least one EPBCA-listed species had on average 1.6 species (maximum 4) (Table 14).

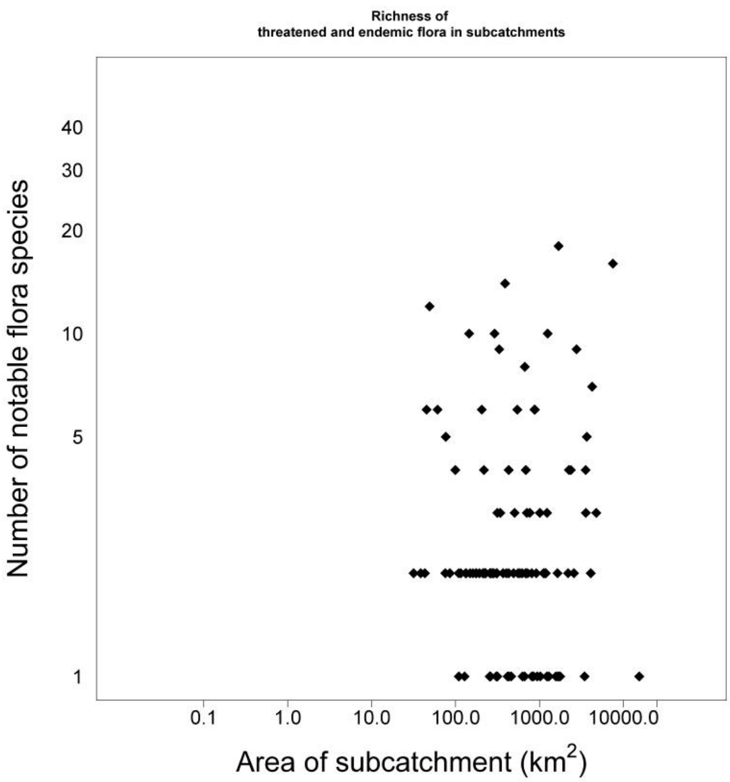


Figure 28: Relationship between richness of notable flora in sub-catchments in the Northern Territory savannas, based on NT categories of vulnerable, endangered, critically endangered and endemic species. Near threatened species are not included.

11.1.1.3.2.2 Number of reports

Most units recording notable flora had multiple reports (mean number of individual records=30.0, sd=99.2, max=943) for the period covered by the database (30 July 1900 to 28 March 2013). As for fauna, the distribution was highly skewed to the lower end (median=5). Records per unit for EPBCA-listed species were more numerous (mean=51.9, sd=171.2, max=940) and again highly left skewed (median=5).

11.1.1.3.3 Indices for flora and fauna

Values of the various indices calculated for sub-catchments (see Table 6) recorded as supporting notable species are summarised in Table 13 and Table 14 and mapped in Figure 31 for NT categorisations. The particular values have no ecological meaning, given the sampling biases alluded to above, and were used principally to group observations to effectively expand sample size when exploring spatial variation in rankings of observed values. Because relatively little of the variance in number of notable species is explained by area of planning units and we found no greater coherence of spatial patterns, we did not pursue use of area weighted indices. There seems to be little point in elaborating more complex indices when the data on which they draw are so sparse and demonstrably biased in spatial coverage.

However, as part of the exploration of options for identifying parts of the landscape that are unusually important for species of particular interest or concern, we repeated multivariate analyses with the simple index for flora and fauna (Table 6) as dependent variable. We do not report the results because they are unreliable.

11.1.1.3.4 Spatial variation in notable flora and fauna

Variation in richness of notable species (all categories excluding near threatened) in sub-catchments is illustrated in Figure 29 and Figure 30 (NT categorisations) and Figure 32 and Figure 33 (national categorisations). There are substantial differences in location of concentrations of notable species based on the different Territory and national categorisations, the sources of which have not been analysed in detail, but which appear to relate to differences in emphasis on migratory (Table 13 and Table 14) and hence marine and other wetland species.

It is particularly important to take account of these sorts of biases in considering the weight given to rankings of sub-catchments in matching conservation priorities to different land use changes and their various impacts. For example, biodiversity based on shorebirds or marine turtles will not usually be supported by offsets developed in response to clearing of terrestrial vegetation. Rankings based on terrestrial flora (Figure 26) may be better matched to land use change that, as will often be the case, requires clearing of native vegetation. But even their utility is in doubt remains because of geographic variation in the intensity of sampling.

In awareness of the strength of those caveats, we nonetheless suggest that this scan of notable species does not materially alter the tentative identification of weak spatial patterns based on all species records offered earlier. The most obvious effect of adding categories of national interest (e.g. migratory species: Figure 32) is to fill some gaps in the map of the study area, but many remain.

Table 13 : Summary of records for notable species in Northern Territory databases based on *Territory Parks and Wildlife Conservation Act* categorisations. The threatened species index was derived as summarised in Table 8. The number of species pooled is less than the sum of categories because some endemics also appear in other categories.

Category	**number of different notable species**	**number of units occupied**	**number of notable species per occupied unit**			
			mean	**sd**	**range**	**median**
Fauna						
- endemic	51	127	2.0	1.6	1-9	1
- vulnerable	40	472	3.3	3.2	1-23	2
- endangered	10	117	1.5	0.9	1-6	1
- critical	10	122	1.1	0.2	1-2	1
- pooled	97	504	4.2	4.8	1-38	2
Flora						
- endemic	670	69	1.7	1.1	1-7	1
- vulnerable	42	95	1.8	1.5	1-8	1
- endangered	18	27	1.6	1.0	1-5	1
- critical	3	7	1.0	0.0	1	1
- pooled	707	103	3.3	3.2	1-18	2
Threatened animal index	-	504	9.1	10.1	1-75	5
Record weighted TAI	-	504	12.8	17.2	1.0-148.4	5.7
Density TAI	-	504	2.0	7.5	0.0003-70.7	0.030
Threatened flora index	-	103	6.1	6.5	2-40	3
Record weighted TPI	-	103	8.9	10.9	2.0-69.0	4.4
Density TPI	-	103	0.03	0.08	0.0002-0.72	0.012
Threatened biodiversity index	-	513	10.1	12.3	1-100	5
Record weighted TBI	-	513	14.7	21.2	1.1-185.8	6.0
Density TBI	-	513	2.0	7.7	0.0003-74.0	0.03

Table 14 : Summary of records for notable species in Commonwealth databases under *Environmental Protection and Biodiversity Conservation Act* categorisations. The number of species pooled is less than the sum of categories because some migratory species also appear in other categories.

Category	**number of different notable species**	**number of units occupied**	**number of species per occupied unit**			
			mean	**sd**	**range**	**median**
Fauna						
- vulnerable	25	281	1.7	1.2	1-9	1
- endangered	12	263	1.3	0.6	1-4	1
- critical	1	6	1.0	0.0	1	1
- migratory	99	361	3.4	3.7	1-18	1
- pooled	125	460	4.4	4.2	1-28	3
Flora						
- vulnerable	14	18	1.2	0.4	1-2	1
- endangered	8	18	1.4	0.7	1-3	1
- critical	1	2	1.0	0.0	1	1
- pooled	23	31	1.6	0.9	1-4	1
Threatened animal index (TAI)	-	460	9.6	8.7	2-58	7
Record weighted TAI	-	460	12.5	13.5	2-110	8.1
Density TAI	-	460	4.1	14.9	0.0003-135.9	0.033
Threatened plant index (TPI)	-	31	4.2	2.7	2-11	3
Record weighted TPI	-	31	6.1	4.3	2.3-18.9	4.1
Density TPI	-	31	0.03	0.06	0.0007-0.30	0.008
Threatened biodiversity index (TBI)	-	462	9.9	9.0	2-58	7
Record weighted TBI	-	462	13.2	14.3	2.2-114.0	8.8
Density TBI	-	462	4.3	15.4	0.0003-139.4	0.034

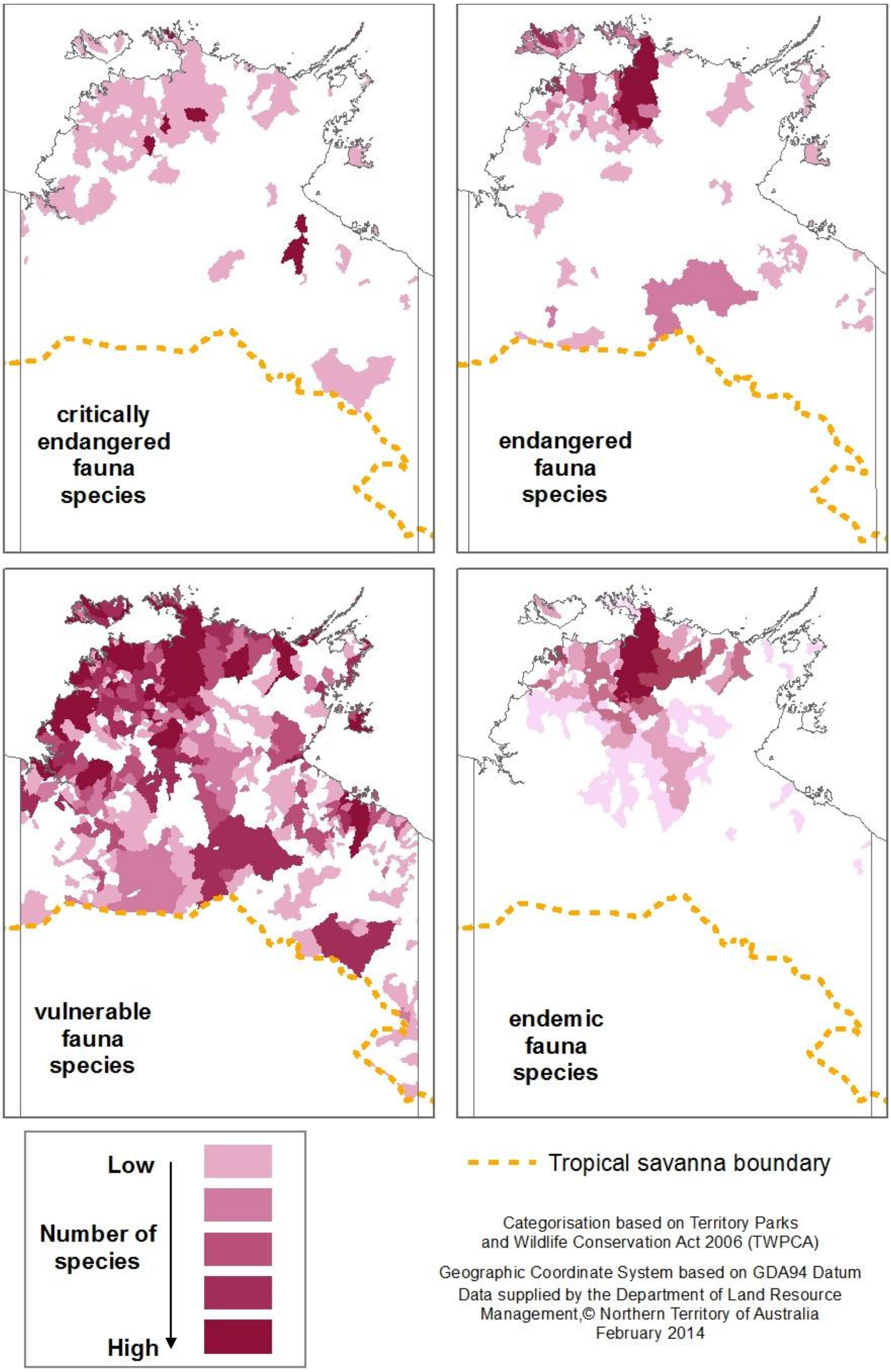


Figure 29: Variation in numbers of species of fauna of conservation interest occurring in sub-catchments, based on NT categorisations. Areas not shaded support no species in the

relevant categories.

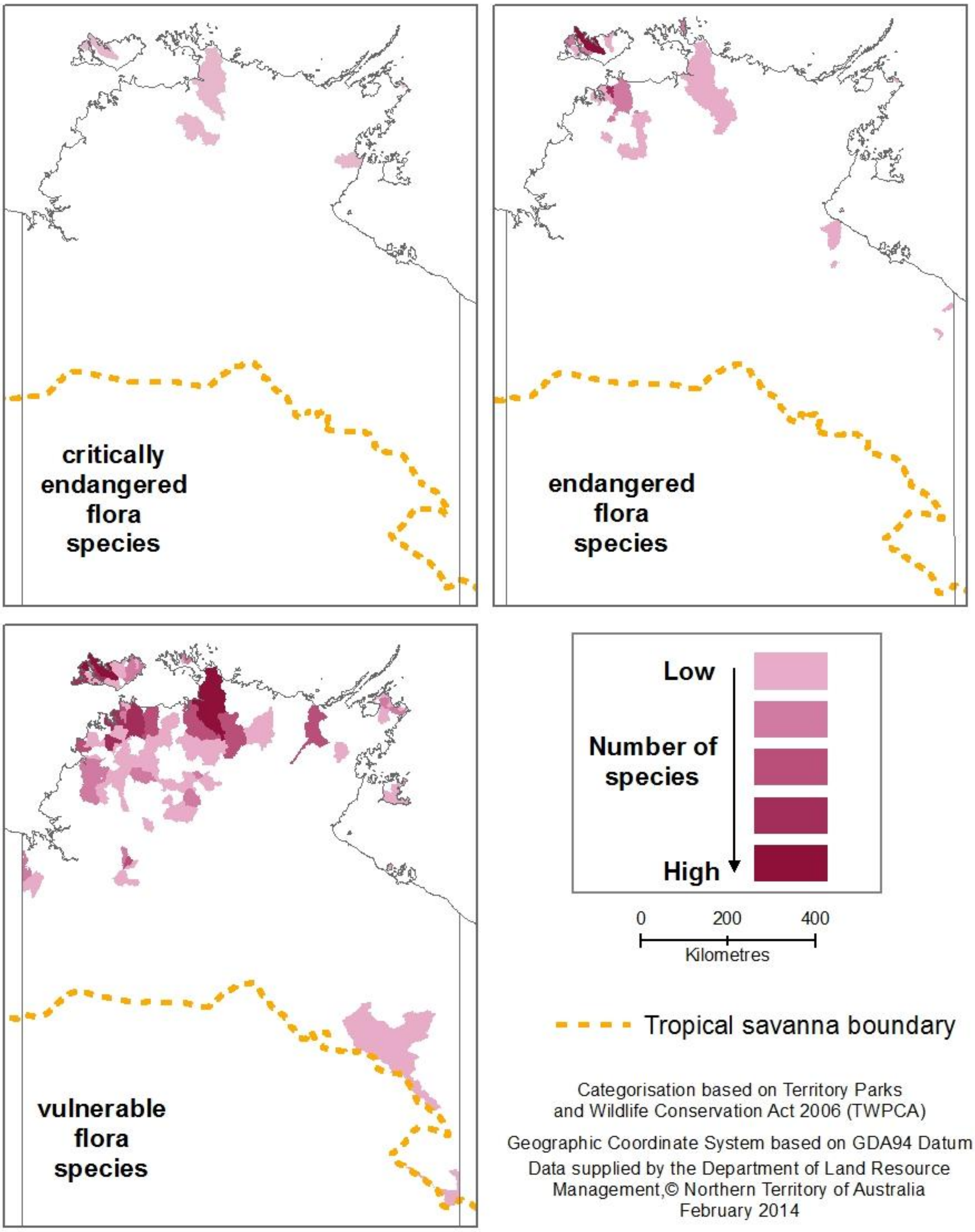


Figure 30: Variation in numbers of species of flora of conservation interest occurring in sub-catchments based on NT categorisations. Areas not shaded support no species in the relevant categories.

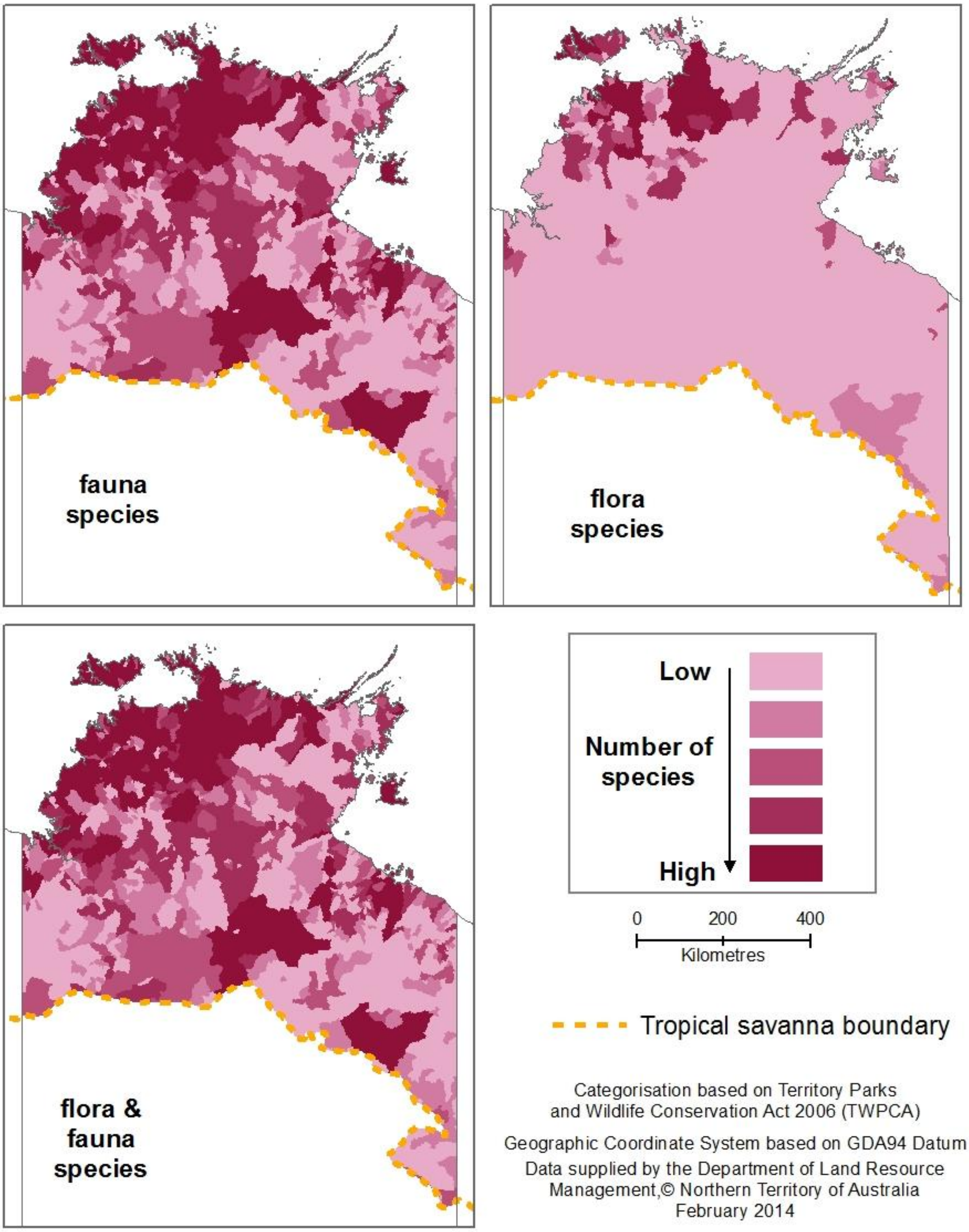


Figure 31: Index of notable species occurring in sub-catchments based on NT categorisations. The index includes weighting for the number of records for each species in each sub-catchment (see Table 6).

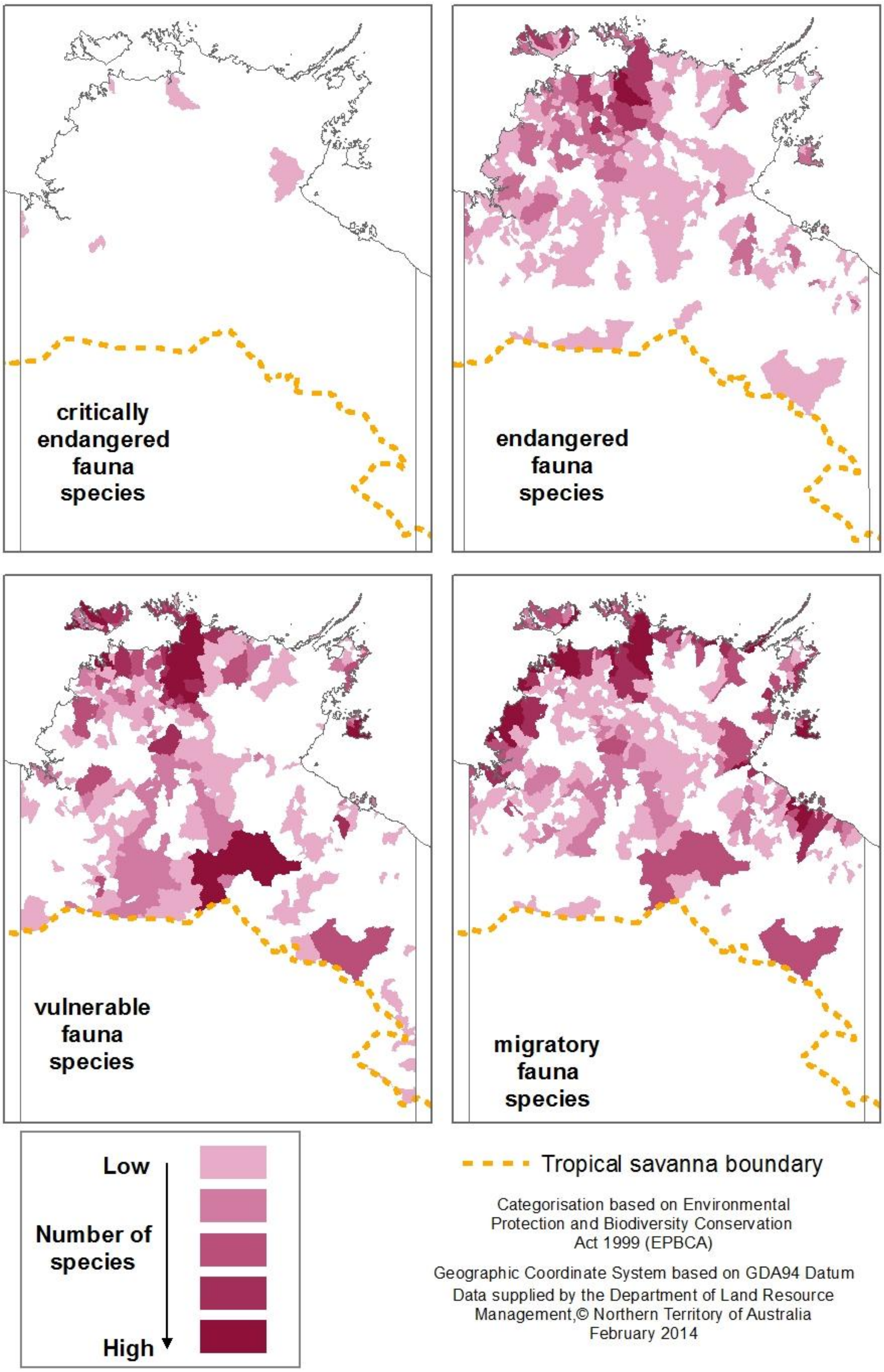


Figure 32: Variation in numbers of species of fauna of conservation interest occurring in sub-catchments, based on national (EPBCA) categorisations. Areas not shaded support no species in the relevant categories.

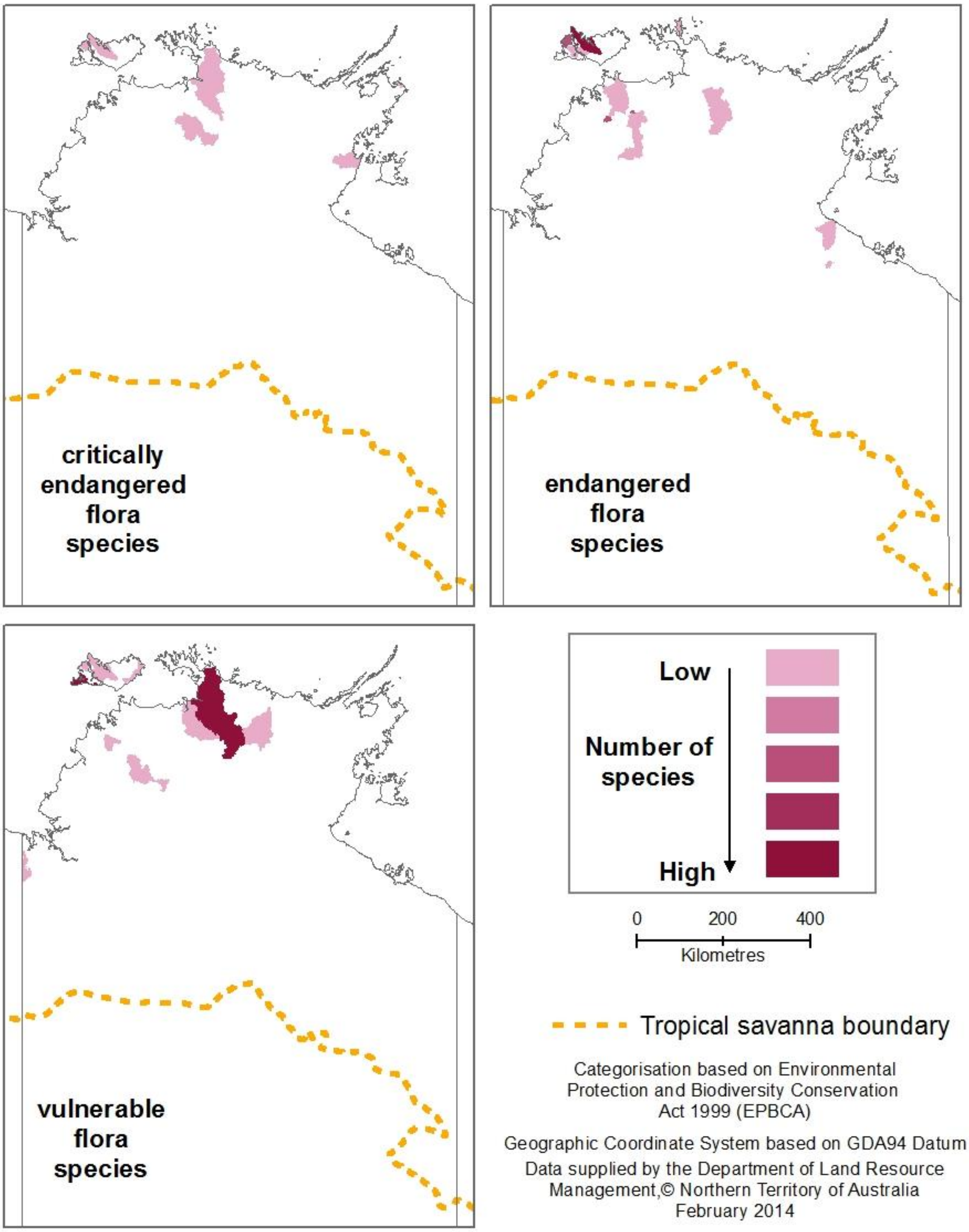


Figure 33: Variation in numbers of species of flora of conservation interest occurring in sub-catchments, based on national (EPBCA) categorisations. Areas not shaded support no species in the relevant categories.

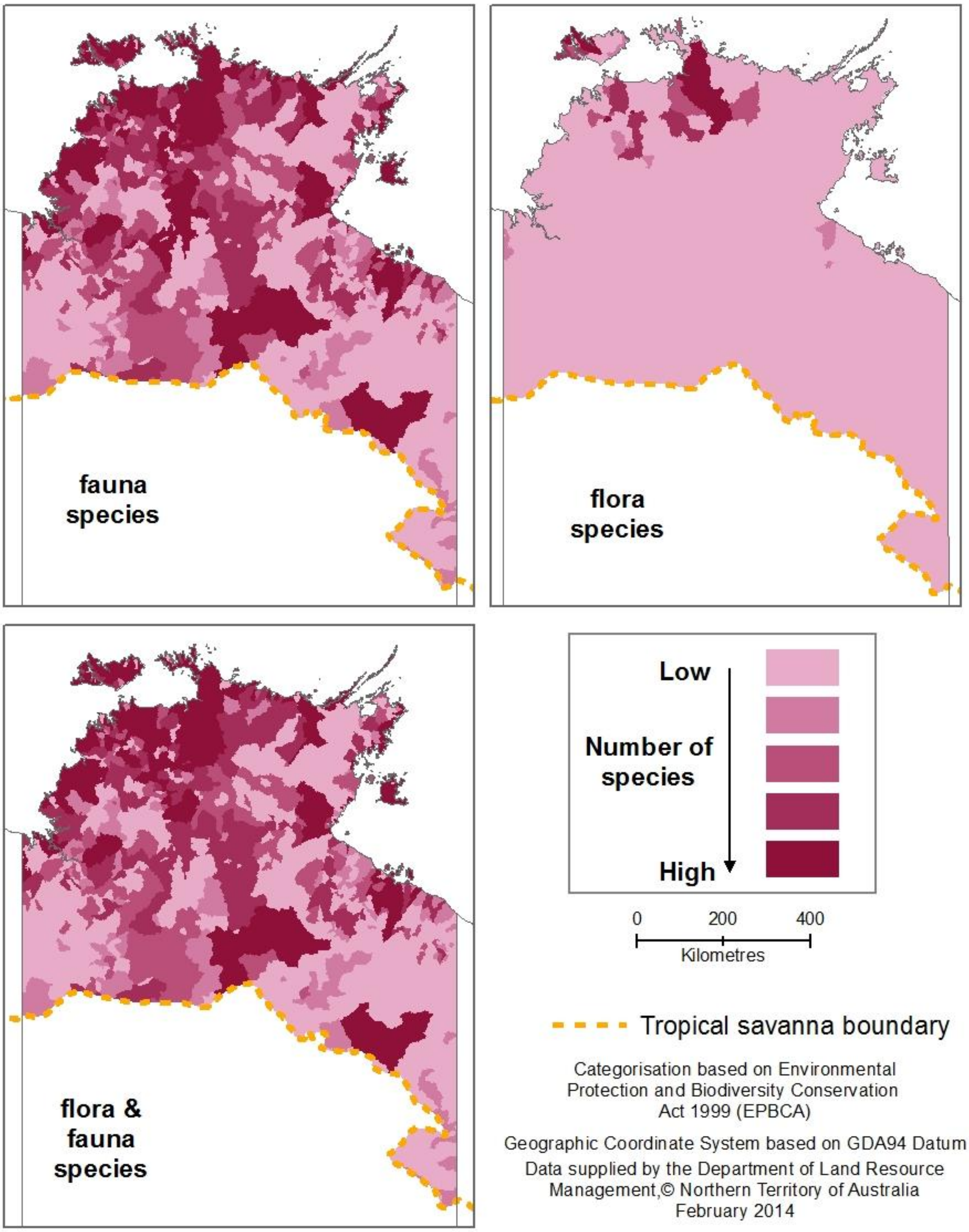


Figure 34: Variation in numbers of species of flora and fauna of conservation interest occurring in sub-catchments, based on national (EPBCA) categorisations.

11.1.1.3.5 *Indices for aquatic ecosystems*

Examples of occurrence of high value aquatic ecosystems in sub-catchments are shown in Figure 35. These are based on indices derived by Kennard (2011) which integrate a large number of measures of site character. As is clear from the maps, it is important to note that the Kennard (2011) analyses do not cover the whole of the chosen study area in the NT. Greater value is generally assigned to coastal sites and in areas of topographic and hence hydro-ecological diversity such as the sandstone of Kakadu and Arnhem Land. There is some evidence of elevated values (e.g. distinctiveness) in the Daly River/Roper River catchments.

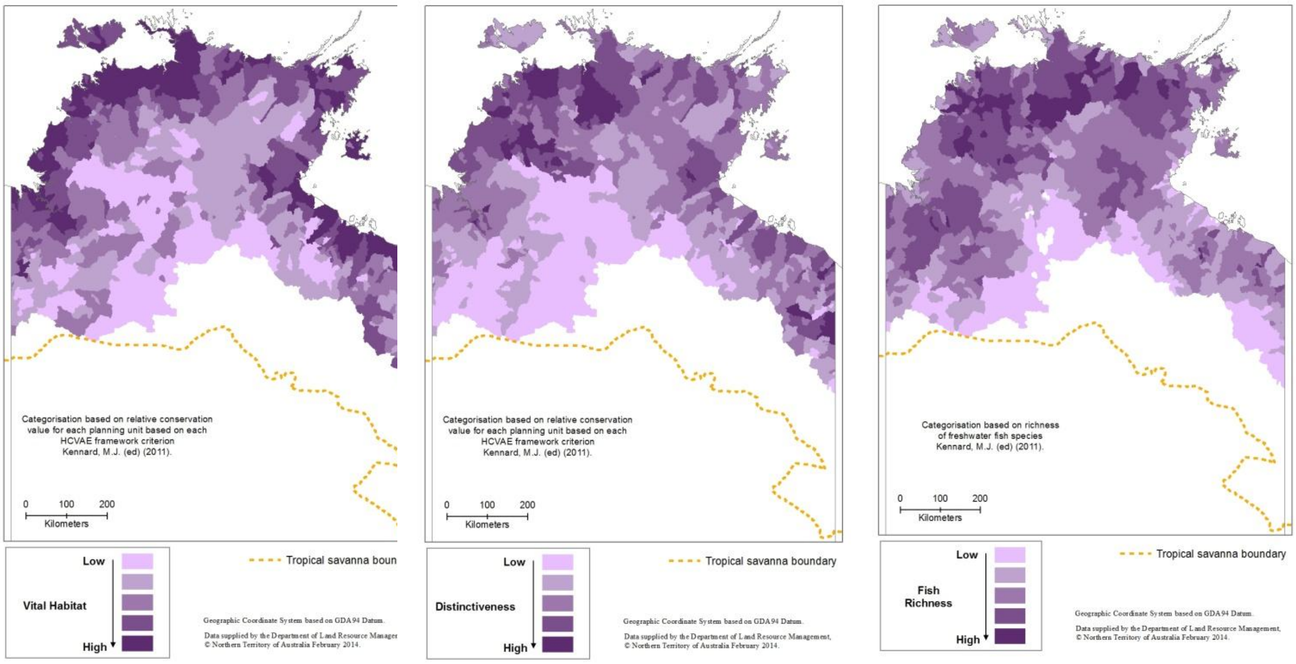


Figure 35: A haphazard selection of 3 of Kennard 's (2011) indices of relative conservation value, from left "vital habitat", "distinctiveness", and species richness for fish.

11.1.1.3.6 *Summary and conclusions*

Unsurprisingly, given the difficulties with patchy sampling we have already identified repeatedly, neither mapping of sub-catchments nor statistical treatment revealed unambiguously favourable sites for focus of conservation work on aggregations of species of particular concern, except perhaps for areas that had been subject to the most intensive sampling, along the northern coastal strip from Darwin through to western Arnhem Land. Those regions were subject to more intensive sampling (e.g. CSIRO in Kakadu in the 1980s and 1990s) because they had already been recognised on many grounds as warranting protection or were subject to threat of change (e.g. Coronation Hill: Braithwaite and Woinarski 1990).

11.1.1.4 Sites of conservation significance

Relationship of planning units to NT sites of conservation significance (SoCs) are shown in Figure 36. Because SoCS are large (mean 3002.8 km^2) compared with sub-catchments (mean area=361.5 km^2), most units (86%) lie entirely within (n=766) or entirely outside (n=769) SoCS. Units falling entirely within SoCS are at the smaller end of the range (mean=29.1 km^2) and mostly coastal.

There is a bias to coastal sites in the SoCS, probably associated with the concentration of high value wetlands on coastal floodplains (Whitehead and Chatto 1996), and influence of migratory species (especially waders) and threatened marine turtles (Chatto and Baker 2007). The few inland sites are mostly centred on wetlands. We interpret the relationship of planning units to SoCS principally as an indicator of priority that may be assigned by government to dealing with the consequences of land use change or other environmental pressure, rather than a dominant indicator of conservation value. We note that in some of its guidance on process (e.g. NTEPA 2014c regarding land clearing on pastoral lands), NTEPA uses proximity to SoCS as a criterion for assessment.

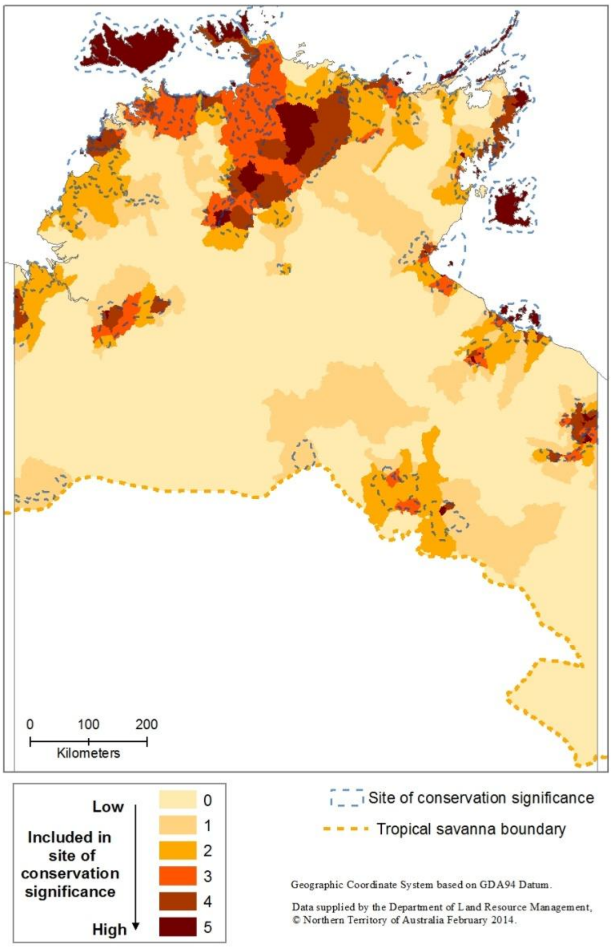


Figure 36: Area of planning units (sub-catchments) falling within the NT's sites of conservation significance. These assignments of significance were tenure blind and so include substantial areas already under conservation management, particularly in western Arnhem Land and Kakadu.

Unsurprisingly, given that we are drawing on the same records that were available to the authors of the SoCS reports, their assignments are broadly consistent with the ambiguous spatial patterns that our exploration based on sub-catchments has suggested. The most obvious difference is the greater representation of inland sites in the catchments we have tentatively identified as having at least somewhat elevated values for species richness and presence of notable species.

11.1.2 Cultural heritage

Our assessments of cultural heritage are largely confined to sites recognised for their Indigenous heritage value, most notably a mix of sites specifically evaluated and recognised in law (sacred sites registered under the *Northern Territory Sacred Sites Act*), sites recorded by the agency administering sacred sites law but not formally registered, and archaeological sites recorded by the Heritage Branch that have automatic protection under the *Heritage Act* (NT) but have not necessarily been evaluated for significance. As well as raw counts, we have presented the distribution of these values (last row of Table 15) by way of an index that weights registered sacred sites highest (Table 9) and archaeological sites lowest.

Table 15 : Summary details for sites of cultural significance recorded by the Northern Territory Government within the study area. Registered sacred sites are protected under the *Northern Territory Sacred Sites Act* and all archaeological sites are at least nominally protected under the Heritage Act (NT) whether formally listed or not. Some sites will also have protection under relevant federal law.

Type of site	**number (%) of units with site(s)**	**Number of sites per occupied unit**	**Area of sites (ha) where recorded**
		mean ± sd, median, range	**mean ± sd, median, range**
Sacred sites (AAPA)			
- registered	296 (16.5)	4.0 ± 5.2, 2, 1-46	1160 ± 2564, 224, 1-20045 (287)
- recorded	764 (42.8)	9.3 ± 18.5, 3, 1-169	940 ± 4759, 48, 1-69618 (527)
Archaeological sites (Heritage)	377 (21.1)	19.0 ± 54.4, 4, 1-577	-
All types of sites	883 (49.4)	17.6 ± 49.4, 3, 1-755	-
Index of cultural value	883	30.8 ± 72.1, 7, 1-987	-

11.1.2.1 Registered sacred sites

Sub-catchments that contained registered sacred sites tended to be larger than those without them (112,537 versus 20,983 ha). In sub-catchments containing at least one site, the number of registered sites increased with sub-catchment area (Figure 37 on logged values r^2=0.21, P<0.0001, n=296). We attribute no particular significance to this observation aside from the obvious point that sites distributed randomly or evenly through the landscape would tend to be more numerous in larger areas .

Attributes that contributed to Indigenous peoples' recognition of site significance related most often to landscape and (fresh) waters (Table 16), although many sites were valued for multiple attributes.

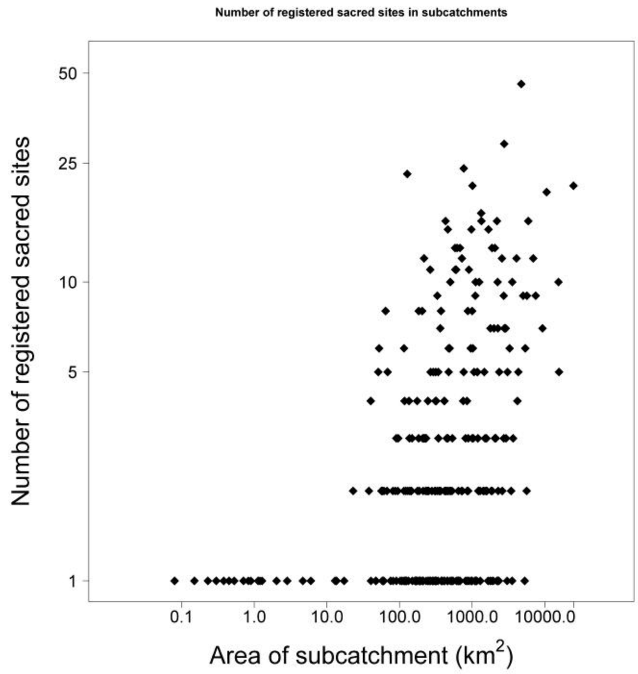


Figure 37: Number of registered sacred sites in sub-catchments of different size. There is a weak trend for increase in the number of sites with sub-catchment area.

Table 16 : Attributes reported as contributing to significance for AAPA registered and recorded sites. Many sites were ascribed multiple values. Summaries for sub-catchments are for those that contained at least one site of that type.

Attribute	**Number of sites**	**Sites per subcatchment** mean ± sd, median, range
Landscape morphology	538	4.5 ± 8.0,2, (1-67)
Water (fresh)	570	6.3 ± 10.5, 2, (1-115)
Vegetation	139	2.7 ± 2.9, 2, (1-21)
Artefact(s)	276	5.3 ± 10.3, 2, (1-117)
Marine	50	1.3 ± 1.0, 1, (1-5)
Not revealed	180	2.3 ± 2.8, 1, (1-20)

11.1.2.2 Other cultural sites

In much of the analysis to follow we consider AAPA recorded sites and archaeological sites in tandem with registered sites.

11.1.2.2.1 AAPA recorded sites

Recorded sites are more numerous and arguably more evenly dispersed across the Territory landscape than registered sites. We attribute this to formal protection being seen by those responsible for sites as more useful outside Indigenous-owned lands where there are fewer controls over access. The relatively large areas of Arnhem Land with no or comparatively fewer registered sites (Figure 38 below). There may be greater incentive to use formal powers on non-Indigenous lands.

11.1.2.2.2 Archaeological sites

Archaeological sites recorded by the NT Heritage Branch are also widely distributed through the study area, although large areas have no sites reported. As in other elements of this study, much of the apparent variation (including absences from areas now occupied by Indigenous people with ongoing affiliations) is likely to be an artefact of idiosyncratic sampling and reporting.

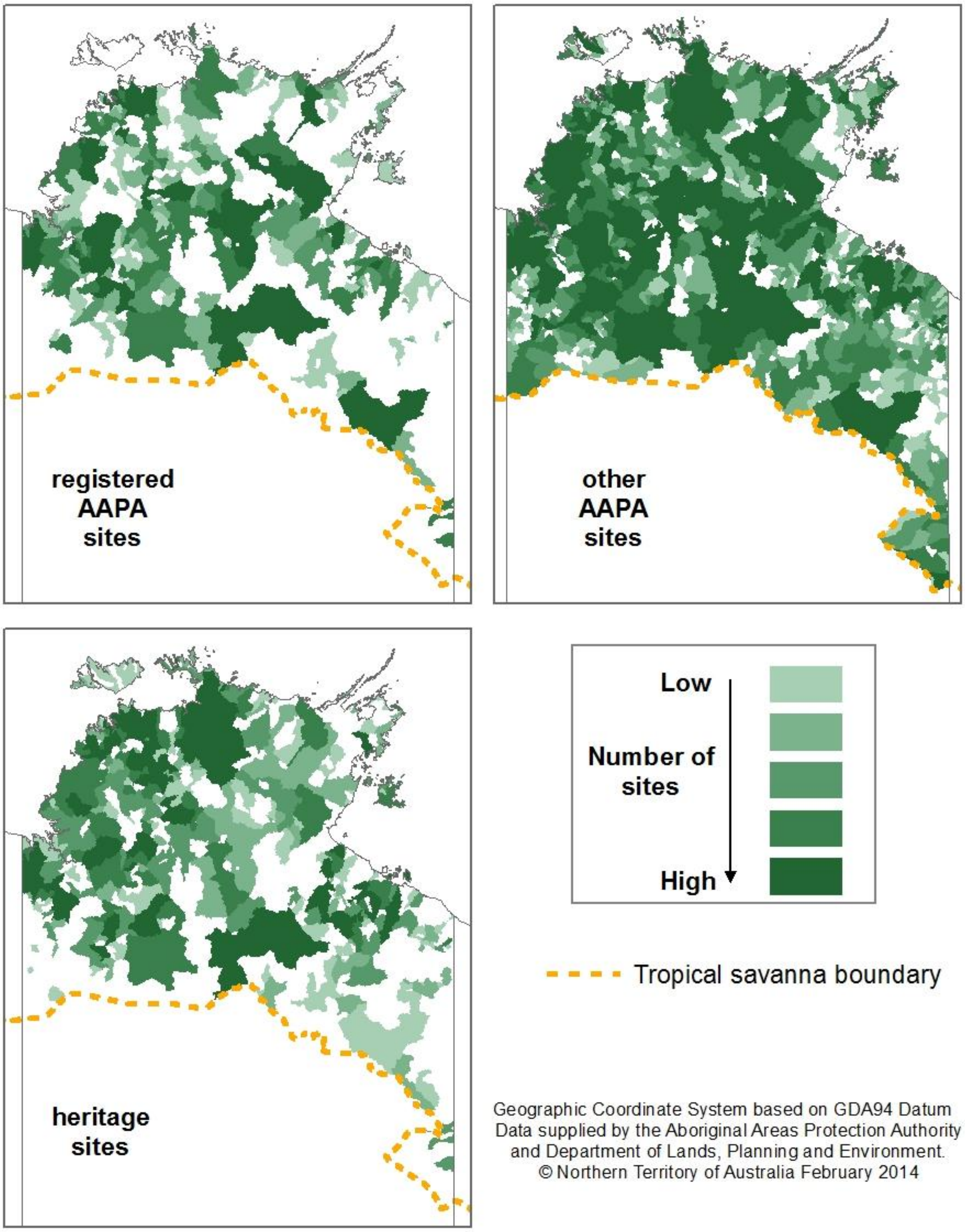


Figure 38: Variation among catchments in the number of sites significant to Indigenous people. Registered sacred sites (upper left) have strong legal protection, archaeological sites recorded by the Heritage Branch of the NT Government (bottom left) are protected automatically. Sites recorded by AAPA have no formal protection but the fact that they have been brought to attention by Indigenous informants is an indicator of their importance.

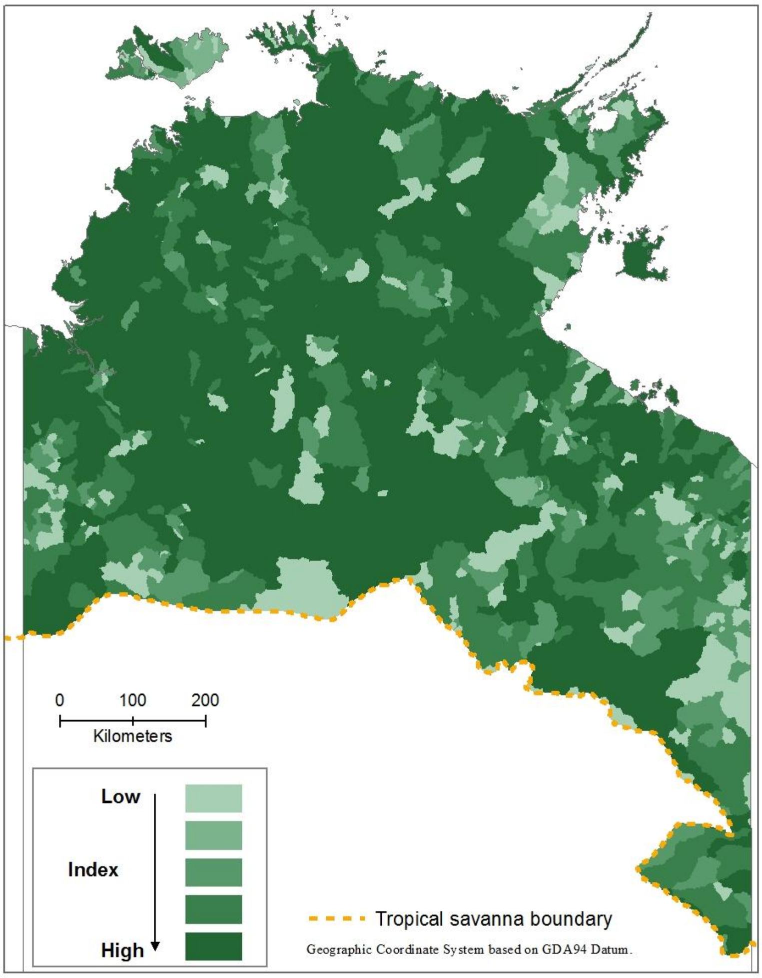


Figure 39: Index of culturally valuable sites in sub-catchments derived as described in Table 9. The index has not been adjusted to take account of variation in sub-catchment size, even though there is a trend for increase in the index with catchment area (Figure 40).

The index described in Table 9 and displayed in Figure 39 also increased with sub-catchment area (r^2=0.36, P<0.0001, *n*=883). The most striking feature of geographic patterning is arguably the ubiquity of recognised sites rather than any particular concentrations or "clumping".

An arguably more important feature of the information presented here is that a substantial proportion of sites are valued on attributes associated with water. This raises particular obligations to go beyond concerns about environmental effects of water use, to consider cultural issues. There is no precedent for allocations of water specifically to protect such values, although the 80:20 rule (see DNRETA 2006) allocates 80% of annual flows or recharge to the environment and other public purposes. Those other public purposes may include cultural water.

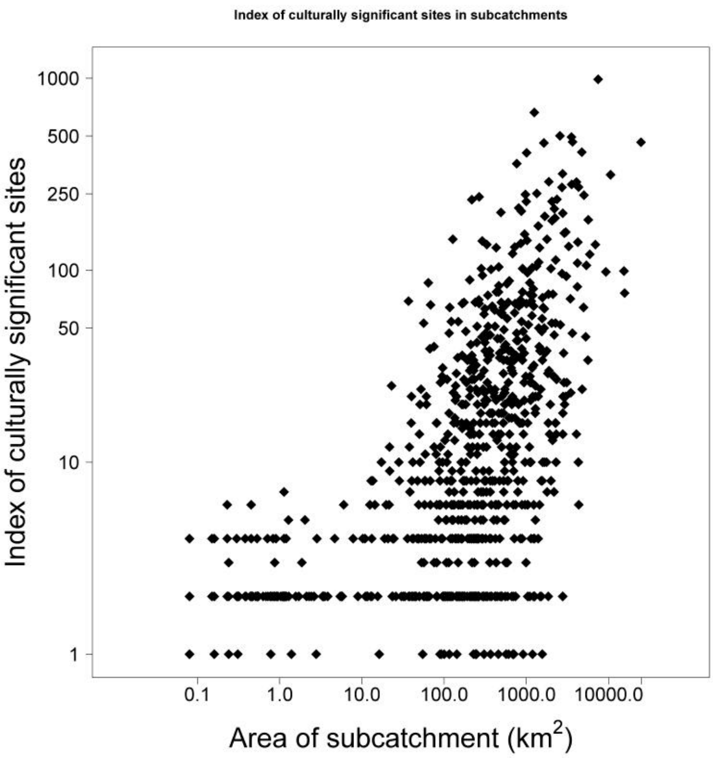


Figure 40: Index of culturally valuable sites in sub-catchments of different size. There is a trend for increase in the index with catchment area.

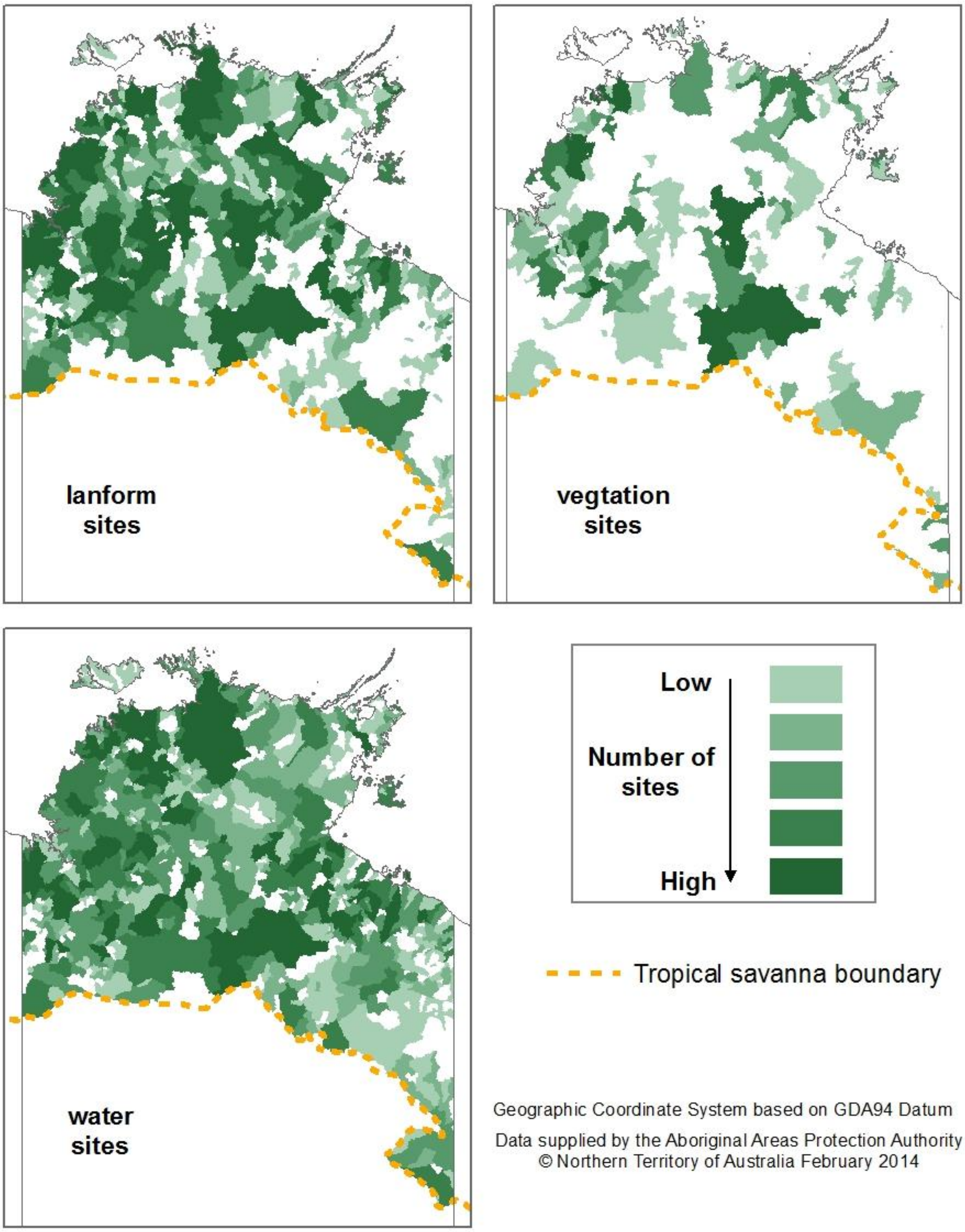


Figure 41: Variation among catchments in the number of AAPA registered and recorded sites identified according to features informants identified as contributing to significance. The prevalence and wide geographical distribution of sites in which water bodies are important contributors to significance is of considerable interest, given the likely impacts of the most probable forms of development on condition of water bodies.

11.1.2.4 Wildlife important in the customary economy

Distribution of records of the focal species groups identified in Table 8 are shown in Figure 42 to Figure 45. There are few strong patterns in the data except obvious correlations with preferred habitat types (e.g. coastal floodplains for Magpie Geese). Whilst the results provide little guidance for selecting sites for special protection they do reinforce the observation that culturally significant sites are widely distributed. That is, wherever large scale developments occur, they will have impacts on the customary economy that should be recognised and so far as possible mitigated.

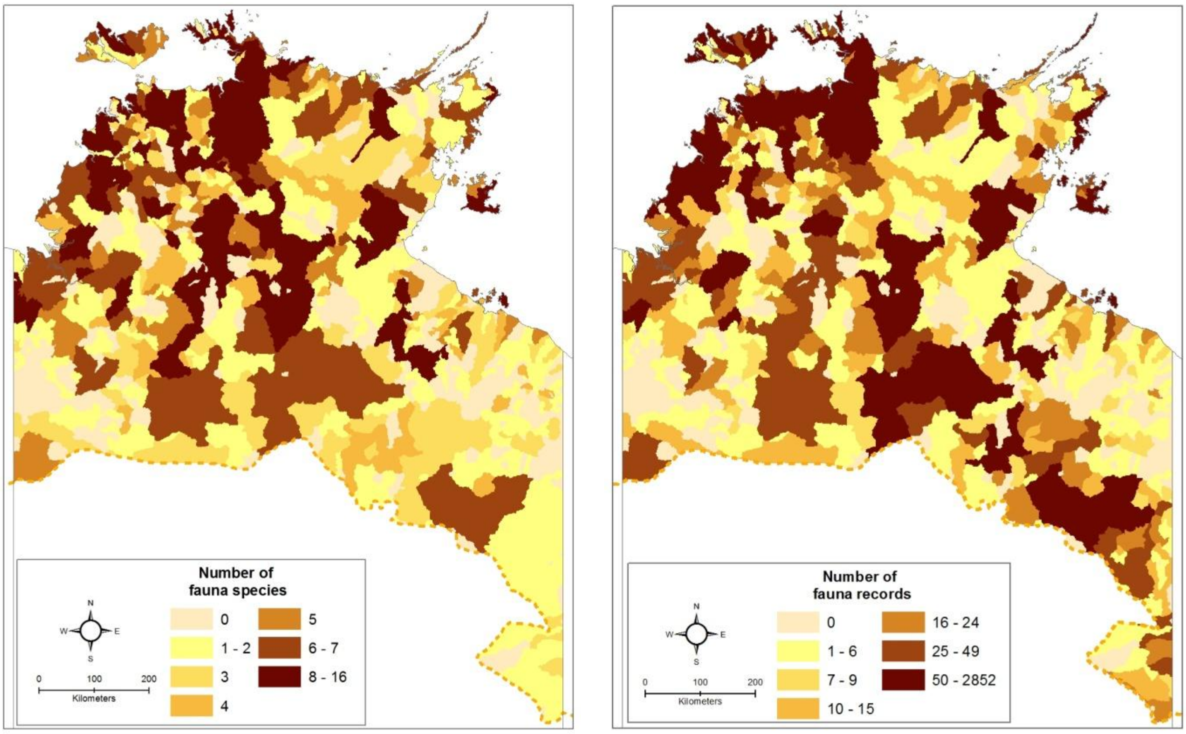


Figure 42: Pooled records of a subset of fauna known to be important in the customary economy (bustard, dugong, emu, freshwater turtles, macropods, magpie geese and marine turtles). Interpretation is confounded by uneven sampling. However, the maps illustrate the presence of economically and culturally significant wildlife through the study area.

Arguably the most significant observation is that the emu is relatively discontinuously reported across the study area, reflecting orthodox conservation assessments that class the emu as vulnerable in the Northern Territory, as well as concerns expressed by Indigenous informants about disappearance from parts of the landscape where they were previously abundant. These changes are sometimes attributed to poor fire management (Garde et al. 2009).

The larger point here is that threats some species important to the customary economy may permit recognition and quantification of impact

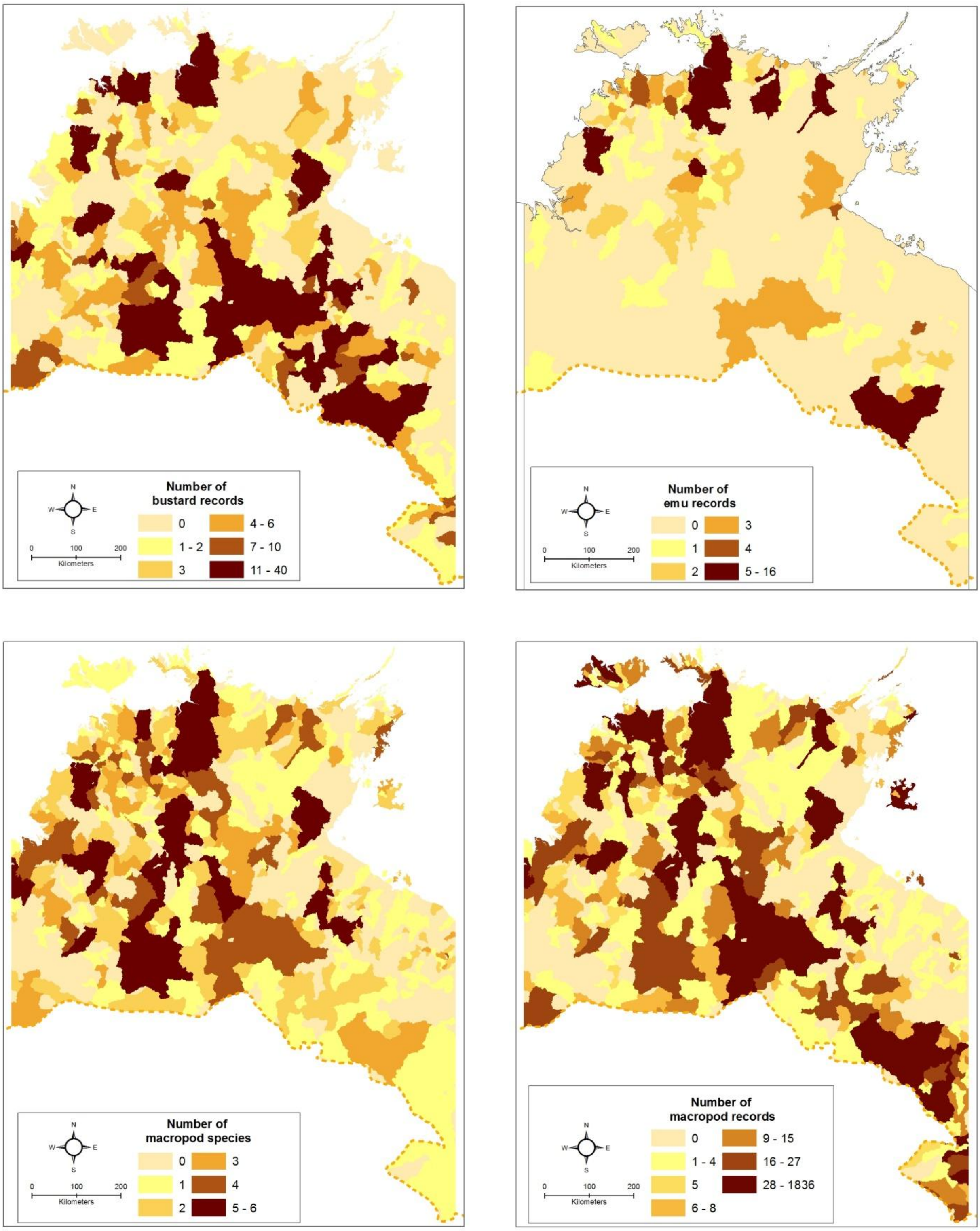
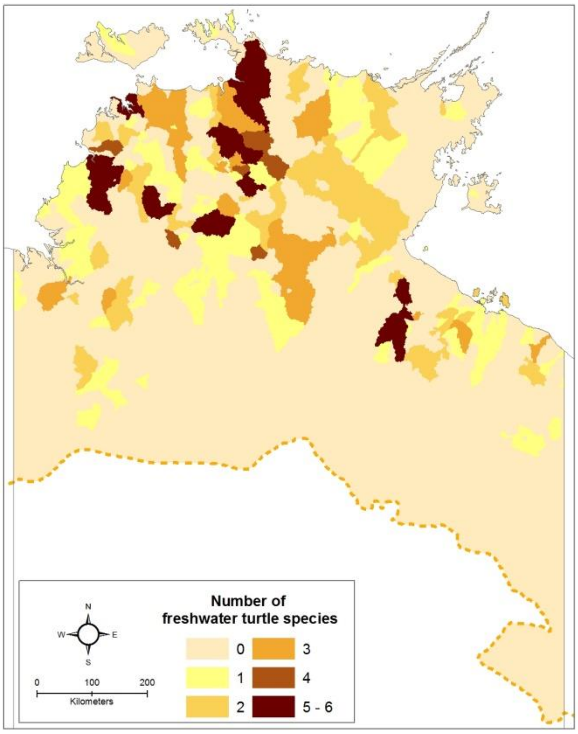
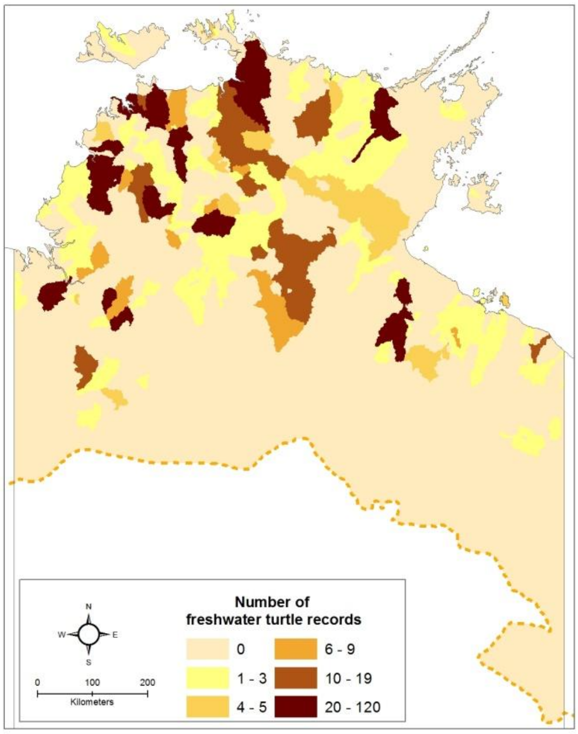


Figure 43: Occurrence (number of species) and numbers of records of terrestrial fauna important in the customary economy.





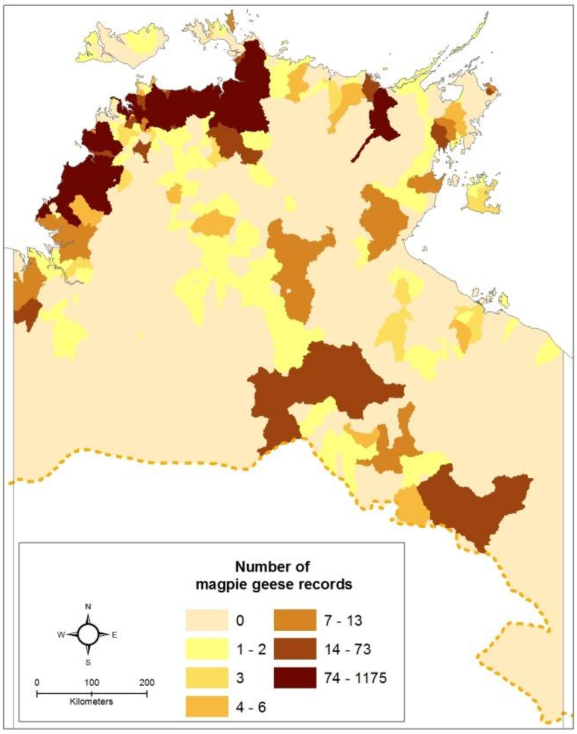
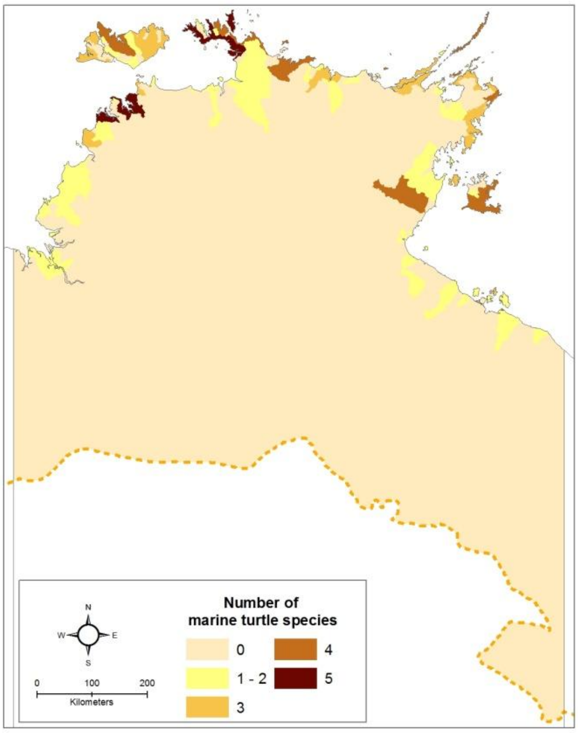
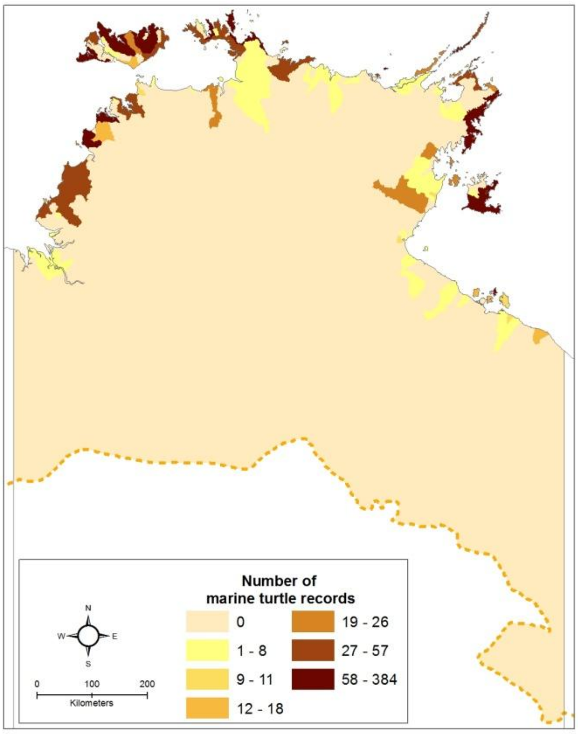


Figure 44: Species important in the customary economy associated with freshwaters.





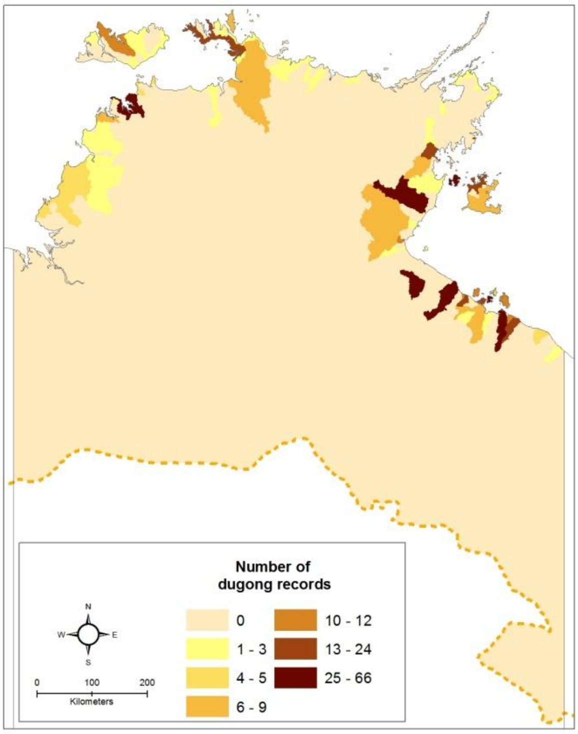


Figure 45: Marine species important in the customary economy. Records are shown against the coastal sub-catchment with which they are most closely associated.

11.1.3 Existing pressures on assets

11.1.3.1 Grazing pressure - domestic stock

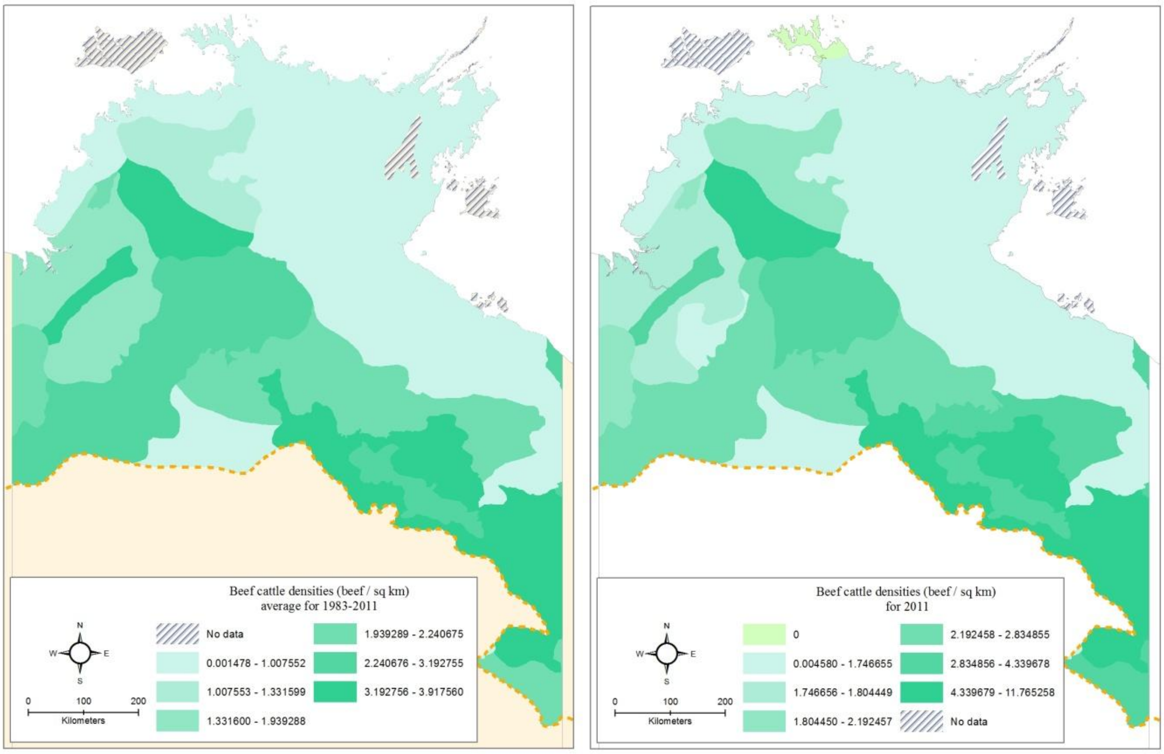


Figure 46: Spatial variation in relative grazing pressure from domestic (managed) stock (a) averaged over the period 1983-2011, and (b) in 2011, summarised at the level of bioregions. Derived from Bastin and Acris Management Committee (2008) and Bastin (2011) and associated spreadsheet summaries.

Bastin (2011) reports that several bioregions in the study area had considerably increased stocking densities over the period 2003-2008 compared with the average between 1984 and 1991. Regions subject to greater grazing intensity included the Daly Basin (within the Daly River catchment), Sturt Plateau, Pine Creek, Gulf Coastal and Gulf Fall & Uplands bioregions. These areas overlap with sites of elevated asset values as revealed in other parts of this study.

Changes in grazing pressure are attributed to variations in demand from key markets, including the live export trade. Impacts on environments are likely to increase when numbers of animals carried increase. For example, the federal government estimates land clearing rates and their greenhouse gas emissions from changes in farming terms of trade. The increases in stocking summarised by Bastin (2011) coincided with a period in the Northern Territory with dramatically decreased monitoring effort (Figure 16), so there was no capacity to identify effects on the public pastoral estate.

Such histories and trends will be important issues to consider in selection of sites for offsets.

11.1.3.2 Grazing pressure - feral animals

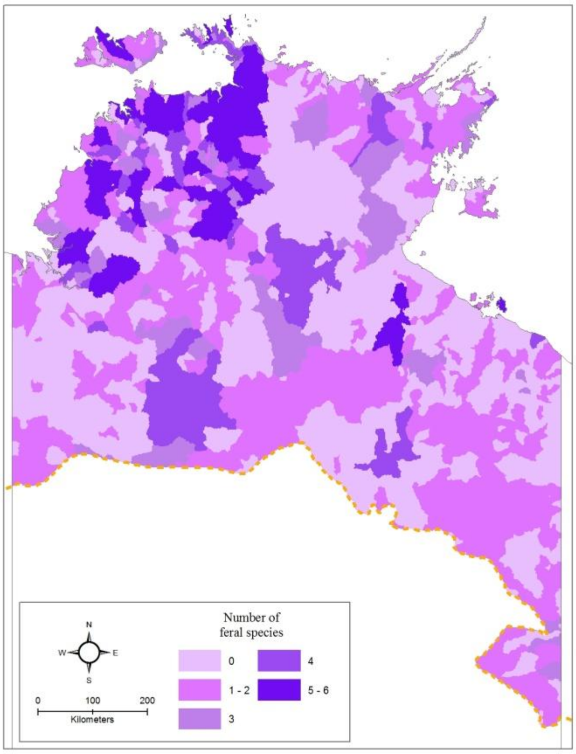


Figure 47: Relative number of feral animal species in sub-catchments.

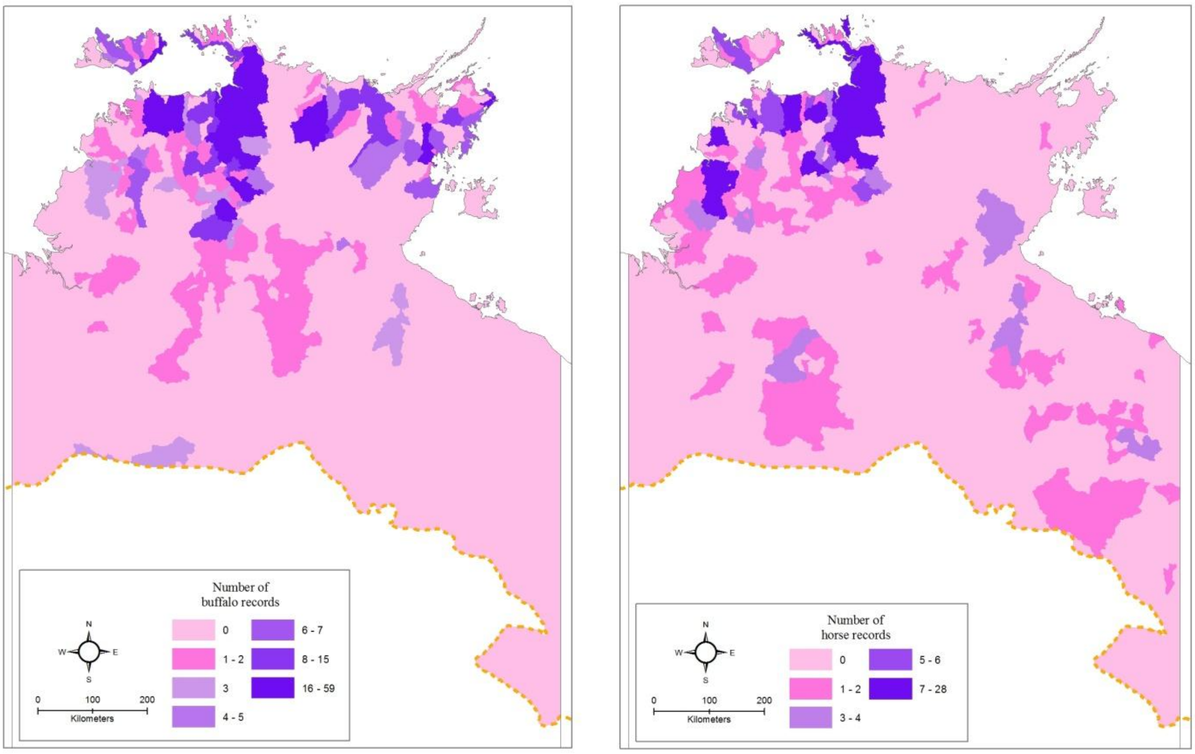


Figure 48: Relative numbers of records of two species of large feral grazing animals in sub-catchments. Records comprise a mix of historical and contemporary records and so illustrate a mix of past and present pressures and needs for ongoing management.

It is worth noting that large feral animals observations to some extent "complement" managed grazing, being higher outside the active pastoral estate on Indigenous land and parks and reserves. Post-BTEC aerial surveys of feral buffalo *Bubalus bubalis* indicate the largest populations are in Arnhem Land, where the BTEC program was curtailed (Robinson and Whitehead 2005), because incidence of animal disease was found to be low and there was little or no direct conflict with managed stock. Feral buffalo are harvested in small numbers in areas within and adjoining the catchment, for local consumption by Indigenous hunters, and mustering for slaughter or live export (Rathsmann 2012). Small numbers of animals are taken by safari hunters (Whitehead 2011). The total harvest appears too small to suppress populations to levels where substantial environmental damage is prevented (Saalfeld 1998, 2006; Gorman et al. 2007).

The effect of substantial feral animal populations is to make grazing by large exotic herbivores all but ubiquitous in the NT savannas. Buffering of grazing impacts on natural values has been indicated in areas that topographically constrain access by cattle (Franklin et al. 2005), but buffalo and pigs *Sus scrofa* appear at best weakly constrained, being found, for example, through much of the rocky and dissected Arnhem Plateau, where they cause sometimes severe damage (Ens et al. 2011).

At most potential offset sites there will be obligations to control feral grazers (and the omnivorous pig), if biodiversity values, cultural values and landscape stability are to be protected long term. And because most sites will have been affected to some extent before being selected for offsets, effective control will provide options to increase offset benefits. An understanding of exotic animal invasion history will be necessary to inform expectations of change and to design relevant monitoring systems for measuring offset performance.

11.1.3.3 Agriculture (including forestry)

Agricultural and most forestry sites are acutely modified, often by large scale clearing of native vegetation continuous over long distances. More recently attempts have been made to interrupt zones of clearing by retaining larger uncleared areas, especially on less productive or more fragile soils (NRETAS 2010).

Present impacts of agriculture are confined mostly to the cleared site itself. Exceptions occur where clearing has been extensive enough to create fragmented landscapes; where isolated remnants of native vegetation of various sizes experience a running down of fauna values (Rankmore and Price 2004). In a few cases on the Daly River, erosion has been severe (personal observation), but the available evidence indicates no significant impacts on processes of sedimentation entering the river and adjacent floodplains (Wasson et al. 2010). Poisoning of wildlife through accidental or deliberate use of agricultural chemicals has been reported (e.g. Bradley 2008).

Although the area cleared of native vegetation for agriculture in the Northern Territory is relatively small, a number of the enterprises for which that clearing was done have failed. In some cases recovery has begun naturally through regrowth from root stock and seed. Recovery can be slow and doubt remains about the extent to which full recovery of ecological function is possible over reasonable time frames. However, some data and analyses are available to predict biodiversity benefits (Woinarski et al. 2009) from protecting previously cleared sites from further disturbance.

Such protection, perhaps supplemented by active rehabilitation, is a plausible option for offsets designed to generate both biodiversity and carbon benefits chiefly in the Darwin and the Daly River region and on Melville Island in forestry plantations. However, there are small pockets of cleared land in parts of Arnhem Land and even in Kakadu National Park that might provide opportunities.

11.1.3.4 Mining

Mining has a long history in the Northern Territory. The industry strongly influenced early patterns of non-Indigenous settlement and temporary movement of Indigenous groups seeking access to resources associated with mining (Jones 1987; Cooke 2009; Levitus 2009; Ritchie 2009). Few of the long-established mining precincts, however, led to long term settlements with the exception of the small township of Pine Creek (contemporary population ~600 but exceeding 3000 in the late 19th Century). The towns of Jabiru (contemporary population 1200) and Nhulunbuy (4000) are heavily dependent on mining. Impacts of mining, like pastoralism, reach well beyond changes directly caused by mineral extraction and processing through influences on human population distribution and associated pressures like fire and capacity to manage them.

Contemporary distribution of mining activity in the study area is shown in Figure 49 below. The most notable features of present and recent past mining activity are:

- mining is occurring in 26 sub-catchments: most sub-catchments (98.5%) have no mineral extraction activity except minor gravel and sand extraction;
- there is some clumping of activity, with foci in the Adelaide to Pine Creek regions (gold and iron ore) in the Gulf and Roper River catchments;
- total area of the sub-catchments supporting mining is 3.8 million ha, or 5.9% of the study area;
- gold mining is dominant (in 7 sub-catchments), with most of the remaining activity involving iron ore (4), zinc and other base metals (3), and diamonds (3); bauxite (3) and manganese (2) mines, although occurring in more than one sub-catchment are fundamentally single operations;
- only one sub-catchment - in the Pine Creek area - had more than one mine type (gold and iron ore);
- a number mines, including the very large Nhulunbuy bauxite extraction and refinery operation, are at risk of closure, raising issues around rehabilitation and security of waste dumps, especially given the Territory's poor past performance in this area;
- sub-catchments with mines under maintenance are in the Darwin and Gulf regions; and
- as noted in consideration of EIA for mines, most of these operations involve extractions and processing of large volumes of ore and over-burden, and subsequent long term storage of large volumes of waste, usually on site.

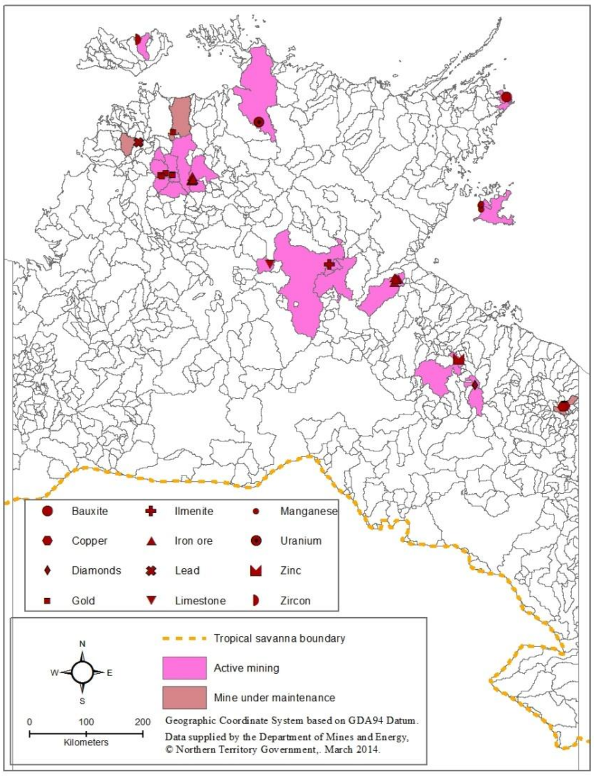


Figure 49: Sub-catchments containing active mines and mines under maintenance. Different symbols indicate dominant minerals extracted at each site. Many mines have secondary products.

Statements regarding potential and actual impacts of mining on Northern Territory environments are summarised in Table 17. This summary is derived mostly from environmental assessment documents for substantial mining developments over 3 decades since 1984 (Attachment 1), plus relevant literature, especially in regard to the biophysical impacts of legacy mines.

There are no unique concerns about the biophysical impacts of mining in the study area. Arguably the most significant features of these summaries are:

(1) Dominance of gold and base metal mining: Twelve of 41 assessments deal with gold mining. The next most numerous cover various base metals, including zinc, lead, nickel and copper (with relatively smaller amounts of silver in some of these sites). Iron ore is also a target at a number of past and present mines. The EIA record does not pick up other large mines, including bauxite at Gove and manganese on Groote Eylandt. Ore grades for precious and base metals are often quite low, for example, at or below a few gm Au per tonne at sites like Mt Todd.

(2) Mostly open cut extraction: Large low grade or inherently bulky deposits are most cheaply exploited by open cut methods. Underground mining is accordingly infrequent. The McArthur River mine moved from underground to open cut, even though this required diversion of a major river, allowing exploitation of a larger proportion of the total reserves. Dewatering of large pits may require disposal of large volumes of polluted water and cause depression of groundwater levels for considerable distances.

(3) Frequent association of deposits with acid forming rock: Many assessments demonstrate potential for acid formation in overburden or waste streams from ore processing, and others raise recurring concerns about failures of project proponents to properly characterise rock and the risk of acid metalliferous drainage. Reviews of the condition of legacy mines, including those established after these assessments show that these concerns were warranted and, arguably, under-estimated and/or under-managed (Attachment 1; NTEPA 2013a, 2014a).

(4) Often large volumes of process water: A combination of low topography, related concentrations of rainfall near the coast and high evaporation rates (considerably exceeding rainfalls over an annual cycle) means that most rivers and streams cease to flow in the prolonged dry season. Water for large scale industrial use is therefore sourced mostly from aquifers or, less frequently, from the few large rivers (e.g. as proposed for SILL80 ilmenite mine) that maintain flows longer (e.g. Daly and Roper Rivers), through contributions of ground-waters to base flows (e.g. Knapton 2009; Smerdon et al. 2012). There has been a tendency to promote the environmental challenges of extracting the Territory's unconventional gas reserves in shale as relatively benign compared with coal seam gas, because the fracking occurs at depths well below aquifers drawn on for human use or maintaining water dependent ecosystems. But fracking shale requires large amounts of water, much more than coal-seam fracking: that water has to be found in competition with other users and all of that water will be polluted in one way or another. Failure of "legacy" well casings is arguably more likely over the greater length and spatially variable conditions experienced by deeper wells.

(5) Pressures on transport infrastructure: Many mines are in isolated areas, placing particular pressures on sometimes fragile road facilities. New haul roads and new or improved port facilities have been required for a number of major developments.

(6) Most mines are relatively modest in scale, but a few have large footprints by regional and national standards: major operations include the Gemco operations on Groote Eylandt, Pacific Aluminium's (Rio Tinto) bauxite mine at Nhulunbuy, and ERA's Ranger Uranium mine in Kakadu National Park.

The particular environmental management challenges most often encountered in the Northern Territory flow directly from these features. We regard impacts on water availability and quality as the most significant issues for mining.

11.1.3.4.1 Waste streams and containment structures

Large volumes of overburden and processing waste require large structures for physically and chemically stable storage over the very long term. The north Australian tropics are subject to extreme weather events, including frequent high intensity cyclones and large rain depressions that cause localised and more widespread flooding. Such events alternate with annual droughts of 6+ months and high rates of evaporation, compromising stabilisation of waste rock dumps and effective capping or other treatment to prevent infiltration.

Tailings structures may be very large, and are usually constructed of local materials, sometimes with limited or no lining to prevent seepage. Seepage of contaminated waters through walls and through floors to surface and to ground-waters is a recurring concern (NRETA 2009;) , and may require indefinite intervention extending beyond end of mine life (e.g. ESS 2012).

Managing water balance in inadequate tailings storages create recurring problems, leading to unscheduled but more or less managed discharges. Extreme weather events may cause overtopping and uncontrolled releases of contaminated tailings waters (NTEPA 2013a), and create risks of catastrophic failure. Acid metalliferous drainage is a recurring and growing problem. Risks of cumulative effects at local and regional scales grow as new mines are added and old mines are decommissioned without fully effective rehabilitation. Environmental assessment documents examined for this study (Attachment 1) refer repeatedly to failures of mine developers to properly assess risks and design to deal with them.

11.1.3.4.2 Water use

Ironically, given the frequency of problems for managing excess water, some mines also impose significant demands on water use, especially during the extended dry season. For example, the SILL80 ilmenite mine (see Attachment 1) proposes to extract 1649 Ml/yr from the downstream Roper River (VDM Consulting 2012). Knapton (2009) identifies the large pools that retain water under low flow or cease to flow conditions, from which SILL80 will extract, as ecologically important. Many other mines require large groundwater use to dewater pits or for process water, depressing water tables over considerable distances (e.g. CCNT 1984). Potential for impacts is exacerbated by handling of water use for mining outside water allocation planning processes. Impacts of reduced water availability for other users may be increased if impacts on water quality conflict with those uses.

11.1.3.4.3 Hazardous materials

There have been a number of significant incidents in the Territory involving spillage or seepage of hazardous materials into the environment, including substances (e.g. sulphuric acid, cyanide, fuels) used in mine operations as well as mining products (e.g. concentrates). Such incidents are difficult to eliminate entirely and are more difficult in the severe environmental conditions experienced in the northern tropics. Whilst it is impracticable to specify direct offsetting treatments in anticipation of such problems, risks should be taken into account in both details of design and of offset quantum.

11.1.3.4.4 Economic failure and inadequate remediation

Projects based on processing large quantities of ore at high production and transport costs for commodities that fluctuate unpredictably in price are at substantial risk of premature closure (e.g. Mt Todd in 1999 and Brown's oxide project in 2009). Sherwin Iron has recently gone into voluntary administration[67] and Frances Creek[68] has recently raised the option of closure. When coupled with

[67] http://www.abc.net.au/news/2014-07-11/nt-iron-ore-industry-suffers/5590672

[68] http://www.abc.net.au/news/2014-07-10/frances-creek-iron-ore-mine-shutdown-northern-territory/5586306

weakly specified and inadequately funded rehabilitation obligations, risks of environmental impacts and public costs in remediation are likely to be increased. Indigenous landholders in particular are in no position to deal with such legacies. Such risks should be taken into account in design of offset regimes and particularly the way they are secured.

11.1.3.4.5 Social impacts

Impacts of mining on local society are mixed, depending on the mode of operation (e.g. fly-in, fly-out or resident workers). In most remote settings in the Northern Territory, the majority will be unable to participate directly in the economic opportunities created by a mine development. These individuals and groups may experience damage to the customary economy by denial of access to previously used sites as well as less tangible but culturally significant impacts on relationships with landscapes. Increasingly, attempts are made to deal with effects on local societies through social benefits packages funded by (larger) mine operators (O'Faircheallaigh 2008).

As noted elsewhere, the NTEPA has invited consideration of environmental offsets in tandem with social and economic impact assessment. The intent is obscure, but as argued in detail in Section 9.1.1 above, it will be important to avoid confounding environmental offsets with social "offsets" to protect the integrity of both. Nonetheless, designers of environmental offset regimes will need to be aware of and take account of social benefit arrangements.

We consider that on Indigenous-owned land, separate agreements should be reached for social impacts and offsetting of environmental impacts because both the impacts and compensating actions require distinctly different measurement and response. However, serious consideration should also be given to designing biophysical environmental offsets so that methods of delivery reinforce social benefits from the development.

11.1.3.4.6 Summary

Mining dominates the environmental assessment record in the Territory and what amount to reviews of its effectiveness in reports addressing legacy problems. Mining is also the sector with the greatest involvement with Indigenous landowners in negotiation of social benefits. But biophysical offsets do not feature strongly in relationships of the mining industry with the Territory community. Most of the larger mines were established before introduction of the federal offsets policy and the short life of the Territory offsets policy. And Indigenous people "hosting" mines in their communities have been focused on addressing pressing social issues.

There is therefore little to review about the success or otherwise of environmental offsets in mining. Direct impacts like alienation of the mine site by land clearing are relatively simply addressed, but approaches to the major risk, long term and hard to manage effects on water quality, approaches are much less clear. Despite the recurring failure of containment and water management systems in the wet-dry tropics, there appears to be an unwillingness to acknowledge chronic and cumulative effects on waterways as a reason for treating such risks as unacceptable - as a reason for rejecting proposals entirely - or accepting their inevitability as an important component of residual detriment that will require offsetting.

This history raises important questions. Indigenous people still engaged in the customary economy, or committed to related activities for cultural reasons unrelated to economic benefits, are particularly concerned at threats to the capacity of waterways and wetlands to support harvested resources and the risk that those resources will be contaminated. Loss of confidence in the health of waterways is a major detriment. Finding ways to offset such impacts is difficult, but at the very least there is a requirement for the highest quality monitoring systems in which affected people take active roles in measurement, interpretation and reporting. We will return to the question of such offsets later.

Table 17 :The most significant changes and associated environmental pressures created by mining activity in the Northern Territory, and the attributes most often affected. The list is based primarily on a summary of mining projects subject to assessment under the Northern Territory's environmental assessment law since 1984 (Attachment 1). Coverage of social impacts is patchy, but may be addressed outside the EIA process and related (e.g. mining) law. Items marked * were not specifically mentioned in assessments. Petroleum and gas exploration and extraction is covered elsewhere.

Mining activity	**Pressure**	**Nature of change**	**Impacts or risks**	**Attributes at particular risk**	**Potential scale of risk or impact**
exploration	land clearing	damage to landscape function direct loss of local biodiversity loss of resources for wildlife	wildlife habitat loss sedimentation pollution unfavourable surface water dynamics	terrestrial biodiversity aquatic biodiversity	chiefly on site and localised but for some activities (eg unconventional gas) may affect substantial areas
	disturbance of landscape features	damage to landscape function	wildlife habitat loss or degradation introduction or spread of invasive plants sedimentation pollution	terrestrial biodiversity aquatic biodiversity water-dependent ecosystems	chiefly on site and local rehabilitation may be successful
	drilling intrusion into aquifers	condition of groundwaters	unfavourable groundwater dynamics	water-dependent ecosystems	potentially important and long term effects offsite
	*fire use	condition of vegetation	wildlife habitat loss or degradation	terrestrial biodiversity	local to regional when fires spread offsite
mineral extraction	removal or substantial modification of landscape features (including land clearing)	damage to landscape function direct loss of local biodiversity loss of resources for wildlife	wildlife habitat loss unfavourable surface water dynamics unfavourable groundwater dynamics erosion and sedimentation	terrestrial biodiversity aquatic biodiversity amenity	physical change mostly onsite local but some products involve large scale change long term
		creation of waste stream	wildlife habitat loss pollution	terrestrial biodiversity aquatic biodiversity	on site and offsite long term
		damage to cultural significance	weakened connection to place	Indigenous cultural value	chiefly local

Mining activity	Pressure	Nature of change	Impacts or risks	Attributes at particular risk	Potential scale of risk or impact
		loss of amenity	aesthetic damage	general amenity	potentially severe and long term
	destabilisation of landscapes and soils	damage to landscape function loss of amenity	sedimentation pollution	aquatic biodiversity water quality	on and offsite long term
	creation unfavourable landscape features (e.g. large water-filled pits)	damage to landscape function creation of waste stream	pollution of contained and flowing waters pollution of groundwaters loss of amenity	aquatic biodiversity water quality local amenity	
	intrusion into water tables	exposure of groundwaters to pollutants	pollution of ground and surface waters	ground- and surface water quality	
	dewatering shafts or pits for operations	creation of waste stream	unfavourable groundwater and surface water dynamics persistently lower water tables reduced base flows in streams, rivers	water-dependent ecosystems aquatic biodiversity economic cultural interests of other resource users human health and amenity	on site and offsite life of mine and longer term
	overburden removal and relocation	exposure to atmosphere and water creation of waste stream gross alteration of landscape configuration unstable landscape elements	pollution affecting ground and surface water quality loss of amenity erosion and sedimentation	terrestrial biodiversity aquatic biodiversity economic or cultural interests of other resource users human health	physical impacts mostly on site pollution effects extending offsite very long term
mineral processing	use of hazardous materials	risks from accident or misuse	spillage misuse inadequate management	terrestrial biodiversity aquatic biodiversity economic or cultural interests of other resource users human health	mostly on site but potential to affect transport corridors
	water use	withdrawal of often substantial quantities of surface or	unfavourable surface water dynamics	water-dependent ecosystems	on site and usually offsite

Mining activity	Pressure	Nature of change	Impacts or risks	Attributes at particular risk	Potential scale of risk or impact
		groundwater	unfavourable groundwater dynamics reduced base flows in streams, rivers drying of springs competition with other consumptive use	water dependent wildlife economic or cultural interests of other resource users	life of mine and longer if water dependent systems are lost or severely damaged
	creation of multiple waste streams, via				
	- crushing	more easily dispersed solid waste airborne particulates (irritants, pollutants)	sedimentation pollution	terrestrial biodiversity aquatic biodiversity local air quality	mostly on site life of mine and long term waste management
	- water use	liquid waste	pollution sedimentation	aquatic biodiversity water-dependent ecosystems other consumptive water uses	on and offsite potential for long term effects with some pollutants
	- chemical use	polluted liquid and solid waste sites hazardous to wildlife (e.g. leach pads, tailings dams)	pollution of soils polluted groundwaters polluted surface waters	aquatic biodiversity terrestrial biodiversity other downstream consumptive water uses	
	- energy use	gaseous pollutants	atmospheric pollution	diffuse impacts	life of mine and beyond
	creation of hazardous materials in concentrates or other products	risk of spillage or other unmanaged dispersion elevated radiation risks	exposure of water, humans and wildlife through spills, dust, rainfall	terrestrial biodiversity aquatic biodiversity human health	mostly on site and transport corridors, loading sites life of mine
product storage	open storage of products	unmanaged dispersion	air or water borne pollutants	terrestrial biodiversity aquatic biodiversity human health	mostly on site, transport corridors, loading sites life of mine

Mining activity	Pressure	Nature of change	Impacts or risks	Attributes at particular risk	Potential scale of risk or impact
mine closure	accumulation of damaged and dysfunctional sites unrestored or weakly restored	cumulative impacts on landscape function and health	chronic pollution of surface and groundwaters loss or weakening of landscape connectivity damage to cultural values weakened sense of place ongoing management costs	aquatic biodiversity terrestrial biodiversity water quality water suitability for other uses general amenity	on and offsite very long term impacts varying with quality of rehabilitation, which is most often poor maintenance costs
	physically unstable storages	destabilisation of natural landscapes and soils damage to landscape function damage to cultural significance	loss of wildlife habitat unfavourable surface and groundwater dynamics sedimentation weakened connection to place aesthetic damage ongoing management costs	terrestrial biodiversity aquatic biodiversity water quality water for other consumptive users general amenity human health	may be very substantial
	structures at risk of leakage or overtopping	unmanaged chronic dispersion risk of catastrophic failure	pollution of surface waters contamination of soils and vegetation		
	chemically unstable storages	creation of unmanaged pollutant streams	pollution of surface and groundwaters contamination of soils	aquatic biodiversity water quality river function human health	
	inadequate design or execution of waste management systems	ongoing requirement for high cost interventions (e.g. interception and disposals of polluted groundwaters)		aquatic biodiversity water quality amenity of waterways water for other consumptive users	
transport of product	risk of spillage or other dispersion	increased risk in transport in weak containment chronic or acute accidental spillage or dispersal in loading/unloading facilities	pollution of soils air pollution surface water pollution	aquatic biodiversity (including marine) terrestrial biodiversity	mostly localised but discharge into streams may have widespread impact life of mine and longer for some pollutants

11.1.3.5 Oil and gas

Conventional oil and gas exploration and extraction has been relatively limited in terrestrial settings in the Northern Territory tropics. There are no operating wells on land in the Northern Territory study area. The region is however, traversed by a number of major gas pipelines that, because they require maintenance and inspection, provide open corridors for movement of vehicles and hence weeds and, potentially, invasive animals. They and associated facilities may also require protection from fire.

Major pipelines traversing the terrestrial study area include the Amadeus Basin to Darwin pipeline, a diversion from that pipeline to McArthur River Mine, and the Bonaparte pipeline carrying gas from a plant at Wadeye to the Amadeus-Darwin pipeline. There are major undersea pipelines carrying gas from offshore production facilities to Darwin and Wadeye and proposals for an additional major pipeline to connect to Inpex facilities at Darwin, but which will have a terrestrial footprint only close to the onshore facility.

11.1.3.6 Unconventional oil and gas

There are no published reports of environmental damage from fracking *per se* in the Northern Territory, which has been confined to exploratory wells so far. However, there have been anecdotal reports of substantial disturbance spread over the areas of seismic surveys conducted in Bulwaddy and Lancewood country in the Beetaloo Basin (Figure 56).

11.1.3.7 Weeds

Compared with many other parts of the nation, much of the Northern Territory landscape is relatively free of unmanaged populations of exotic plants, including invasive species classed as weeds. However, that situation is inexorably changing as existing populations of highly invasive species expand their range and increase in density. The history of Gamba grass is a good illustration of that process (DLRM 2010).

Gamba grass also illustrates the potentially severe impacts of such plants, including extreme modification of the dominant vegetation types through effects on fire regimes. Recent and ongoing studies suggest that woody vegetation may be entirely displaced from badly affected sites (Rossiter 2004; Rossiter-Rachor 2008). Costs of asserting control are high and growing (Setterfield et al. 2013).

Maintaining the ecological integrity of most terrestrial offset sites in the Northern Territory savannas will require attention to weed management and may contribute substantially to ongoing costs, especially as obligations of neighbours may be less stringent than required for maintenance of a high quality offset site (see DLRM 2010).

Numbers of weed species in sub-catchments were substantially correlated with numbers of feral animal species (r=0.58, P<0.0001). We make no assumptions about cause and effect from this observation, but note that effectiveness of weed control may be influenced by presence of feral animals as sources of landscape disturbance and propagules. In offset sites it will often be necessary to factor in costs of controlling both.

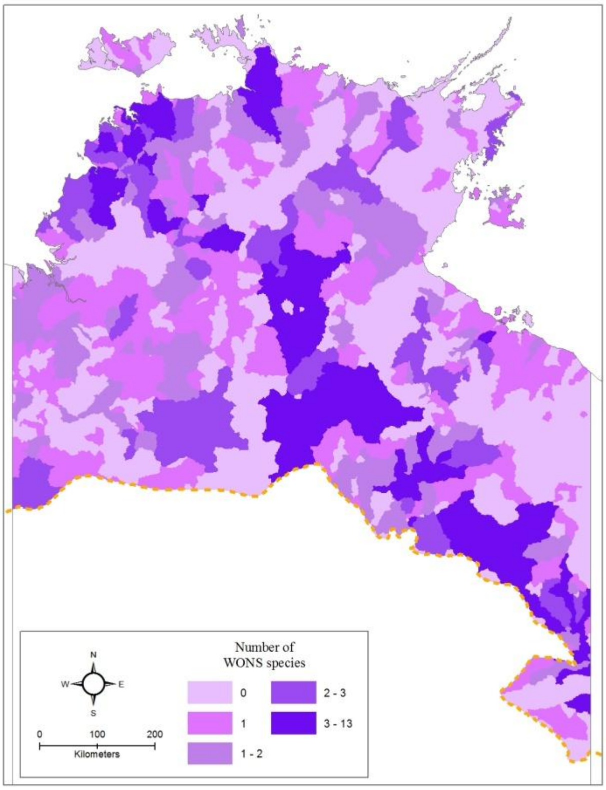


Figure 50: Number of weeds (species) of national significance in sub-catchments. As with diversity of feral animals (Figure 47 above), diversity of weeds is greatest close to Darwin and often very low in remote sites. This apparent pattern is in part, as with datasets for native plants and animals, a product of variable sampling effort, but in some cases quite intensive floristic surveys have found no or few exotic plants in remote locations.

11.1.3.8 Fire

Fire is all but ubiquitous in Australia's savannas (Russell-Smith et al. 2007). Fire exclusion may be more or less successfully practiced in some pastoral landscapes (e.g. tussock grasslands: Whitehead et al. 2014), but is also used as a management tool in less productive sites and where woody thickening is a problem (Dyer et al. 2001). In some settings the loss of Indigenous fire management practice has increased wildfire, resulting in suppression of some woody vegetation (e.g. Russell-Smith et al. 2009; 2010). In lower rainfall savannas used predominantly for pastoralism, reduced burning of any sort has seen increases in density of woody vegetation (Lewis 2002; Sharp and Whittaker 2003).

Russell-Smith et al. (2012) have assigned traits related to fire persistence to a large subset of the north Australian savanna flora, and argued that these traits can be used to predict responses to different fire regimes. Here we have used their dataset and a fire history derived from the North Australian Fire Information (NAFI) website to summarise fire regimes in terms of fire frequency and the proportion of fire (by area) occurring late in the dry season (August or later) and hence more severe and to consider relationships with fire sensitive plants.

We assigned summary variables to each sub-catchment as follows:

(1) average fire frequency (area weighted) for sub-catchment
(2) roughness of terrain using an index calculated as described by Russell-Smith et al (2012)
(3) mean annual rainfall as a driver of fuel production
(4) mean rainfall in the driest quarter estimated as described in Whitehead et al. (2014).

We also generated a number of variables summarising the number of fire sensitive species in different classes and sought to relate them to fire histories.

11.1.3.8.1 Unfavourable fire regimes

Arguably, fire regimes are unfavourable over much of the Australian savanna, including most of the Northern Territory (Russell-Smith et al. 2007). To identify sites with unusually adverse regimes, we related fire frequency observed over the period 2001 to 2013 inclusive (confined to sites where there was any fire recorded :fire was absent in many very small coastal sub-catchments) to mean annual rainfall, topographic roughness and rainfall in the driest quarter, all of which are recognised as important biophysical influences on fire behaviour. A simple linear model (with all variables logged) explained 28.8% of variance ($F_{3,1096}$=115.3, P<0.0001), with average fire frequency in sub-catchments increasing with roughness and annual rainfall, and declining with rainfall in the driest quarter, congruent with the savanna-wide analyses of Whitehead et al. (2014).

We took the top 10% of (positive) residuals from this regression as indicating anomalously high fire frequencies. Results are shown in Figure 51 below.

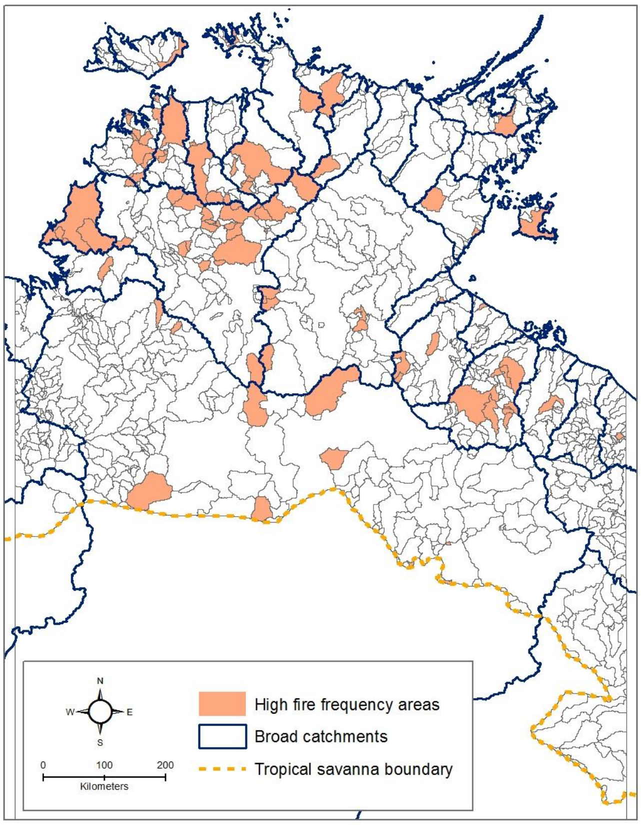


Figure 51: Top decile of residuals from a regression equation relating sub-catchment fire frequency to physical variables (see text). These sub-catchments are considered to experience very anomalously high fire frequencies which warrant investigation.

Sites with especially high fire frequencies, taking account of physical context, are widely spread through the study area, with some concentration in the Darwin and Daly River regions (including the Moyle River catchment)and in the eastern Roper River catchment and Gulf of Carpentaria. We treat the natural and cultural heritage values such sites as at risk from too frequent fire amenable to intervention and hence as sites in which offsets addressing a range of biodiversity, landscape condition and carbon offsets can be offered.

11.1.3.8.2 *Fire sensitive plants*

We used the proportion of obligate seeder species in the flora recorded in sub-catchments as a surrogate for fire sensitive plants. After accounting for annual rainfall and rainfall in the driest quarter, we found that the proportion of obligate seeders was lower in sites with higher fire frequencies measured over the 14 years to 2013 (t=-5.85, P<<0.0001). It is unclear from such crude analyses whether this pattern is a consequence of very long term responses to prevailing conditions (see Russell-Smith et al. 2012) or substantially influenced by unfavourable contemporary conditions. At the very least they indicate that such species persist in substantial numbers in settings where contemporary fire regimes appear *prima facie* to be unfavourable and that more detailed examination of trends is warranted.

Land-based offsets based on improved fire management may need to incorporate specific measures of the status of such species in demonstration of performance.

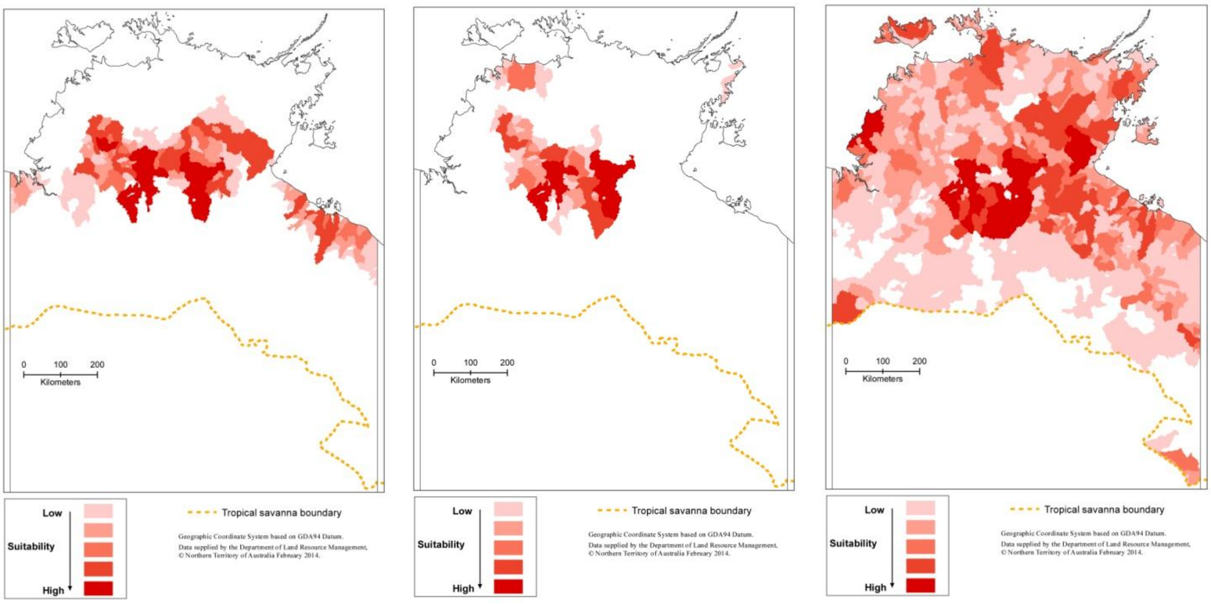
11.1.3.9 Land use and species richness

In addition to examining relationships among apparent species richness and dominant "natural" biophysical features of sub-catchments (Section 11.1.1.2), we had intended to relate apparent species richness to dominant land use in multivariate analyses. Given the severe constraints imposed by patchiness of records and severe under-sampling of many (most) sub-catchments, we do not report that analysis.

11.2 Directions for land use change

11.2.1 Agriculture - prospects of new agricultural use

Prospectivity scores for a number of agricultural activities are shown in Figure 52(a) to (c) and summarised across all activities described by Pascoe-Bell et al. (2011) in Figure 53 below.



(a) Broad scale rain-fed field crops

(b) Broad scale irrigated field and row crops

(c) Spatially constrained (patchy) irrigated field and row crops

Figure 52: Maps of relative prospectivity for agriculture of sub-catchments. It should be noted that these maps and the analysis on which they are based offer no judgments about the plausibility of successful agricultural development but rank relative suitability based on presence of suitable soils (most often patchily distributed) and nominal availability of water.

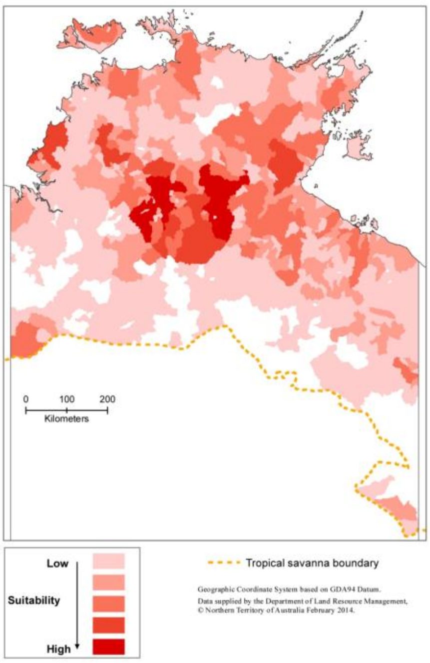


Figure 53: Maximum agricultural prospectivity index for sub-catchments in the Northern Territory savannas. Mapping as "density" (index divided by total sub-catchment area) does not materially alter these patterns, which suggest particular foci for development in the Daly and Roper River regions as well as more weakly in the Keep River region. It should be noted that use of catchments as a planning unit produces mapping outputs that could be taken to imply that coastal floodplains are treated in NTG assessments as prospective for agriculture. This is not the case, although some areas adjacent to large floodplains are viewed as having agricultural potential.

It is of interest here that the NTG work on prospective regions ranks the Keep River region relatively low for irrigated agriculture, presumably based in part on the limited availability of irrigation water on the Territory side of the border. Nonetheless the Territory government is strongly committed to developing this region, presumably because water sourced from the Ord River development will be used, and access to product processing and handling facilitates may improve financial viability.

11.2.2 Mining - options for new mining activity

Sub-catchments within which NT DME has identified highly prospective opportunities are illustrated in Figure 54 below. There is clearly a concentration of sub-catchments with significant deposits in the (1) Darwin to Katherine area (the Daly, Finniss, Adelaide, and Mary River catchments in particularl) (2) in the Gulf of Carpentaria (McArthur and Limmen River catchments most affected) and (3) in the Roper River catchment.

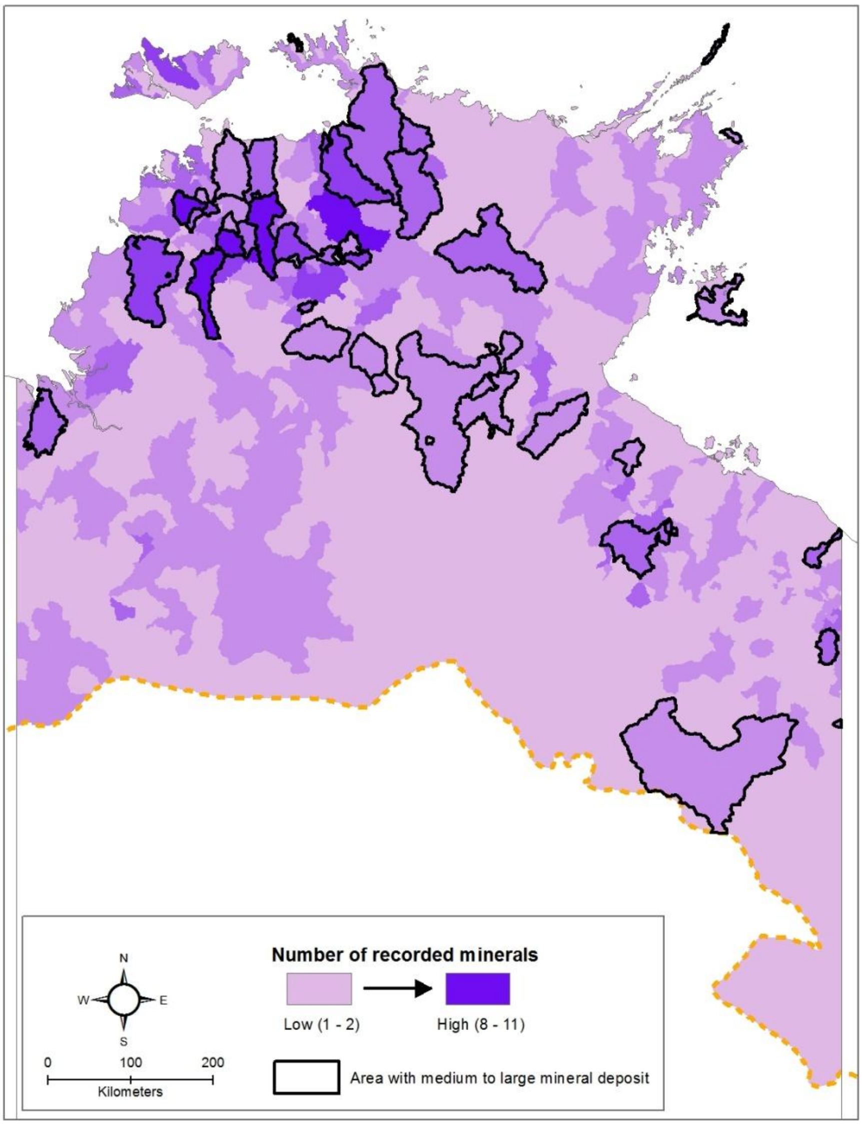


Figure 54: Map of sub-catchments within the Northern Territory that contain ore bodies or other geological strata that the NT DME regards as highly prospective.

Sub-catchments in which new mines are seriously proposed (have reached the environmental assessment phase of project development) are considered in the case study phase. In most cases, these areas of prospectivity already have mines proposed (in the environmental assessment phase) or active mines present (Figure 49). However, there are a few areas where mining has yet to occur and which, based on these data, might be vulnerable to related change in the future (Figure 55).

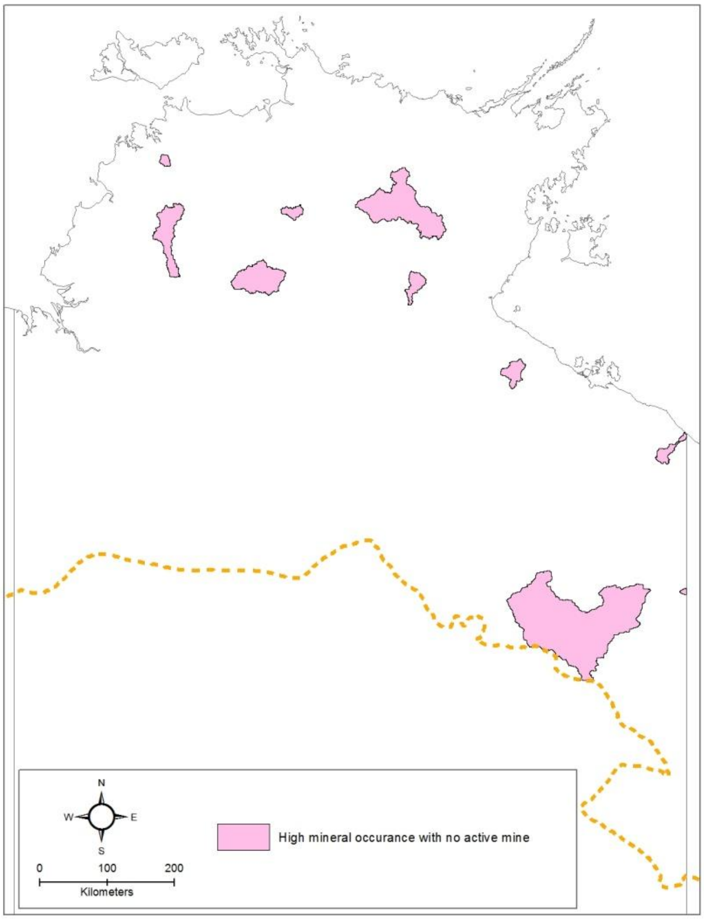


Figure 55: Map of sub-catchments containing significant ore bodies as defined by NT Department of Mines and Energy and in which no active mine is present (in July 2014). These are not incorporated in ranking of pressures in the whole of study area scan but considered in the case study phase.

Because the options identified are relatively sparse and sometimes involve relatively minor deposits, we have not incorporated these observations in broad scale assessments of the prospects of land use change. They will of course be informative when case study sites are identified.

11.2.3 *Petroleum and gas - projected activity*

11.2.3.1 Conventional oil and gas

We assume that new on-shore developments in conventional oil and gas will arise in tandem with increased investment in unconventional oil and gas and so consider likely activities in conjunction with development of unconventional oil and gas.

11.2.3.2 Unconventional oil and gas

Areas of the NT considered prospective for shale oil and gas in relation to the sub-catchment unit of analysis are indicated in Figure 56.

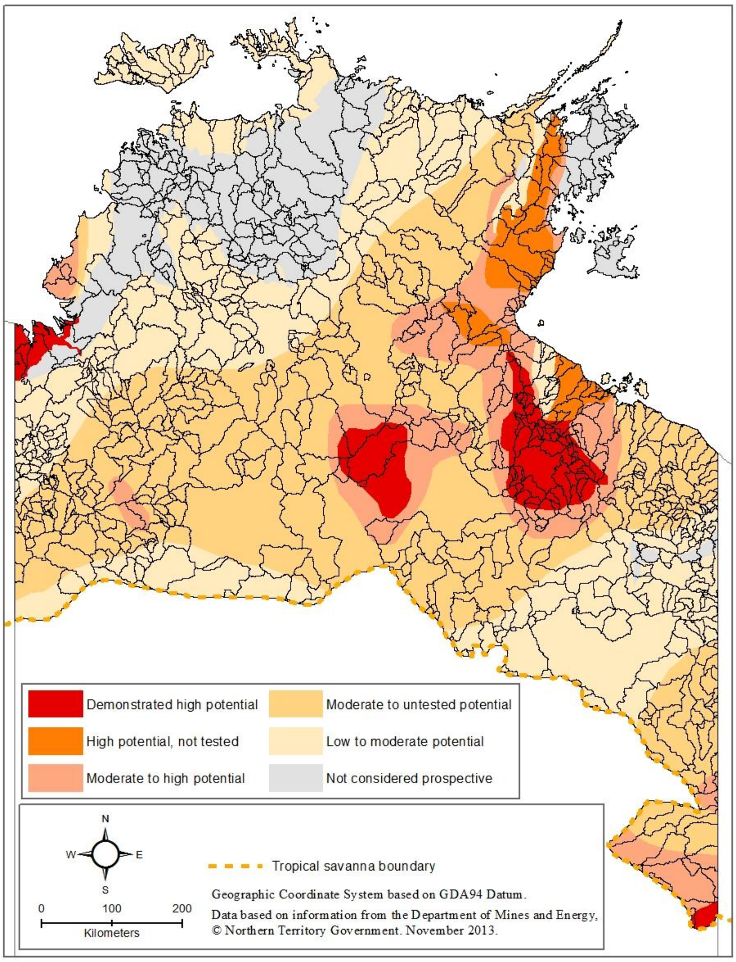


Figure 56: Areas of the NT regarded by the NT DME as prospective for unconventional (shale) oil and gas. Areas of tested high potential and moderate to high but untested potential are focused in the Roper River Catchment, the Gulf of Carpentaria, the Bonaparte Gulf region (Keep River) and Sturt Plateau region. The map was prepared by digitising line work on maps presented in public forums by DME personnel. The agency refused to make available GIS coverages of these data.

Areas regarded as demonstrating high potential totalled 3.0 million ha, untested high potential 2.1 million ha, medium to high 6.5 million ha, untested medium 24.6 million ha, and low prospectivity 19.6 million ha. Only 8.8 million ha were considered to offer no opportunity. Accordingly, most catchments (75.3%) included areas considered at least a little prospective. This apparent ubiquity of opportunity will probably not withstand practical scrutiny. For example, in considering these assignments of potential further, we discount for broken surface topography which may add to development costs.

Figure 57 below adds details of the areas covered by exploration leases in which we are aware that recent activity has been reported. The south-western Gulf of Carpentaria and Roper River catchment, areas around the Sturt Plateau and the Joseph Bonaparte Gulf (Keep River Region) appear most likely to see the earliest related developments if resources are proved and appear extractable at reasonable cost. The extent of the Territory's gas and condensate pipeline network (see Section 11.1.3.5) is likely to increase markedly if unconventional gas production is found to be economically viable.

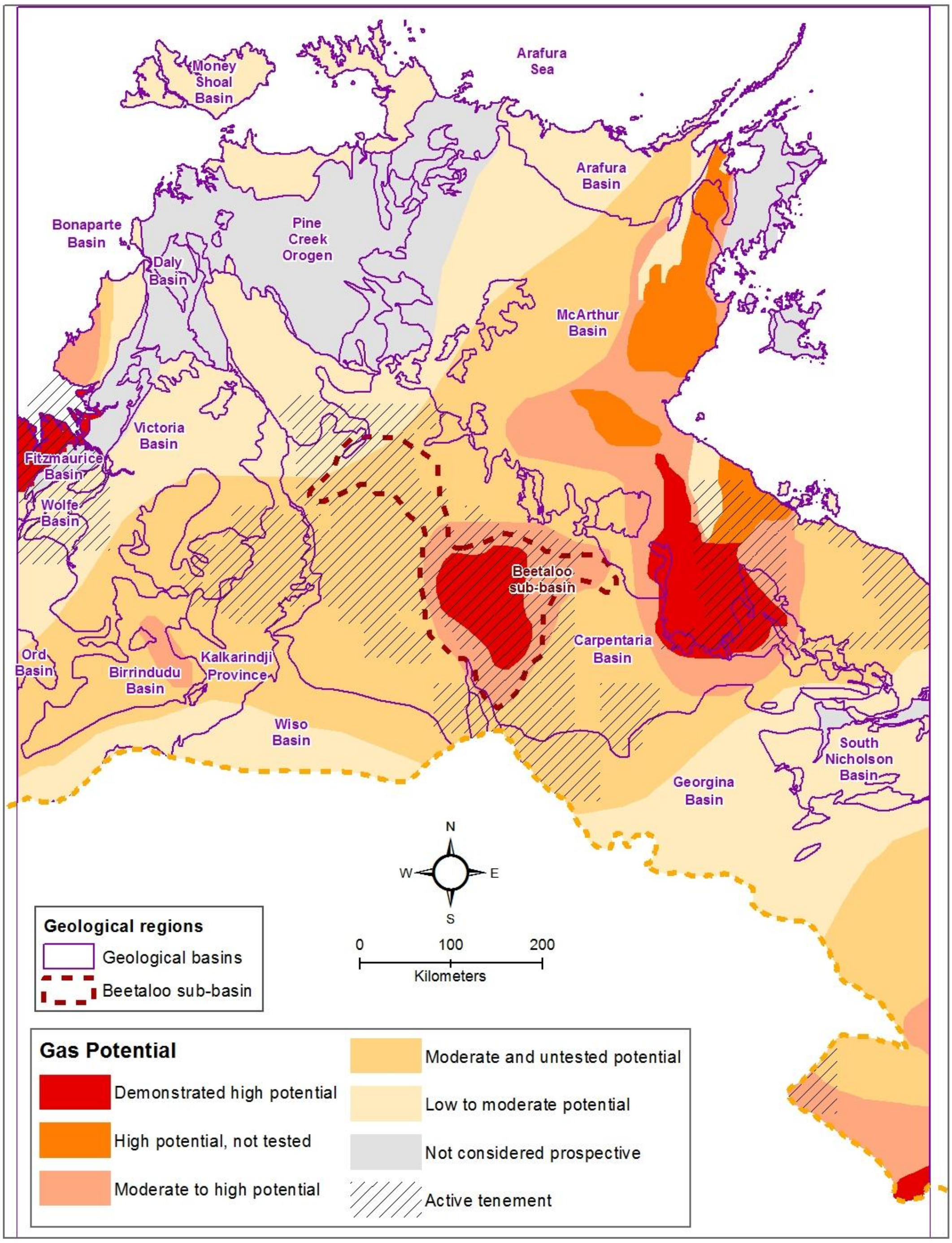


Figure 57: Location of exploration leases issued under petroleum law on which operators and DME report recent exploration and/or flow testing activity for extraction of tight oil and gas from shale.

11.3 New or increased impacts and pressures on values

Predicting land use change and impacts are an uncertain undertakings, especially when prior experience of emerging options in the landscapes subject to change is limited. Here we do not attempt to make quantitative or comprehensive predictions, but rather indicate where problems in managing impacts on the particular values of a region appear most likely from projected change, soon after the processes of change begin. We also offer some comments on the implications of new impacts and their implications for design of offsets.

11.3.1 Agriculture

We have already outlined the general effects of agricultural development on terrestrial and aquatic systems (see Sections 6.4 and 11.1.3.3 above). In the Territory context the proportion of the landscape suitable for cropping and especially irrigated agriculture is considered to be relatively small, with all analyses emphasising the patchiness of favourable soils in conjunction with access to irrigation water.

All clearing of native vegetation triggers change in nutrient loads in rivers and streams, but impacts are particularly marked above 40% (Figure 12 in Harris 2001). If development is confined to suitable situations and regulators act responsibly (e.g. in line with caps on clearing such as those presently adopted for the Daly River: Adams and Pressey 2013), then risks of exceeding the land clearing thresholds - when impacts on terrestrial and aquatic ecology greatly increase - could be minimised by design, especially if they are offset by positive actions in other parts of catchments.

In these circumstances, it would appear that impacts depending on the proportion of a catchment cleared, like sedimentation and nutrient leakage, while of great long term significance, may be of less immediate concern than some forms of enabling change: like construction of large in-stream impoundments or excessive allocation and use of groundwater where the extraction thresholds for ecologically relevant change can be readily crossed (Erskine et al. 2003).

On these grounds, catchments at special risk from agricultural development can be identified as:

(1) Adelaide River: where construction of an in-stream impoundment has been proposed in the past and off-stream wet season water harvests are in planning[69]

(2) Daly River: one of two perennial rivers where dry season flows are maintained by groundwater inflows and ecologically important features (exceptionally low midstream turbidity) are maintained by particular groundwater sources.

(3) Roper River: the second perennial river, which is also highly dependent on groundwater for maintaining dry season flows and characteristic (low turbidity) water quality.

It is desirable that approaches to offsets that deal explicitly with impacts of water extraction and impoundment be developed, but these raise difficult operational questions in the Territory's policy and legal regime (Sections 8.1.3.7 and 8.2.1.4.3).

11.3.2 Mining impacts

We have devoted considerable space to cataloguing the impacts of mining, in part because the environmental assessment record which was scanned to identify issues is dominated by mining

[69] From the Draft Darwin Regional Land Use Plan 2014. "Options being considered in the medium term include a new in-stream dam on the upper Adelaide river, an off-stream storage to be filled from flood flows in the Adelaide river, augmentation of Manton Dam's storage and desalination". The strategy retains previously identified options for water storage, including the Marrakai and Mount Bennett dams, for further assessment in the longer term.

proposals in the Territory. And the performance of many mines in meeting environmental standards has been bad enough often enough to generate considerable reporting.

Impacts of mining are likely to continue to grow without addition of new mines, because there are a substantial number of operating and legacy mines generating pollutants that continue to enter waterways. Reliance on wet season flushing to remove such pollutants and dilute them to the extent that they are of no concern is probably inadequate. Many important systems (e.g. floodplain back-swamps) act as sediment and nutrient traps, and may accumulate pollutants in the same way.

Addition of new mines is likely to be incremental, with activity tracking commodity prices. Most of those developments are likely to involve increased pollution risks, especially in acid mine drainage. Sub-catchments in the Darwin/Daly region, East Alligator and Liverpool River catchment, parts of the Roper River catchment, and in the Gulf of Carpentaria appear most likely to experience change, although timeframes are difficult to predict. At present mines are closing with the fall in iron ore prices. Cumulative impacts are possible in those areas where mining is already concentrated and legacy mines are already present, like the Finniss, Adelaide and Daly River catchments.

Aside from direct on site impacts for which offset design is relatively straightforward, the most directly applicable offsets for more serious impacts on waterways present considerable difficulties. Logically, these may be best addressed by reservation of equivalent streams under conservation laws and permanent or very long term reservation from mining. As noted earlier, such levels of security in many settings would require strong intervention from government and may be difficult to achieve.

However, the particular rights of Indigenous landholders to manage access to their land may offer some unique opportunities. For example, a miner seeking to damage a waterway supporting threatened species may seek to provide offsets by rehabilitating and protecting a stream on land they control. However, they could not guarantee that rights to explore and mine would not be issued over that offset site in even the short term future. Indigenous landholders, however, offer greater certainty, perhaps through binding contracts with penalties for premature termination of the agreement. The option of traditional owners to protect sites long term from mining is a controversial and should not be exercised lightly given the economic status of many groups. But a program for protecting waterways of great significance to their Indigenous custodians and affiliated clans, through financial support coming at least in part from offset arrangements, could make a major contribution to conservation in northern Australia.

11.3.3 Petroleum and gas impacts

11.3.3.1 Conventional oil and gas

Impacts of new conventional oil and gas development are also likely to be incremental: in addition of a small number of additional fields and expansion of the pipeline network. We have assumed that those increments will be small compared with effects of unconventional oil and gas exploration, with their potential to generate relatively dense and extensive networks of wells and connecting infrastructure. Development of new gas and oil fields extractable without fracking may be accelerated by the exploration activity around unconventional oil and gas.

11.3.3.2 Unconventional oil and gas

Levels of development of this industry are difficult to predict, but substantial investments are already being made in exploration, by an array of companies. This confidence and positive exploration reports suggest reasonable prospects of such development in a number of regions in the study site.

The potential impacts of this activity will depend in part on the quality of regulation, which is presently the subject of an independent inquiry (Attachment 4). Given that most potential tight gas/oil resources are well below the level of groundwater resources likely to be used domestically or for agriculture, contamination risks by movement of pollutants within and around wells are thought to be lower than with the Australian coal seam gas industry, provided well design and construction standards are high.

There may, however, still be impacts on water availability and quality. Total water demands are difficult to predict. However, any increase in demand may be important where dynamics of water systems already oscillate around thresholds for ecologically significant effects like dry season cessation of flows in major rivers (e.g. Erskine et al. 2003, Knapton 2009). Substantial increases in frequency of no flow conditions are a real possibility in rivers like the Daly and Roper, with effects that extend beyond the ecological to include loss of cultural values (see Section 12.1.6.3 below). Competition with agriculture is possible (e.g. in the zones of overlap between high agricultural potential and prospectivity for shale gas (Figure 63 below). There may be difficulties with disposal or storage of polluted fracking water, particularly in recharge zones for near surface aquifers.

The most obvious and immediate impacts are by intrusion of heavy equipment and construction of wells and infrastructure including pipelines linking quite dense networks. It is these impacts that appear to be most amenable to optimised development and offset designs, using the principles and practices of Development by Design.

11.4 Choice of case study area

Here we apply elements of the process outlined at Figure 21 above. As noted early in this section, geographic patterns were relatively weak, but there were some suggestions of clumping that may support identification of sites in which application of DbD processes might be favoured. In an effort to better discern favourable sites, we chose to re-examine the highest 10% (top decile) of values.

11.4.1 Natural Heritage Assets

Spatial patterns in the distribution of fauna and flora including notable species were generally weak in the sense that there were few discrete nodes of consistently extremely high richness or derived index values, or larger zones made up of contiguous catchments of above average values (Figure 24**Error! Reference source not found.**, Figure 26, Figure 29 to Figure 34). Nonetheless some clumping of values was identified as follows:

11.4.1.1 coastal sites

Most NT SoCS (Figure 36) are coastal. This is attributable in part to an emphasis in their derivation on migratory and wetland species and inclusion of marine and migratory species as matters of national environmental significance. Those influences are discernable in plots of fauna records. Migratory species use habitats in which they are conspicuous and so more likely to be observed and systematically surveyed (see Chatto 2003). Some threatened species like marine turtles are similarly conspicuous when they visit shallow waters and shores to feed and nest (Chatto 2007). Accordingly, such species appear regularly in fauna databases despite their formal status as threatened or worse. Aquatic values of numerous river systems along the northern coast also add to recorded values (e.g. Kennard's (2011) vital habitat index in Figure 35).

11.4.1.2 concentrations of threatened and endemic species in the Kakadu/West Arnhem Land region

The fauna databases available to us do not permit direct analysis of relative sampling effort, but it is highly likely that apparent foci (e.g. endangered species in Figure 29) are attributable to a heavy concentration of relevant studies in these regions as well as the intrinsic values of the Arnhem Land Plateau. CSIRO Darwin focused its efforts in Kakadu for decades (Braithwaite and Werner 1987; Anderson et al. 2003), disputes over mining in the Conservation Zone attracted much additional effort (Braithwaite and Woinarski 1990), and this early work has been followed up with repeat surveys in many of the same locations (e.g. Woinarski et al. 2001). The distinctive flora of the Arnhem Land Plateau has been much studied in regard to its sensitivity to fire (Russell-Smith et al. 1998). Intrinsic value is obviously very high. Much of the region is already protected in formally declared reserves (Kakadu, Nitmiluk and Garig) and receives other forms of support (Djelk and Warddeken IPAs).

11.4.1.3 concentration of notable fauna in and around the Darwin region

Again, in addition to intrinsic value, intensity of sampling and proximity to coast are likely to influence this pattern.

11.4.1.4 a less coherent focus in the Gulf of Carpentaria, especially in the McArthur and Robinson River catchments

Associated largely with coastal and island (Pellews) values and, considering its relative isolation, a substantial sampling effort.

11.4.1.5 portions of the large Daly River catchment

Various sub-catchments support a mix of values, including all classes of threatened fauna, endemics and vulnerable flora. Parts of the Daly River catchment with existing agricultural development have been reasonably well-sampled compared with many other regions. Aquatic values are well-recognised, including a high diversity of freshwater turtles and large populations of the pig-nosed turtle *Carettochelys insculpta*.

11.4.1.6 the northernmost portion of the Wiso catchment

This appears to arise from the wetland and migratory fauna values of Lake Woods and the terrestrial fauna values of the Sturt Plateau.

11.4.1.7 recurring high ranks in the Keep and Victoria River catchments

Based on critically endangered and vulnerable fauna and vulnerable flora. The region includes an NT SoCS.

We acknowledge that these observations are substantially a product of uneven sampling. But even patchy records from a subset of the region are valuable because they demonstrate that values recognised in law are found in those places. Rather than a comparison based on reliable quantitative ranking of well-understood values, the comparison is perhaps more correctly presented as known value with unknown or poorly known value.

11.4.2 Cultural Heritage assets

Spatial patterns of sub-catchments supporting recognised Indigenous cultural values were if anything more diffuse than natural heritage values. We interpret the wide distribution of significant sites as evidence of ongoing connections with land over most of the Top End, including close to Darwin, rather than as indicating special value of particular regions. The issue here is therefore not so much a search for the unique but rather identification of locations that present particular challenges to site protection under broad-scale development because of the relatively high densities of sites (Table 15).

In these terms, sub-catchments with large numbers of registered sacred sites (top 10%) were concentrated in the Timber Creek to Keep River regions (Keep and Victoria River catchments: KEE iand VIC in Figure 58 below). The Daly (DAL) and Roper (ROP) catchments and areas in the Gulf also had substantial numbers of sites. There was a weak trend for the number of sites to increase with the area of the sub-catchment (Figure 37), but most variance (79%) remains unexplained. It is difficult to determine how much these patterns are influenced by idiosyncratic variation in the activity of anthropologists. However, the necessary levels of engagement of traditional owners in the nomination and registration process demonstrate unequivocal local interest in seeing such sites protected. Very high density of registered sites (top 10% in number of sites per unit area) were seen in the Gulf of Carpentaria in very small coastal catchments. In non-coastal catchments, higher than average densities were seen in each of the regions noted as having high absolute numbers of sites.

There were very many more recorded sites (with details held by the AAPA but not yet registered) and archaeological sites (Table 15). Spatial patterns did not vary markedly from those seen with registered sites, but collectively (Figure 41) they record that most of the study area (97.6% of catchments covering 90.6% of the area) shows physical and cultural evidence of past and mostly ongoing connection.

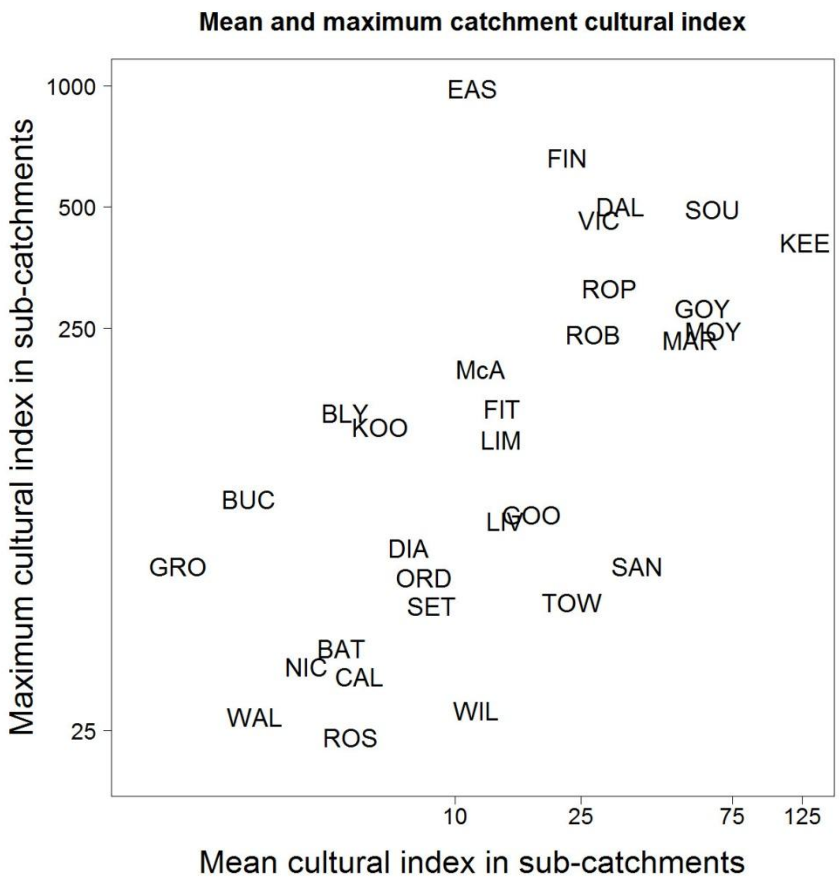


Figure 58: Position of different regions (major catchments) in space defined by the mean and maximum of cultural index for subcatchments. As with apparent species richness, the catchments in the Darwin to Arnhem Land coastal arc are high ranking (FIN=Darwin Finniss River, SOU=South Alligator, , EAS=East Alligator, MAR=Mary River). The label for the Adelaide River has been suppressed because it overlapped closely with the Roper River (ROP).

11.4.2.1 Fauna of customary significance

We have presented a haphazard selection of species that have been repeatedly identified as important components of the Indigenous customary economy (Figure 42 to Figure 45). We acknowledge that these are of no particularly significance for selecting case study sites, but rather serve to illustrate that wherever development is proposed, effects on the customary economy and cultural values can be anticipated and should be considered in offset selection and design, wherever development takes place.

11.4.2.2 Combining natural and cultural heritage assets

We have made a crude effort to combine natural and cultural values by simply adding the index for natural (biodiversity) values (Table 6) to that for Indigenous cultural values (Table 8). We normalised each index by dividing by their individual maxima before adding them, effectively weighting biodiversity and cultural values equally. We did not include the Kennard (2011) datasets for aquatic values nor the ranking according to the proportion of the sub-catchment falling in a SoCS because the same or similar data were used in generating them.

The result did not reveal any new patterns but reinforced those observed in the separate biodiversity and cultural plots. Namely:

- a striking concentration of high value units (top 10% of non-zero values) in the Finniss River-Darwin-Kakadu coastal and subcoastal strip, with the only site with maximum scores in both natural and cultural values in Kakadu
- a less striking (lower values but many of them in the top 10%) but still strong concentration in the Daly River catchment
- a more diffuse set of high value (top 10%) sites in the adjoining Roper River catchment
- an arc of interest from the WA border in the Keep and Ord River catchments through the Timber Creek region into the Victoria River catchment
- a significant clumping of values in the McArthur and Robinson River catchments in the Gulf of Carpentaria.

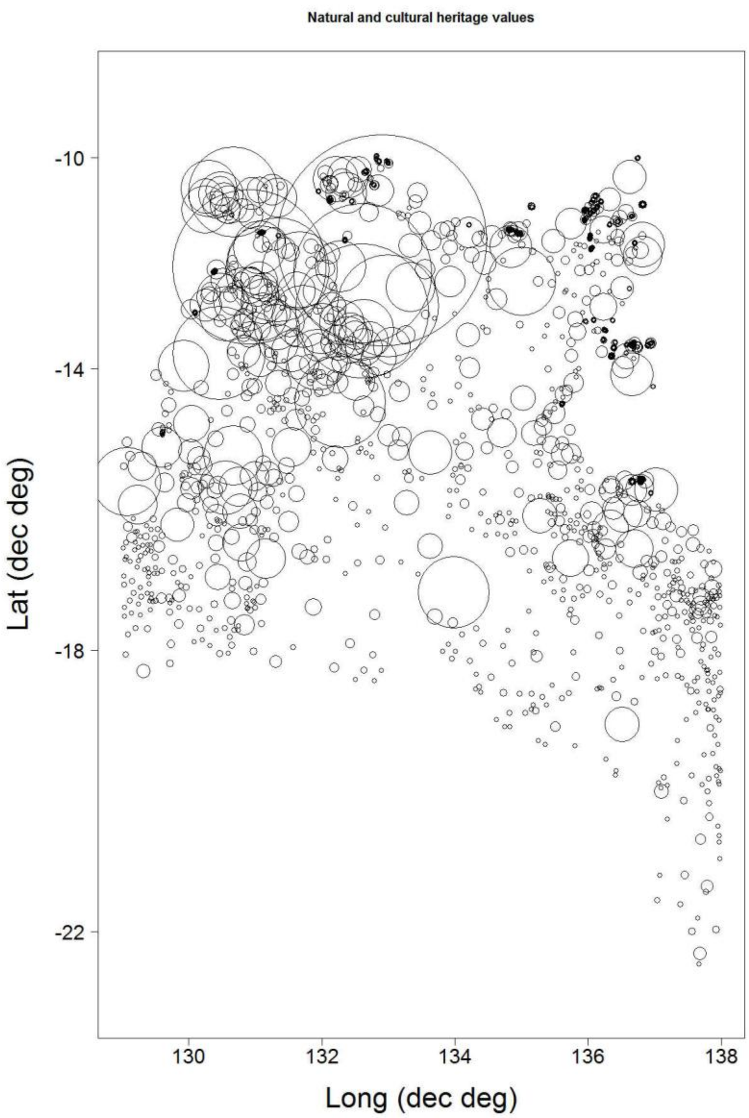


Figure 59: Combined values of indices for biodiversity and cultural values in sub-catchments. Values for both indices were normalised to their individual maxima, effectively weighting biodiversity and cultural values equally. Diameter of circles is proportional to the summed index value.

We regard all of these presently loosely defined regions as potential foci for DbD work on the grounds that there are both important values requiring protection and opportunities for supporting high quality offsets in demonstrably significant sites.

Reinforcing this view, there is substantial overlap with the NT SoCS in each of these regions (Figure 36 above). For example, 77 of 96 (80.2%) of sub-catchments with the top decile of biocultural index scores show some overlap with SoCS. Similarly, 20 of 76 (26.3%) of top decile Kennard diversity scores (aquatic values) align with the top decile of our biocultural index, compared with only 5.4% of the whole sample. The top decile of the Kennard (2011) diversity index shows clumping in each of these regions, with a somewhat stronger representation in the Roper River than the biocultural index.

High value aquatic values (top decile of index scores) also showed broadly similar patterns of clumping with a generally stronger coastal bias, especially the in Naturalness and Vital habitat indices. But these also showed a cluster of sub-catchments in the northern Keep/ northern Victoria River. The highest levels of the Diversity index were clumped in the Darwin Daly regions and eastern Gulf of Carpentaria, with lesser groups of more or less contiguous sites in the Roper catchment and Timber Creek to Keep River regions. High levels of the Representativeness index were strongly focused in the Darwin/Daly and Gulf of Carpentaria. High values of the Evolutionary history index were also strong in the Darwin and Daly River regions, with more diffuse clumps of sites in the Gulf of Carpentaria. The distinctiveness index was strongest in the Darwin Daly regions, with, additionally, clumping of sites along the eastern Gulf of Carpentaria. In addition to these recurring foci, similar to those found in broader biodiversity indices, these indices showed some clumping in north-east Arnhem Land where indices including terrestrial phenomena were less conspicuous.

11.4.2.3 summary of heritage values

We interpret the data we have presented on biodiversity values, cultural values and associated indices as indicating that even within the Territory's mostly structurally intact landscape, it is possible to identify areas that offer better than average prospects for protecting a mix of values matched to the interests of both local people and orthodox conservation interests. This is not to argue that some parts of the landscape are of inherently low value and warrant less consideration, but rather that returns on conservation investments, if well targeted and competently delivered in collaboration with a supportive local community, which is probably facilitated when cultural values are taken seriously and also actively protected, can be more readily demonstrated in some sites than in others.

11.4.3 Drivers of Change

11.4.3.1 Agriculture (including intensified pastoralism)

In Figure 52 and Figure 53 we have shown sub-catchments considered to favour various forms of agriculture. We identified the Daly and Roper catchments, with lesser foci in the Keep River area. To align treatment here with heritage values, we also looked at the top decile of index values for agricultural prospectivity, calculated as the total area of the highest ranked use (see Table 10) within each sub-catchment. The location of these "top" sites is shown in Figure 60.

This treatment does not alter the general conclusions about favoured areas but reinforces the status of the Daly and Roper River catchments, and offers some more detail in showing the Moyle River catchment as relatively highly ranked as is a cluster of sub-catchments in the Nicholson River catchment.

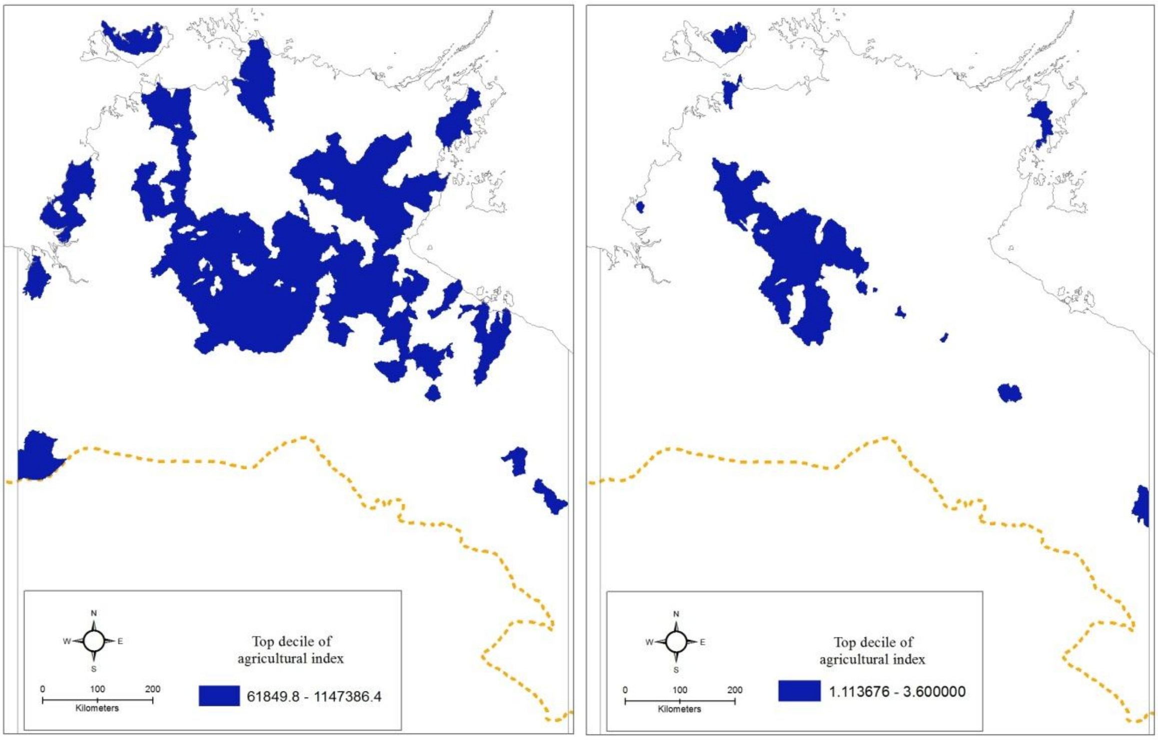


Figure 60: Relative values of indices of agricultural prospectivity for the top decile (top 10%): (a) based on total area of the highest ranked use within the catchment and (b) the density of highest ranked use.

11.4.3.2 Unconventional oil and gas

We present areas of prospectivity for unconventional oil and gas in Figure 56 and Figure 57. Here we examine an index which integrates those maps of variation in prospectivity with evidence of recent activity while discounting for operational constraints associated with elevated and broken terrain. As with agricultural prospectivity, we identify the top decile of rankings (Figure 62).

There are clusters of higher value sites in the Moyle, Fitzmaurice and Keep River catchments; much larger aggregations of favourable catchments in the Gulf of Carpentaria coast (both north and south east of the Roper River mainstream and so including the Roper River catchment; and a particular concentration in the Towns, Limmen, Rosie and McArthur River catchments.

The largest all but contiguous area of favourable sites runs from the Gulf of Carpentaria north through the Roper River catchment to north-east Arnhem Land. Another large area is in the Sturt Plateau area in the north of the Wiso catchment (Figure 61). There is another cluster of sub-catchments further south in the Georgina catchment and a smaller but nonetheless substantial area in the Keep River region.

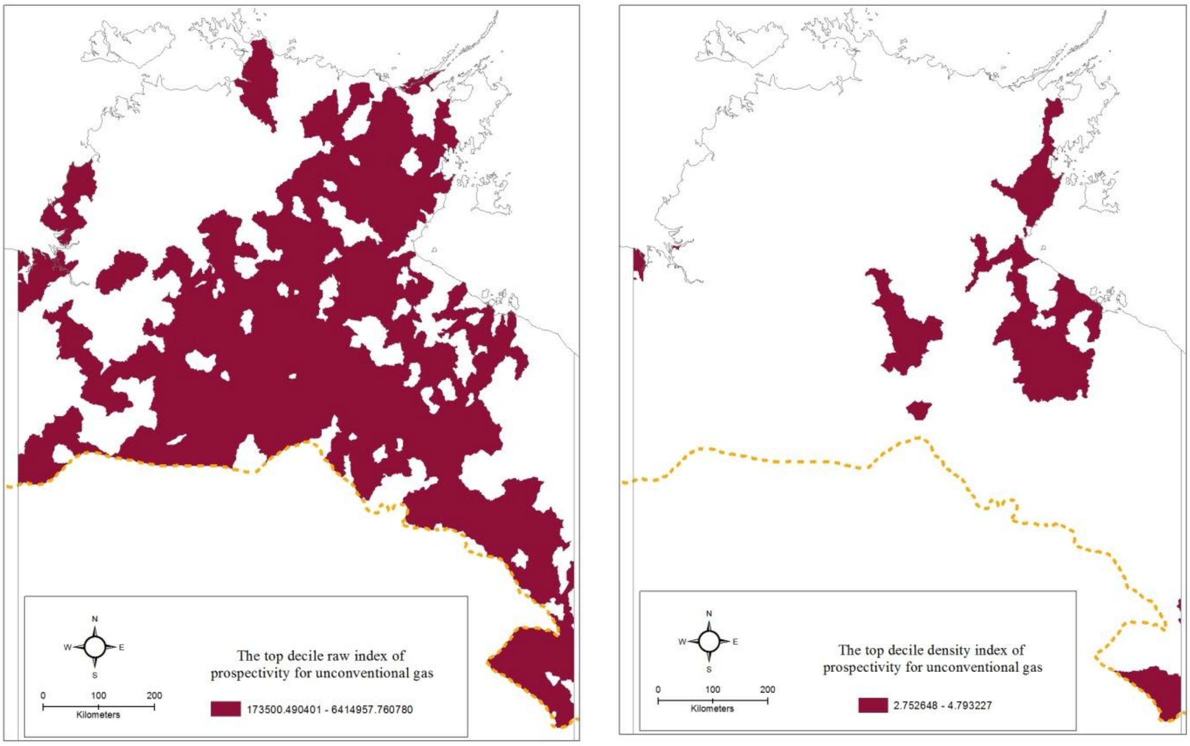


Figure 61: The top decile of sub-catchments ranked on an index of prospectivity for unconventional gas. Raw index on the left, density (index divided by sub-catchment area) on the right.

11.4.3.3 Combining broad scale drivers of change

Agricultural development and unconventional gas exploitation involving fracking both depend on large scale presence in the landscape. In the case of agriculture large to very large (broad scale) clearing of native vegetation replaced by crops, and in the case of unconventional gas individually relatively small but potentially numerous drill pads and connecting infrastructure ramifying through the landscape. We have therefore chosen to consider together the top decile of agricultural and unconventional gas drivers of change. Finer scale or less direct influences like locations of individual mines will be considered at the case study scale.

In Figure 62 we show the catchments in the top 10% of bio-cultural rankings that also show top decile rankings for either of agriculture and shale gas or both together. The plots indicate at least somewhat clustered sites for direct conflicts in the Tiwi Islands, Darwin-Finniss, Moyle, Daly, and Roper River catchments, and several Gulf of Carpentaria catchments, including the Limmen, McArthur and Robinson Rivers. Arguably the plots based on raw indices provide a better guide to development probabilities because they incorporate measures of sheer scale as well as densities of favoured resources. It should be noted that these broad scale analyses take no account of likely variations in availability of water resources or proximity to relevant infrastructure Their implcations will be considered in the case study.

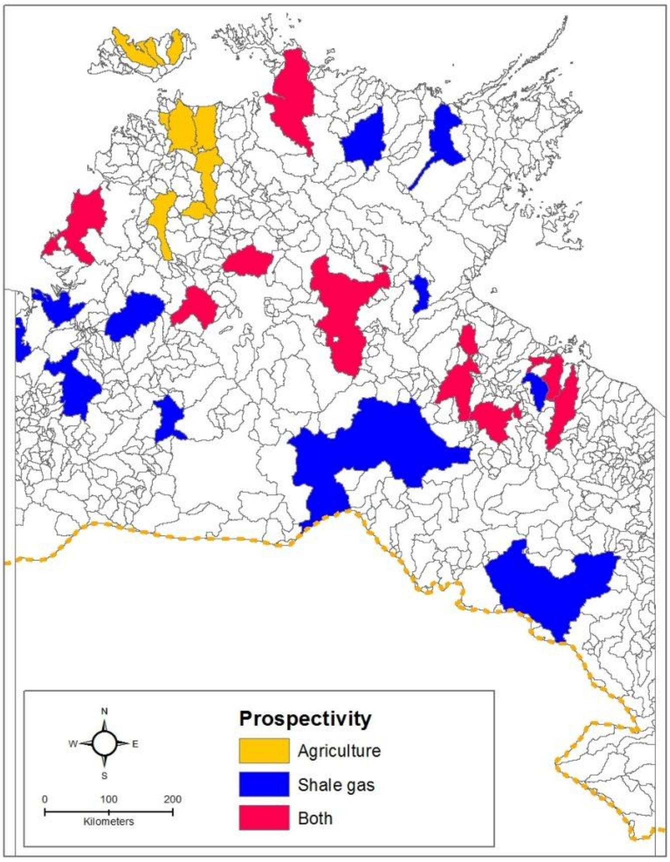


Figure 62: Location of sub-catchments showing sites where the top decile of biocultural values coincide with similar rankings of agricultural and shale gas prospectivity. The left map uses total sub-catchment wide values and the right density values in which sub-catchment size does not influence ranking.

11.4.4 Responding to land use change

We have already highlighted the substantial regional variation in capacity to respond effectively to either threats or opportunities in large scale environmental management. Issues of interest and capability are obviously relevant to selection of case study sites for DbD. Distribution of townships and of regularly occupied Indigenous outstations is shown at Figure 65. Active Indigenous Ranger groups are also shown.

Most of the Territory land area supports biological and cultural assets warranting serious investment in better management than they currently receive. No region is unambiguously superior to all others. Even should available data suggest strong differences, the obvious biases in sampling compromise confident assignment of geographic priorities. The best we have been able to do is identify a number of loosely bounded areas in which important assets have been shown to be present at reasonable levels over substantial areas and change is most plausibly imminent. We have summarised the options identified by this mix of opportunity and threat, obligation and capability, in Table 18. We omit from further consideration the high value/high land use change sub-catchment in the mid-northern Top end on the grounds that it is in a region of high formal protection through both declared reserves and IPAs. For example, the combined areas of the connected Kakadu and Nitmiluk National Parks and Djelk and Warddeken IPAs exceed 4.35 million ha.

We have sought to identify features that might influence prospects for applying DbD principle and practice within each of those regions. Here we expand a little on that summary to focus on the match between the particulars of threats to values emphasised in ranking of the region, and the ability to identify offset providers with both the interest and capability to respond to related opportunities.

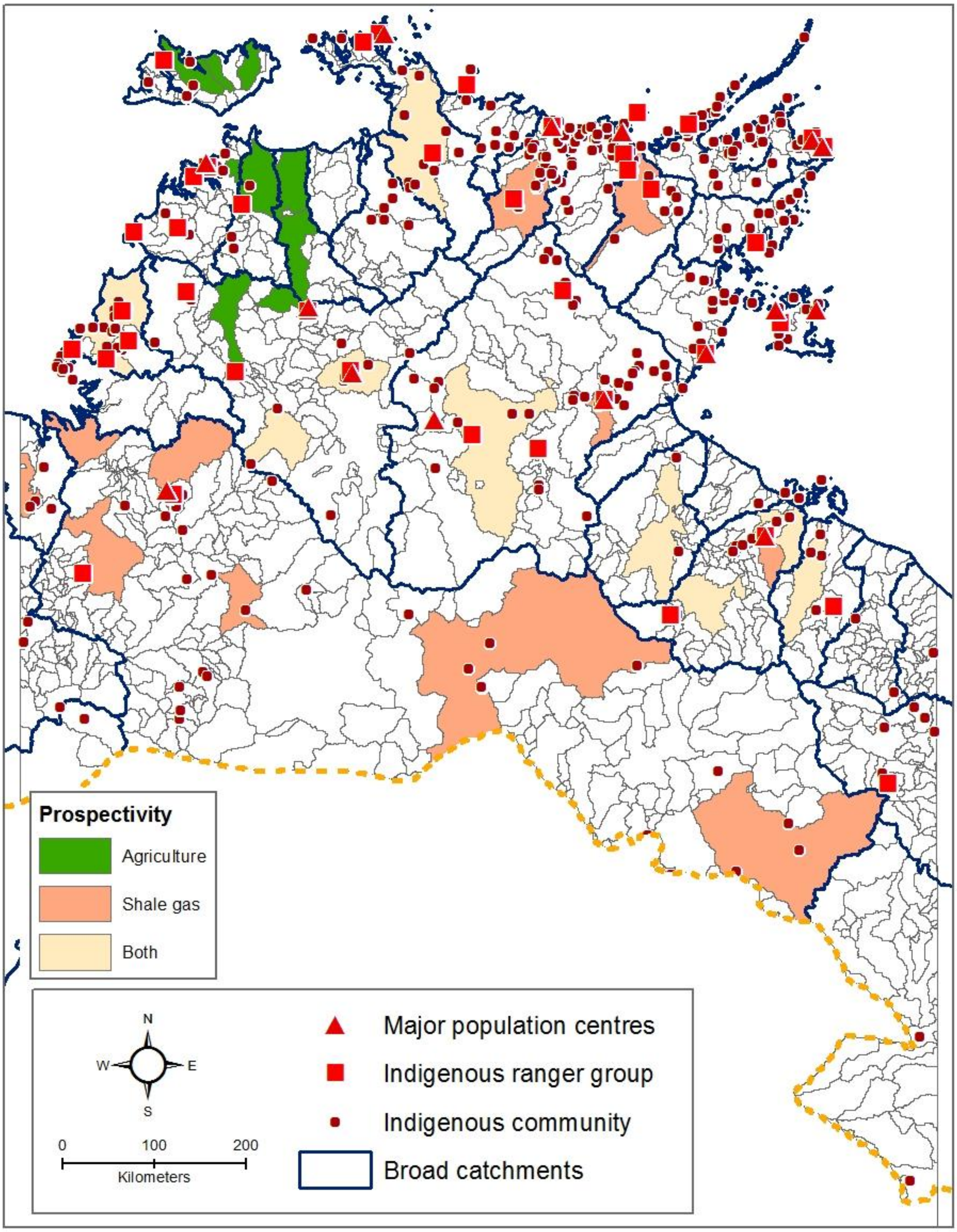


Figure 63: Map showing the sub-catchments where the highest decile of an index of biodiversity and cultural values coincide with either or both the most prospective (top decile) areas for shale gas or agricultural development, in relation to population centres and Indigenous groups engaged in land management.

Table 18 :Attributes of clusters of sites of high heritage conservation value vulnerable to change and their potential suitability for application for Development by Design methods.

Region	Key drivers of change	High ranked assets	Impacts requiring management	Factors influencing desirability/favourability				
				land tenure/ on country presence	**offsets available locally**	**local/regional institutions**	**formal land management capability**	**prospect of interest**
Tiwi Islands	agriculture mining	terrestrial and marine biodiversity values identified as NT SoCS registered cultural sites relatively few possibly because custodians have not seen need for this protection	gross physical disturbance (land clearing and mineral extraction) invasive species projected impacts directly affect high ranked values	all ALRA land under control of local land trusts 3 main communities and several outstations	rehabilitation of disturbed sites forestry sites may offer options for biodiversity conservation and other offsets carbon farming (savanna burning and forest restoration)	strong independent land council with NRM group NT government support for development initiatives	marine Ranger group well-developed strategies and plans in NRM	highly independent approach development orientation history of failed orthodox enterprise
Darwin/ Finniss	agriculture mining	high terrestrial and aquatic biodiversity values water-dependent ecosystems identified as supporting NT	gross physical disturbance (land clearing and mineral extraction) mining and agriculture related pollution erosion and	complex mix, including Indigenous, private freehold, native title, pastoral Indigenous presence in	predominantly rehabilitation; mine sites and other degraded areas	numerous potentially competing interests	Bulgul Rangers and Larrakia Rangerweaker structures than some other areas part of area s	land holdings of relatively modest size may constrain options *interest in environmental management work*

Region	Key drivers of change	High ranked assets	Impacts requiring management	Factors influencing desirability/favourability				
				land tenure/ on country presence	**offsets available locally**	**local/regional institutions**	**formal land management capability**	**prospect of interest**
		SoCS (Darwin and Finniss)	sedimentation	townships relatively sparse outstations				
Moyle River	agriculture shale gas	predominantly wetland and marine values numerous cultural sites identified as supporting NT SoCS (Hyland Bay and associated floodplains)	gross physical disturbance (land clearing) habitats of species generating high biodiversity ranking least likely to be directly affected by likely changes	predominantly ALRA; and pastoral substantial numbers of outstations	protection of wetlands from invasive species substantial opportunities in carbon farming (inc. savanna burning) weed management to protect floodplains marine megafauna (turtle & dugong)	Thamarrurr Development Corporation previous exposure to gas extraction (Black Tip)	Thamarrurr Rangers working lands and seas	ranger foci on NRM; treating NRM as enterprise
Keep/ Victoria Rivers	shale gas agriculture	high terrestrial and aquatic biodiversity values concentration of registered sacred sites and other cultural interests water-dependent	gross physical disturbance (land clearing) land clearing intensified grazing exotic pastures	mostly pastoral and relatively small parks and reserves Timber Creek Ranger group working in Gregory National Park	rehabilitation of degraded pastoral sites opportunities in carbon farming on non-Indigenous and Indigenous lands	government commitment (funding) to agricultural development	limited at present: local Ranger group occupied mostly in Gregory	Indigenous native title interests concerned to protect important values, concerned at agricultural initiatives

Region	Key drivers of change	High ranked assets	Impacts requiring management	Factors influencing desirability/favourability				
				land tenure/ on country presence	offsets available locally	local/regional institutions	formal land management capability	prospect of interest
		ecosystems identified as supporting NT SoCs						
Daly River	agriculture shale gas	terrestrial and aquatic biodiversity values (e.g. freshwater turtles) high value water dependent ecosystems identified as supporting NT SoCS cultural sites less dense than some other sites	gross physical disturbance (land clearing) agricultural pollution water use affecting high value water dependent ecosystems	complex mix of pastoral, freehold, crown lease, ALRA, native title, small parks and reserves; ownership extends to beds of rivers and low water mark in tidal areas	carbon farming (savanna burning, reforestation) on Indigenous and non-Indigenous lands water quality management	government commitment to agricultural development in the region local sustainable development planning group recently disbanded by government water planning committees inactivated	Malak Malak Rangers Wagiman Rangers Jawoyn Ranger program Werenbun Aboriginal Corporation	strong Indigenous interest in water issues, agricultural development, land clearing strong non-Indigenous interests in recreational fishing and tourism values
Roper River	agriculture mining shale gas	terrestrial biodiversity values; water dependent ecosystems biodiversity values less concentrated than some other	gross physical disturbance (land clearing, mineral extraction) water use in agriculture and mining both within and outside the catchment (e.g.	ALRA, pastoral, native title Indigenous presence in several townships, numerous outstations/ communities	some opportunities in carbon farming (savanna fire) some specific habitat types (lancewood, bulwaddy) at risk which might	Yugul Mangi Aboriginal Corporation	Numbulwar Numburindi Amalahgayag Injung Rangers Yugul Mangi Rangers	strong Indigenous interest in water issues planning for IPA well-advanced (Yugul Mangi)

Region	Key drivers of change	High ranked assets	Impacts requiring management	Factors influencing desirability/favourability				
				land tenure/ on country presence	**offsets available locally**	**local/regional institutions**	**formal land management capability**	**prospect of interest**
		sites identified as supporting NT SoCS substantial array of registered cultural sites, especially relating to landforms	Roper affected by decisions in Daly catchment) water quality (pollution)	especially along Roper River	be addressed through offsets			
Gulf of Carpentaria	agriculture shale gas mining	terrestrial and marine fauna identified as supporting NT SoCS	mining pollution agricultural pollutants gross disturbance (land clearing and mineral extraction) water use	ALRA, pastoral, other leasehold, native title, parks and reserves	mine rehabilitation, carbon farming, biodiversity, water quality	local councils	Garawa and Waanyi/ Garawa Rangers Li-Anthawirriyarra Sea Rangers (Borroloola)	strong Indigenous interest in riverine and marine values concerns at mining impacts

11.4.4.1 Darwin/Finniss

This region is ranked high for bio-cultural values principally on marine and freshwater wetland values, as exemplified by statements for the NT SoCS Darwin Harbour, Shoal Bay, Fog Bay, and Finniss River Floodplain (Harrison et al. 2009). Other sites of interest include the unusual vegetation of the Howard River sand-plains (also a SoCS) already threatened by sand extraction.

The most likely forms of spatially extensive development include urban expansion and infilling (Planning Commission 2014), plus development of irrigated agriculture on favourable soils, requiring substantial land clearing and putting additional pressure on arguably already over-exploited ground-waters or requiring on-stream or off-stream impoundments (PowerWater undated). Net reductions in the areas of habitat available to wildlife in the region appear inevitable. Incremental agricultural developments are not usually subject to specific environmental assessment and there are no mechanisms to deal explicitly with cumulative impacts, except perhaps in release of wastes and pollutants to water (NRETA 2014).

However, the values for which the region ranks high (including marine and coastal species) are arguably less directly and immediately affected by these broad scale changes than often widespread and abundant terrestrial species directly damaged by land clearing. Options for framing compelling biodiversity offsets for the sorts of values emphasised in this region may be limited. The most immediately relevant options include:

> (1) rehabilitation of sand-plains: early environmental approvals for sand extraction made apparently inept obligations to stockpile topsoils and relace them in areas of extraction, which may have resulted in propagules for terrestrial vegetation being re-placed in depressions that ultimately become small wetlands. There would appear to be a need to develop and apply new habitat protection and rehabilitation methods that deal with the specific requirements of the endemic *Utricularia* (carnivorous plant) assemblages for which the Howard SoCS is valued.
>
> (2) protection of floodplains: NTG analyses of areas favourable for agriculture do not presently include seasonally inundated floodplains, although some interests are promoting rice growing (see Section 10.2.1 above). Offsets offering equivalence in terms of compensating for impacts on wetland fauna will be theoretically plausible if agricultural development involves methods of water use (e.g. in-stream impoundments) and/or growing of rice or similar crops that compromise floodplain function. But practical responses to impacts on river flow and floodplain inundation regimes will be hard to identify and implement.

Identifying providers for these sorts of offsets is problematic because forms of effective intervention are uncertain, but likely to require large scale responses that are unavailable to individual landholders. Forming effective coalitions would require considerable investments of time and funds. Indigenous land management groups in this region are arguably less developed than in other more remote regions because the fragmented nature of the Indigenous estate has not provided the critical mass and potential to build relationships with government or non-government environmental interests to establish strong capacity.

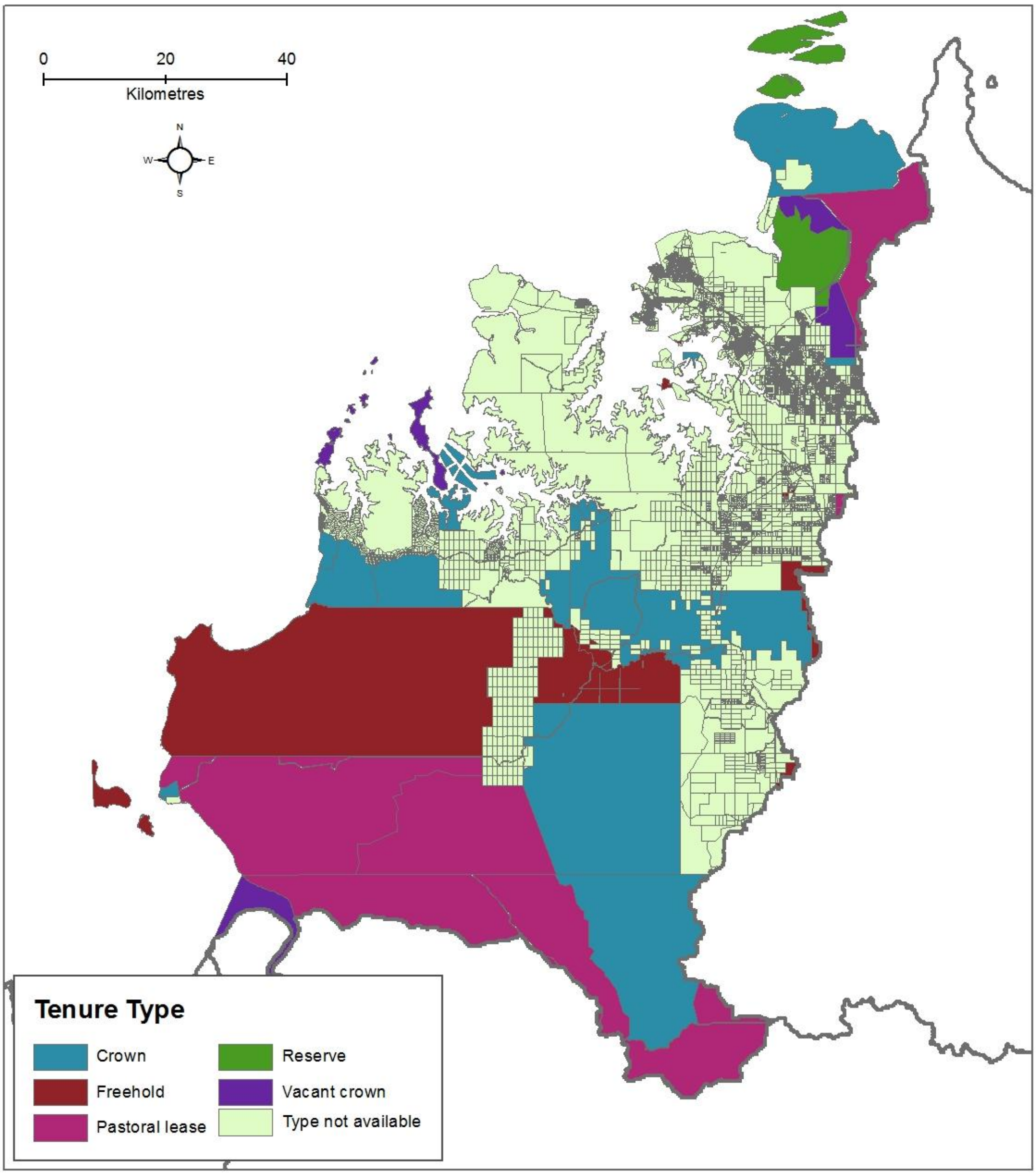


Figure 64: Map of the Finniss River catchment illustrating the relatively high level of urban and per-urban development that mitigate against large scale conservation actions and effective application of DbD.

11.4.4.2 Daly River catchment

This region ranks high on aquatic, wetland and coastal values as illustrated in the SoCS statement for the Daly River middle reaches and Anson Bay (Harrison et al. 2009). The region supports no unusually diverse assemblages of terrestrial flora or fauna (DIPE 2003). Impacts on special values are likely to be mostly indirect, relating to water use and its effects on in-stream flows and effects on other groundwater dependent ecosystems, and sedimentation and other pollution from changed land use.

These impacts can be ameliorated by limiting areas of clearing, especially near river channels, and hence reducing potential agricultural water demands; and designing clearing configurations to minimise both immediate and cumulative risks from erosion and wildlife habitat fragmentation (Rankmore and Price 2007). Large areas of Indigenous land remain undeveloped and have soils regarded as suitable for agricultural development, especially on the western side of the Daly River. Total clearing on some non-Indigenous freehold and pastoral land remains below what would be permitted under present land clearing guidelines, offering options for highly relevant offsets if landholders choose to clear below "potential". Biodiversity oriented offsets would also help protect cultural values such as maintenance of customary harvest and sacred sites associated with the river and its tributaries.

Options exist to better manage fire within the catchment (Figure 51 above), especially in the north-east adjacent to Kakadu National Park, distant from the areas where agricultural impacts are most likely. Improved fire management could deliver carbon, biodiversity and landscape stability benefits.

Government interest in facilitating such offsets through compatible policy settings and treatment of decisions to defer approved clearing long term is uncertain but may not be favourable. The NTG has recently withdrawn support for the Daly River Management Advisory Committee and relevant water planning committees appear to have ceased to function. These decisions imply an increasingly "hands off" approach to agricultural development matching deregulatory rhetoric. Regulatory support for offsets that have the effect of limiting local development appears improbable. Even "passive" support to help make voluntary arrangements effective, like recognising and supporting landholder decisions to limit or modify development of their properties, may be problematic.

A number of Ranger groups are present but comparatively sparse (Figure 65 below) and narrow in work focus given the array of issues and the large size and topographic diversity of the catchment. These structures are supplemented by organisations like the Savanna Solutions[70] group which seeks to connect Indigenous land managers with NRM employment.

11.4.4.3 Moyle River

Again this region ranks on wetland and coastal biodiversity values (see the values identified for the Hyland Bay SoCS). Cultural values (AAPA-recognised sites) are also ranked high, more strongly on landform attributes (Figure 38 above).

Sites at risk of change are mostly terrestrial. We have not discounted in our indices areas likely to be exploited for shale gas and oil on risks of seasonal inundation, but this is likely to limit or at least increase the cost of exploitation and so protect the lower-lying parts of this region and their associated wetland values. Similarly, unless rice-growing is promoted (and this is arguably more likely to occur closer to major centres with transport infrastructure), agricultural development will mostly have indirect impacts on wetland values.

Values-relevant offsets would emphasise protection of floodplain habitats, whilst impact-relevant offsets would focus on effects of land-clearing. Options exist to offset carbon effects of clearing

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[70] See http://www.ntibn.com.au/members/member25/

through improved fire management (Figure 51 above) in areas around sites likely to be affected by agriculture.

Regional capacity to implement offsets is relatively strong, with a substantial Indigenous presence across the landscape and a number of Ranger groups in a relatively small area (Figure 65 below).

11.4.4.4 Keep River/northern VRD

This region ranks high on terrestrial flora and fauna values, but also includes some riverine values. Cultural values based on landforms (Figure 41 above) are relatively high.

Risks involve mostly land clearing for irrigated and rain-fed agriculture, as well as shale gas. Prospects of agricultural development are elevated here by the strong commitment of the Northern Territory government to such development driven by the availability of large volumes of water from the Ord River in WA. Public funds have been allocated to facilitate agreements with Indigenous interests.

Offsets might in theory include landholders withholding land from development despite actual or potential approvals for development under prevailing law and policy. But as indicated in regard to the Daly River, robustness of such arrangements will be at least partly dependent on government facilitation to ensure that rights or licences are not withheld or withdrawn when landholders decide to forgo development options.

Capacity to develop and deliver offsets in the area most likely to experience agricultural and shale gas development is weaker than many other sites, although there is an operational Ranger group in Timber Creek working with Gregory National Park, and the potential for support from the small staffing of Keep River National Park. However, we consider that sympathetic government treatment of offsets that involve forgoing development opportunities is improbable given long-term bipartisan commitment to agricultural development in the region, and steps already taken by the present NT government to discard use of offsets in any setting.

11.4.4.5 Roper River

Roper River sub-catchments ranked high for biodiversity values included a mix of terrestrial and aquatic (Mataranka Pools and Limmen Bight SoCS) values. Terrestrial values include a number of threatened species of flora and fauna (e.g. Gouldian Finch *Erythrura gouldiae*, Brush-tailed Rabbit-rat *Conilurus penicillatus* and Bare-rumped Sheath-tailed Bat *Saccolaimus saccolaimus*)

There is strong representation of cultural sites based on landform and vegetation attributes (Figure 41 above and Figure 58).

Sub-catchments in the Roper River catchment are prospective for both agricultural and shale gas development (Figure 61 above), as well as additional mineral extraction (Figure 55 above). The catchment is already affected by a number of significant mines (Figure 49 above). New impacts will include land clearing and increased water extraction for irrigated agriculture, mineral extraction and fracking. A major mining development in the region extends into adjoining Gulf catchments (see Section 11.1.3.4 above). Increased water extractions in the neighbouring Daly River surface catchment also draw on the same large (Tindall Limestone) aquifer that contributes to base flows in the Roper River (Knapton 2009). Some communities along the river rely on dry season flows for their domestic water supplies, including the settlement of Ngukkur.

Offsets for impacts of water extraction in settings that lack approved water allocation plans present some difficulties. There is no mechanism available to make binding decisions to reduce water usage in one area or sector to offset increased usage in another. Offsets for land clearing are more plausible to deal with carbon emissions through improved fire management, and perhaps by reductions of feral animal populations. Biodiversity offsets based on protection of terrestrial species and general improvements in land condition through better management of fire, ferals and weeds are also plausible through mechanisms like the IPA proposed by Yugul Mangi[71].

The region has a number of active Ranger groups and numerous outstations, particularly on the Arnhem Land (northern) side of the Roper River. The work already done on a proposal to create an IPA indicates the interest in land management work. The potential to identify offset providers appears good.

11.4.4.6 Gulf of Carpentaria

High biodiversity rankings apply to a number of river catchments draining into the south-western Gulf of Carpentaria, especially the Robinson, McArthur, and Limmen (Figure 29 above to Figure 31 above). Several somewhat clumped sub-catchments in this region are in the top rank of prospects for development in both agriculture and shale gas. Values are biased to the aquatic and especially marine, as indicated by the region's SoCS for the Sir Edward Pellew Islands. However, the islands also support a number of highly significant terrestrial species which are under threat from feral stock and domestic animals (Harrison et al. 2009). Terrestrial biodiversity values on the mainland are not ranked especially high.

Cultural values rank high on both mainland and islands, and include both landform and aquatic sites (Figure 41 above).

Direct impacts associated with prospective land use change relate to land clearing, water use, and deterioration in water quality.

Options for offsets include improved management of the region for fire, feral animals and weeds (Figure 48 above Figure 50 above and Figure 51 above) and better protection of sites representative of the region. In this context it is important to note that the region's largest reserve (Limmen National Park) is likely to be subject to mining involving high levels of disturbance. Western Desert Resources Roper Bar Project proposes to export 3 million tonnes of iron ore pa from open pits through the Bing Bong port. Investments in island sites may be useful to buffer against these sorts of large scale impacts on both terrestrial and aquatic values.

The region has an active Ranger group at Borroloola, with outstations in each of the most relevant catchments. Some traditional owners are concerned at the impacts of mining at McArthur River and are likely to welcome support to manage existing and projected impacts.

11.4.4.7 Summary and conclusion

This scan of options - in catchments where high values and prospects of change coincide - has revealed some challenges for application of Development by Design principles and process. In the absence of declared threatened ecological communities (with the exception of the Arnhem Land Plateau which has already attracted significant public and private investment), Territory rankings of sites of conservation significance have relied on wetland values in particular, reflecting national interests and obligations associated with international conventions.

The most immediate and direct impacts of the two classes of imminent development likely to affect large areas arise from removal of native vegetation (land clearing) for improved pasture, crops or orchards or infrastructure for collecting shale gas. These impacts are most immediately apparent, readily measured, and invite conceptually simple responses in protection of multiples of equivalent vegetation types. Achieving net biophysical environmental benefit or at least no net loss will require that the ecological condition of these sites be improved.

[71] http://www.yugulmangidevelopment.com/Yugul_Mangi/IPA.html

This might be achieved through better management of fire and ferals over large areas. We are aware of no published quantification of the full array of feral animal impacts in the regions we have identified, but Faulks (2001), for example, reported grazing and watering points for domestic stock and feral animals in the Roper River as a "major disturbances to stream reaches" and modification of riparian vegetation as sometimes extreme.

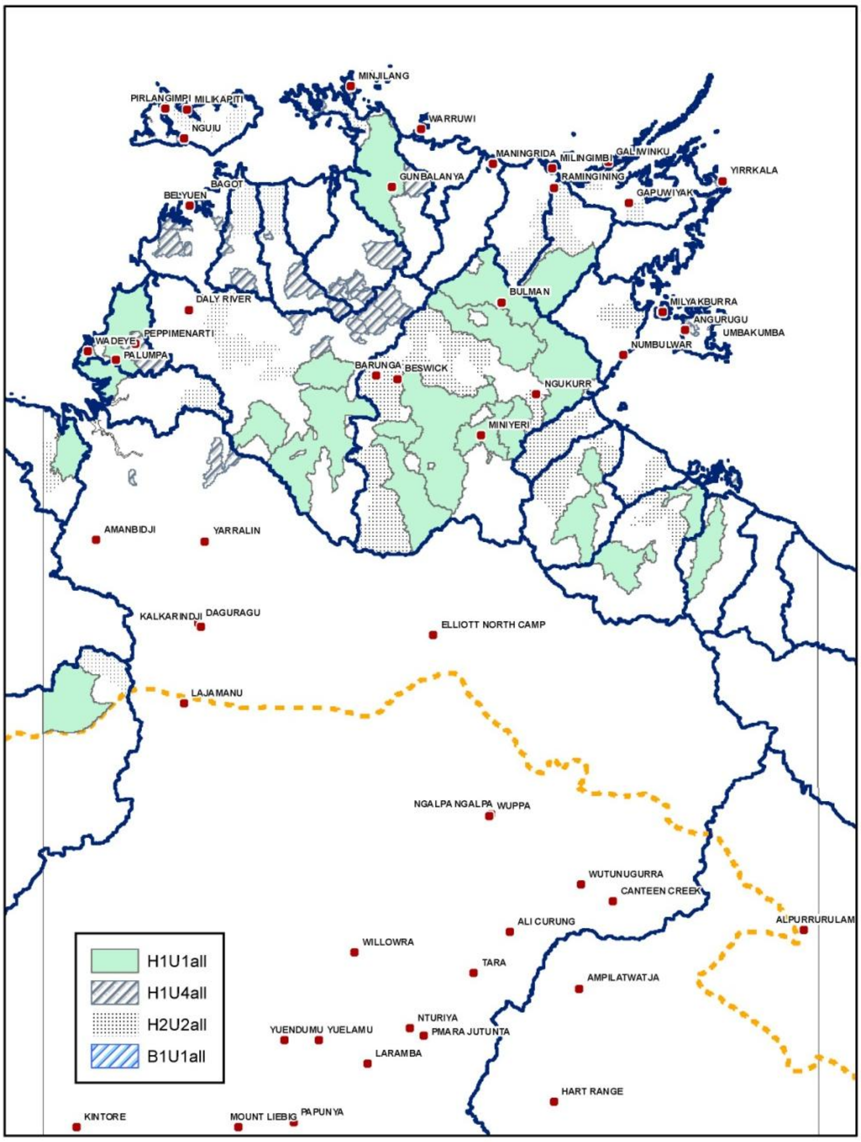

Figure 65: A more comprehensive map of sites of potential conflict between high level bio-cultural values and broad scale development (agriculture and unconventional gas extraction). In this map biodiversity value is based on species richness of sub-catchments rather than only threatened or otherwise notable species. H1U1all=top decile of biocultural values and most prospective for both shale gas and agriculture, H2U2all=top 20% of values and prospects of land use change, B1U1all=top biodiversity values and high likelihood of increased use. H1U4all are sites where biological and cultural heritage values are high but use value is ranked outside the top 30% of sub-catchments. This last category arguably indicates favourable sites for offsets less likely to be subject to large scale disturbance.

Indirect, "flow-on" impacts from reduced water for the environment, sedimentation and pollution are arguably more serious than the immediate impacts, involving long term but out of sight change in the biota of streams and other wetlands that may take some time to become apparent. Increased agricultural, fracking and mining water use appears likely to increase the frequency of low and no flow conditions in the Territory's only two perennial rivers (Knapton 2009) and may affect other water dependent ecosystems (e.g. spring fed jungles). We have discussed the difficulties involved in offsets based on diversion of water use entitlements to the environment when water markets do not exist and water allocation plans have not been completed. Permanent or temporary (for the life of the use being offset) reductions in the consumptive pool to match specific water offsets for agriculture or mines would achieve genuine additionality. But such arrangements appear likely to be particularly challenging in the Northern Territory as a jurisdiction that is simultaneously dismantling both its community water planning arrangements and offsets policies and capabilities.

A somewhat contrived alternative not requiring the direct support of government - except to issue related permits - would be to pump water from deeper or distant aquifers into depleted streams or other water-dependent ecosystems to create artificial "islands" of elevated water tables (see Brodie et al. 2007, pp. 164-5 for a brief discussion). This would need to be sensitively done to avoid impacts at the sites of extraction of supplementary water and must be maintained for the life of the offset. Other possibilities might include high quality monitoring systems that go beyond observance of water quality standards to encompass phenomena and indicators of particular interest and relevance to local livelihoods and land management obligations.

We do not suggest that such difficulties of matching response closely to the most immediate and obvious biophysical impacts warrant abandonment of attempts to use offsets productively, but to indicate that prescribing like for like approaches is unlikely to be particularly productive. Rather we believe that flexibility and development of options in close collaboration with affected and interested communities will be an essential feature of the offset process (see Cowling 2008).

An obvious corollary of more complex and participative approaches to identification, design and implementation of offsets is that demonstration of the most favourable areas for DbD work itself becomes a more contingent process, especially when other cultural values are assigned to parts of the landscape that are unconnected with orthodox assessments of biodiversity values.

On balance, we consider that the Roper River catchment offers a reasonable choice from the several areas considered here for examining in greater detail the options for application of DbD in a large, mostly undeveloped region on the cusp of seeing increased pressures on its heritage values. Landowners are likely to see land use changes that involve substantial structural modification of landforms and vegetation over large areas, and hence powerful shifts in local people's relationships with landscape. We base this proposition on:

(a) a large proportion of the sub-catchments within the region falling into categories representing our highest category of biocultural values and use values (the green areas in Figure 65 above), and much of the remaining area falling into the next highest category
(b) a mix of terrestrial and marine biota of conservation interest (Figure 24, Figure 26 and Figure 35)
(c) inclusion of a (small coastal) part of the region in an NT SoCS (Figure 36) plus connections to other SoCS and IPAs in the north-east
(d) numerous registered and/or otherwise recognised cultural sites for which protection is sought by local people (Figure 40)
(e) plausible threats of land use change affecting both terrestrial and freshwater values through direct structural impacts and other widespread disturbance (Figure 52 and Figure 56), and water use both within the region and in adjoining sites connected through aquifers that support dry season flows in the Roper River
(f) some opportunities to improve fire management to protect heritage values and generate saleable credits under national schemes (Figure 51)
(g) local Indigenous interests actively pursuing options for achieving IPA status for substantial areas of land and savanna burning projects[71]

(h) relatively good representation of Indigenous ranger groups (Figure 63)
(i) mineral extraction (Figure 49) and serious unconventional gas exploration (Figure 57) already occurring within the region, indicating imminence of change
(j) major allocations of water made from relevant groundwater resources, justified in part by switch to a less risk averse approach to allocation (Sections 6.1 and 6.4.5)
(k) other sites (Daly River, Darwin/Finniss River) that on the basis of available but heavily biased records appear to offer greater conservation opportunities, arguably invite greater risks of political contestation which history suggests will not be readily overcome, or in the case of Kakadu/western Arnhem Land region have already attracted major government and non-government investments.

We turn now to a more detailed examination of opportunities for use of DbD approaches in the Roper River catchment and the partnerships and processes that would favour productive application.

12 CASE STUDY

The Roper River catchment is very large (75,713 km^2), representing 11.7% of the Northern Territory study area. Much of its area is extraordinarily isolated, especially the north-east with limited infrastructure, including few formed roads.

Access is therefore difficult for much of the year, especially when rivers and streams rise and low-lying areas flood during the December to April wet season. Topography is mostly subdued, but there are substantial areas of broken terrain which further limit access.

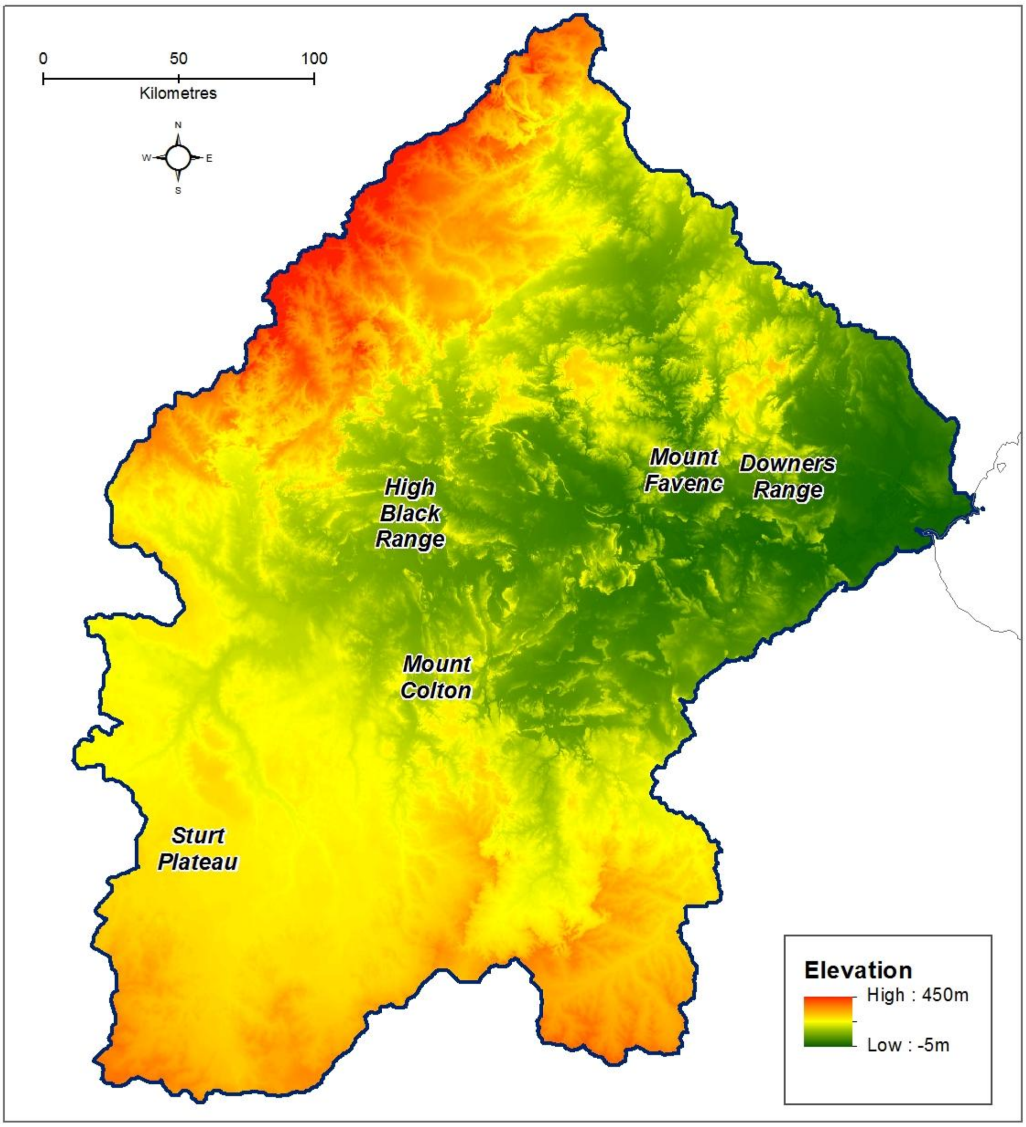

Figure 66: Variation in elevation in the catchment.

The Australian Bureau of Statistics classifies the whole of the region as very remote (the highest remoteness category: ABS 2011). For many sites for much of the year, access is available only by light aircraft. Goods are moved about by road in the dry season but less so in the long wet season when local roads, including connections through sealed roads to major centres like Darwin are often impassable. Barge transport to a few centres operates throughout the year (Figure 67).

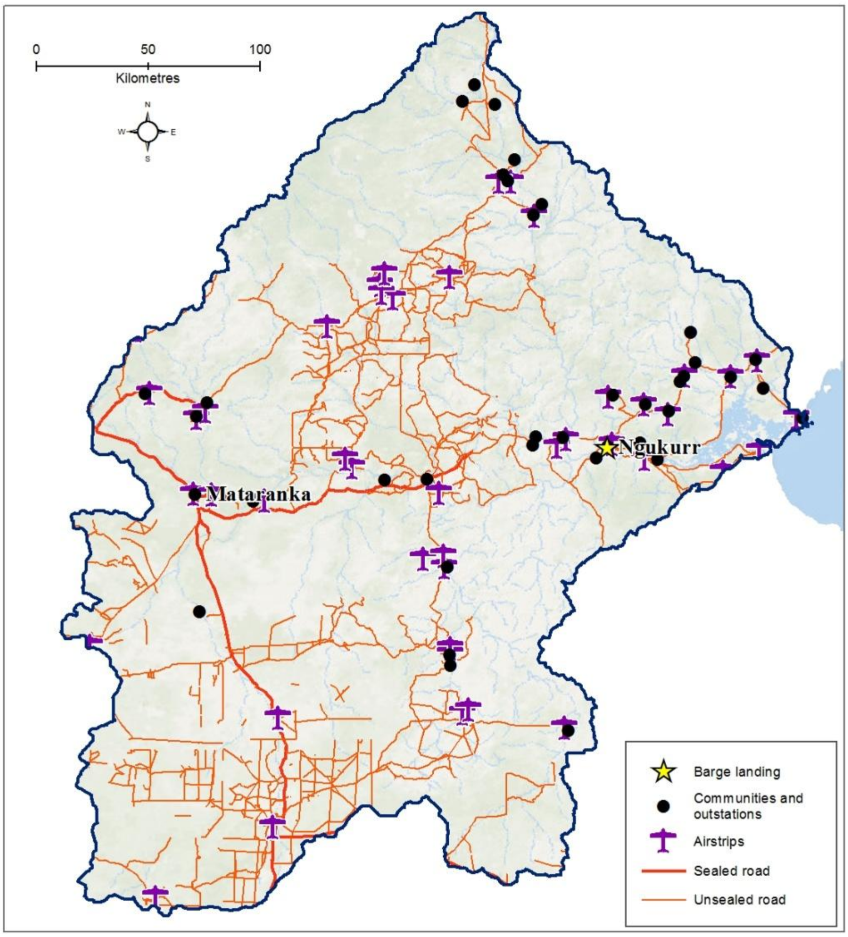

Figure 67: Map of settlements and outstations and road and other transport infrastructure (barge landings, airstrips, roads and tracks) in the Roper River catchment.

12.1 Characterisation of site

Here we present the best available mapping (or at least spatially referenced) biophysical and social attributes relevant to development and conservation in the region.

12.1.1 Natural heritage values

12.1.1.1 Vegetation pattern

The only vegetation map of consistent scale for the Northern Territory is a 25 year old 1:1,000,000 product (Wilson et al. 1990). This mapping and other finer scale work in other parts of the Territory has informed NVIS coverages for the Northern Territory. The NVIS (ESCAVI 2003) system offers potential to scale up and down through a hierarchy of 6 levels which at the top provide structural information and from the 3rd level down provide some floristic information as well, ranging from the dominant genus in the uppermost or otherwise dominant stratum (level III) to 5 dominant species in all strata (Level VI). We have used NVIS to illustrate broad scale vegetation patterns in various parts of this report and here provide a vegetation map for the catchment based on NVIS level IV (Figure 68).

Important features of the vegetation pattern are the relatively extensive floodplains at the (eastern) coastal margin on which high rankings for notable fauna are partly based, ribbons of riparian vegetation along major watercourses, and substantial proportion of the Territory's lancewood forests (Figure 70).

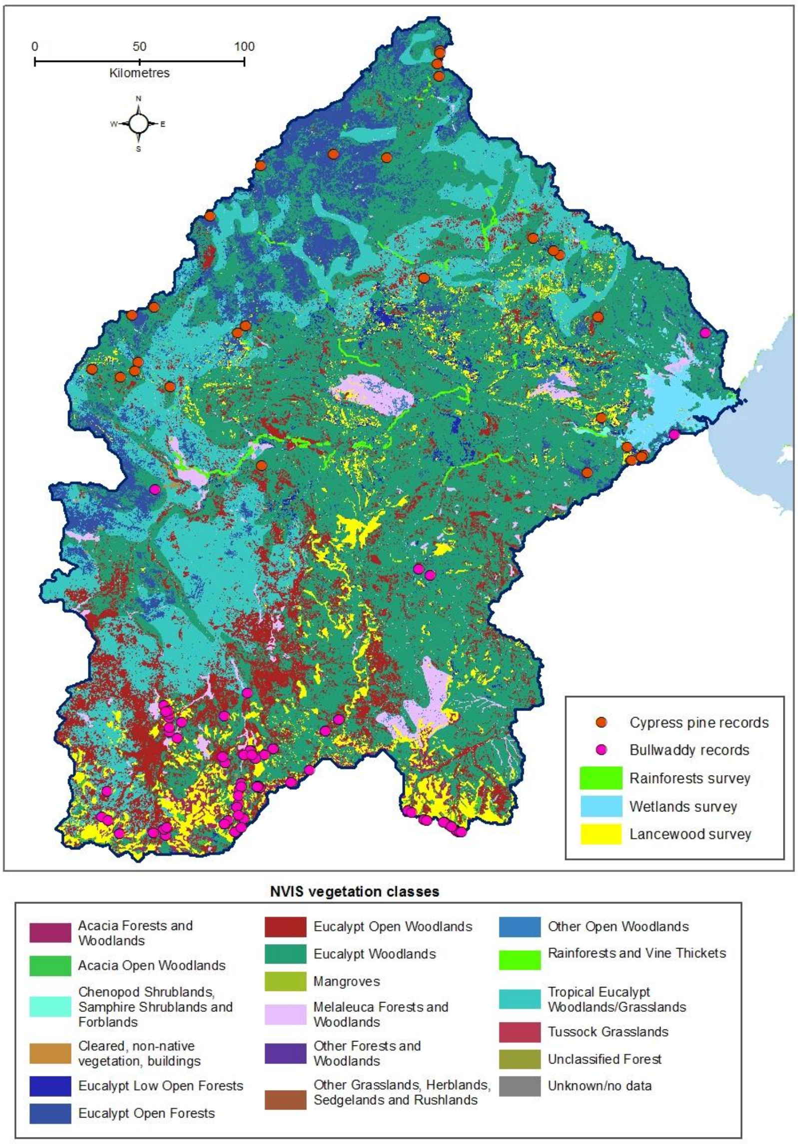

Figure 68: Vegetation map for the Roper River catchment based on NVIS level V units and labels, overlaid with additional mapping of distinct vegetation associations thought to be of particular interest for understanding conservation issues in the catchment.

In addition, the Department of Land Resource Management and its predecessors has integrated land systems mapping across a large part of the Northern Territory[72], including the Roper River catchment, where mapping is described as complete. Land systems are "an area or group of areas throughout which there is a recurring pattern of topography, vegetation and soils" (Christian and

[72] See http://www.ntlis.nt.gov.au/metadata/export_data?type=html&metadata_id=8E85C28F9C9285EBE040CD9B21447F57 for a description including important caveats on data quality

Stewart 1953). Land systems mapping has historically been somewhat idiosyncratic, varying in design to match specific purposes. And this has created enduring problems in scaling up or down for more general use. But recent efforts to standardise, driven in part by programs to produce nationally consistent soils and vegetation mapping are arguably creating more generally useful products. For example, the present mapping recompiles vegetation descriptions to nationally consistent NVIS (ESCAVI 2003) categories (Lynch et al. 2012).

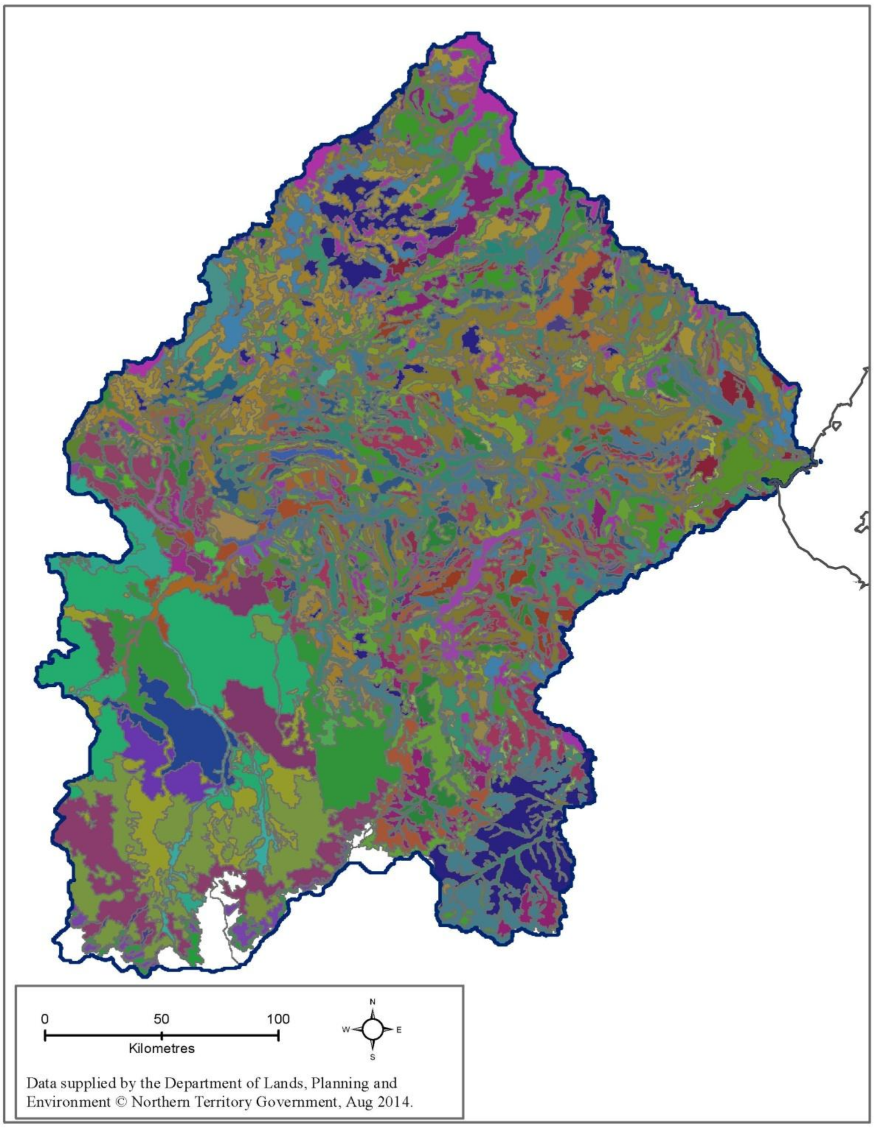

Figure 69: Map of land systems at 1:250,000 scale, illustrating spatial variation in a combination of topography, soils and vegetation presently recognised at this scale. At least part of the apparent variation is likely to be attributable to differences in the purpose and quality of surveys that have been joined to generate this coverage. There are 103 different systems mapped for the region, which are not readily re-interpreted hierarchically. Details are available from the sources given in Attachment 7.

It appears to us likely that future mapping of this region will be based on refinement of these products and their ultimate contribution to NVIS rather than entirely new, locally-produced, mostly floristically-based vegetation mapping. Moreover, this form of mapping with its emphasis on topography and soils has been and will continue to be used for assessments of suitability (and land capability) for agriculture (Pascoe-Bell et al. 2011) and other development purposes (see also Section 8.1.3.2). A map illustrating spatial patterns of land systems at 1:250,000 scale is at Figure 69.

This map and the underpinning data and description which include soils are relevant particularly for identifying "hotspots" for agricultural development that may be obscured by Pascoe et al.'s (2011) broad scale assessments.

12.1.1.1.1 Restricted vegetation types

A number of vegetation types warrant particular attention here due to their conservation value based on orthodox assessments of rarity in the landscape or support for individual species of interest, or value in Indigenous society due to their significance to particular groups or more general utilitarian value as sources of food, medicines, shelter or implements. Here we present details of rainforests and vine thickets, including riparian strips, lancewood and wetlands which fit all of there categories.

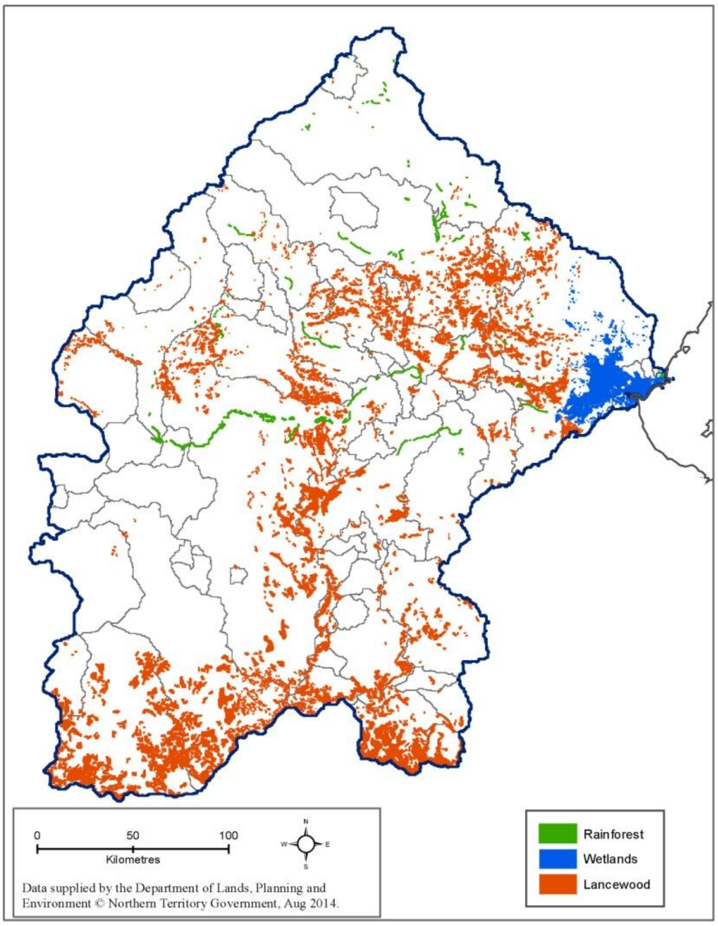

Figure 70: Map of restricted vegetation types in the Roper River catchment that are considered as important for maintaining natural heritage values and living cultural heritage through their significance in the customary economy.

Other groundwater water-dependent ecosystems are usually too small to map at this scale.

Some of these vegetation types may be important indicators of standards of landscape management from both Indigenous and non-Indigenous perspectives. For example, loss or contraction of fire sensitive lancewood and bullwaddy associations may indicate unfavourable fire regimes (Russell-Smith et al. 2010, 2012). Floodplain wetlands may be susceptible to saline intrusion associated with sea-level rise (Whitehead et al. 1990), changes in seasonal flow regimes, weed invasion (Cook and Setterfield 1996; Ferdinands et al. 2005), or feral animal (especially buffalo) impacts (Skeat et al. 1996). In stream (aquatic vegetation) of the type contributing to Kennard's (2011) syntheses may be affected by changes in flow regimes, water depth and water quality. The riparian rainforests along the Roper River mainstream are particularly significant at a regional scale.

12.1.1.2 Fauna

12.1.1.2.1 species richness

Databases maintained by the Northern Territory Government showed the total number of species of vertebrate fauna in the catchment was 482 (number of records=25487). Species recorded for sub-catchments ranged from 0 to 269 (mean=73.1, sd=77.0, n=63). There was wide variation in the number of records for sub-catchments (range 0-3077). The median number of records from sub-catchments was 78. Twelve sub-catchments (19.0%) were un-sampled. Sub-catchments without fauna records were often substantial in size (mean area=18,769 ha, range 694-50122 ha).

Whilst there was a number of larger poorly sampled sub-catchments (e.g. sub-catchments with apparent species richness<10 ranged from 8632 to 123950 ha) , there was nonetheless a significant relationship between sub-catchment area and reported species richness (log(number of fauna species)=0.41+0.32(log(area): r^2=0.13, $F_{1,49}$=7.4, P=0.009).

Overall, the region is relatively weakly and patchily sampled with an average density of records of 0.9 per km^{-2}.

12.1.1.2.2 notable species

Locations at which near threatened and threatened fauna have been recorded are in Figure 71. The single record for an endangered species is an historical record (1911) for the Golden Bandicoot *Isoodon auratus* (Woinarski et al. 2007). The single critically endangered species is the Northern Quoll *Dasyurus hallucatus*. Records for threatened species (766 excluding near threatened) in this large catchment are relative sparse compared with well sampled catchments like the smaller South Alligator River (n=5565) in Kakadu National Park and Finniss River (near Darwin).

The appearance of sub-catchments in this area among those ranked well above the whole study area median for threatened or other wise notable species, despite the obvious sparseness of records (near threatened were not used in the ranking) illustrates the weakness of point records of threatened fauna, whether listed under Territory or federal law, as a tool in planning. Their contemporary utility lies in the alert they provide on those occasions when a specific development site coincides or nearly coincides with a record of a threatened species. We are not aware of any occasion where choice of development site has been determined by such a record, but that option is available for both of the major sources of change posited for this catchment (tight gas and agriculture) unlike (say) a mine exploiting a discrete ore body. Given the thin scatter of records, the probability of this trigger being activated by a smaller project, like a discrete mine site is likely to be low.

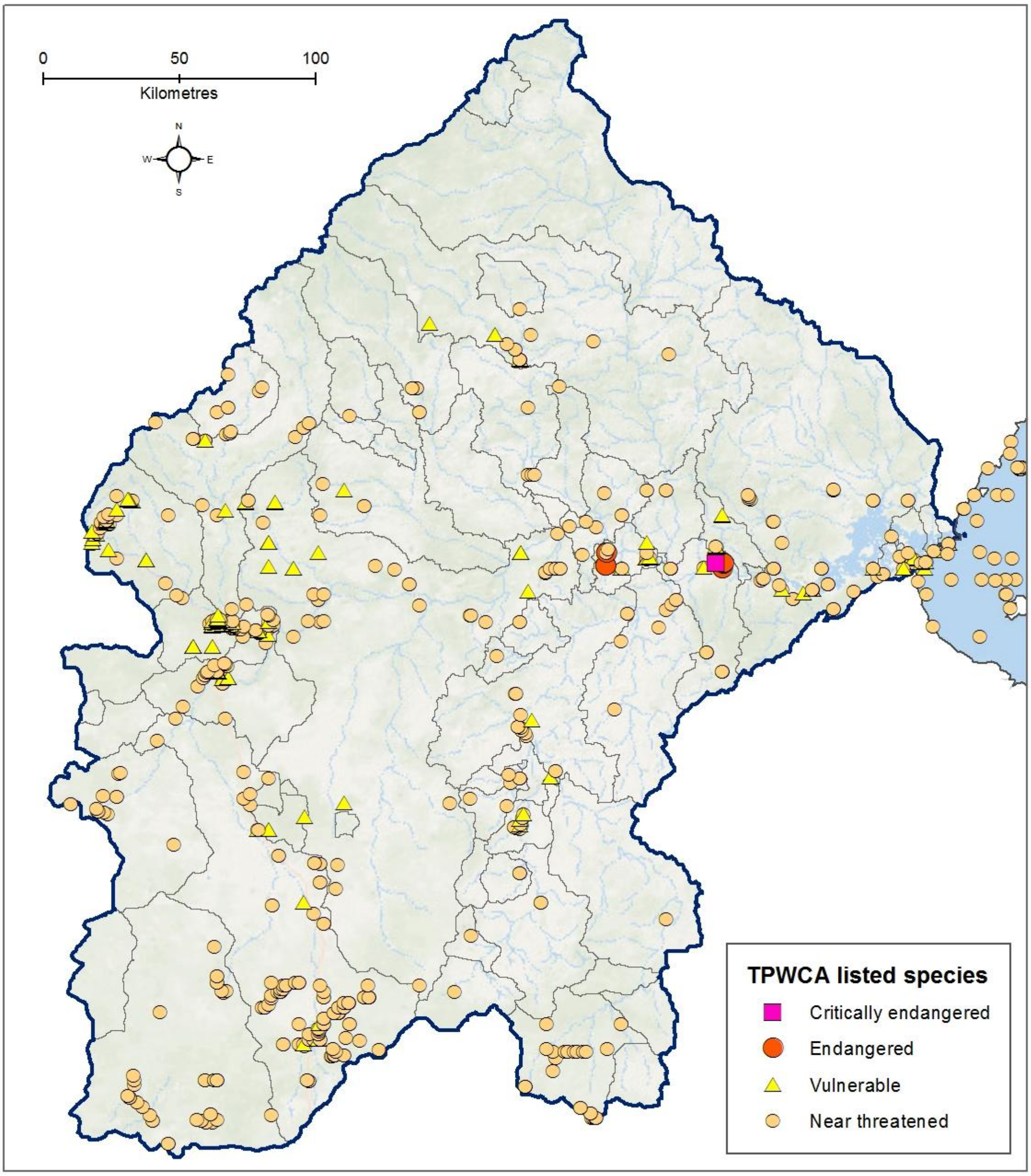

Figure 71: Locations within the Roper River catchment at which threatened species of fauna listed under Northern Territory law have been recorded. The critically endangered species is the Northern quoll *Dasyurus hallucatus*

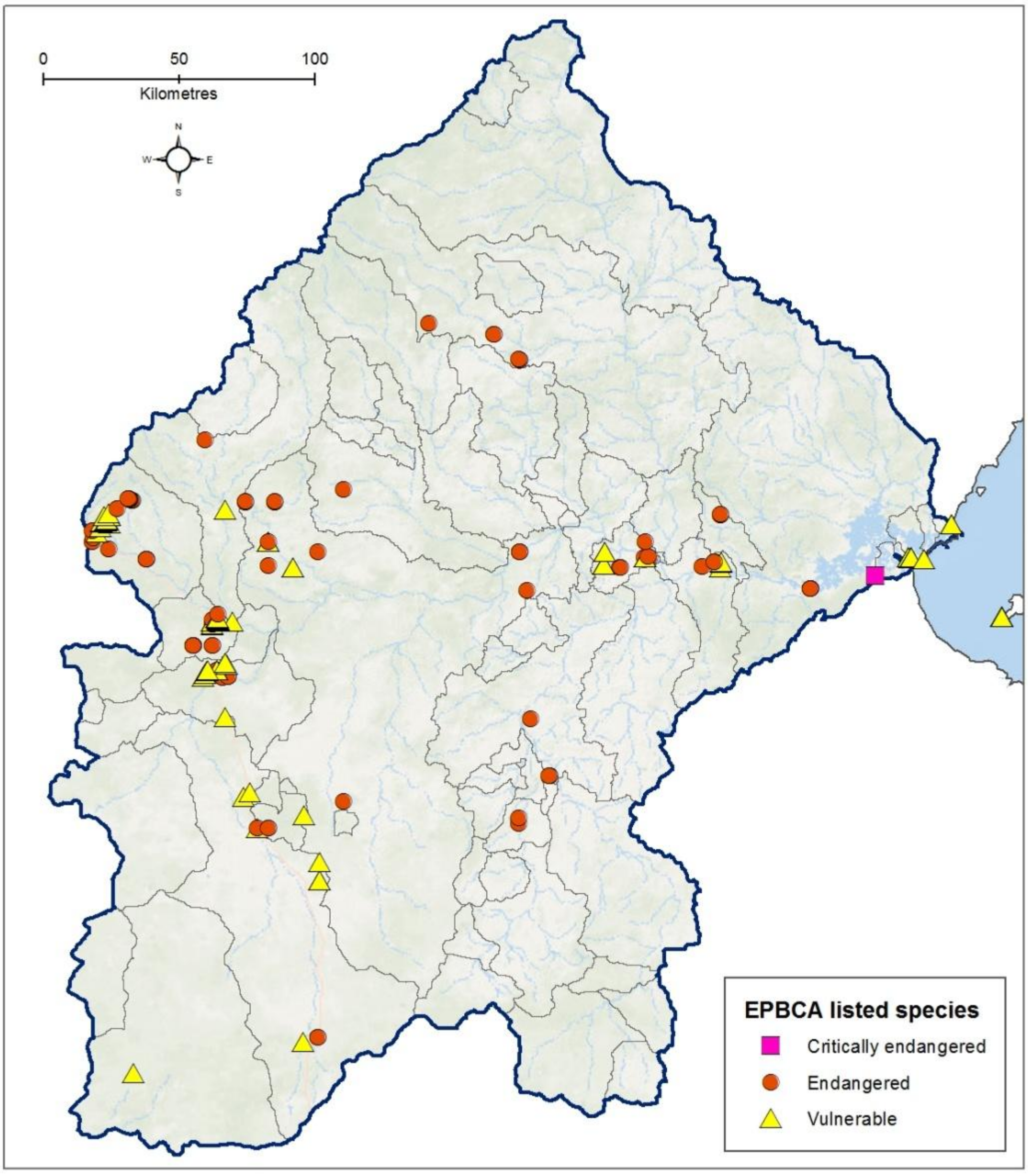

Figure 72: Locations at which fauna listed in threatened categories made under federal law (the *Environment Protection and Biodiversity Conservation Act* 1999) have been recorded in the Roper River catchment. The critically endangered species in the EPBCA categorisation is the Bare-rumped Sheath-tailed Bat *Saccolaimus saccolaimus*.

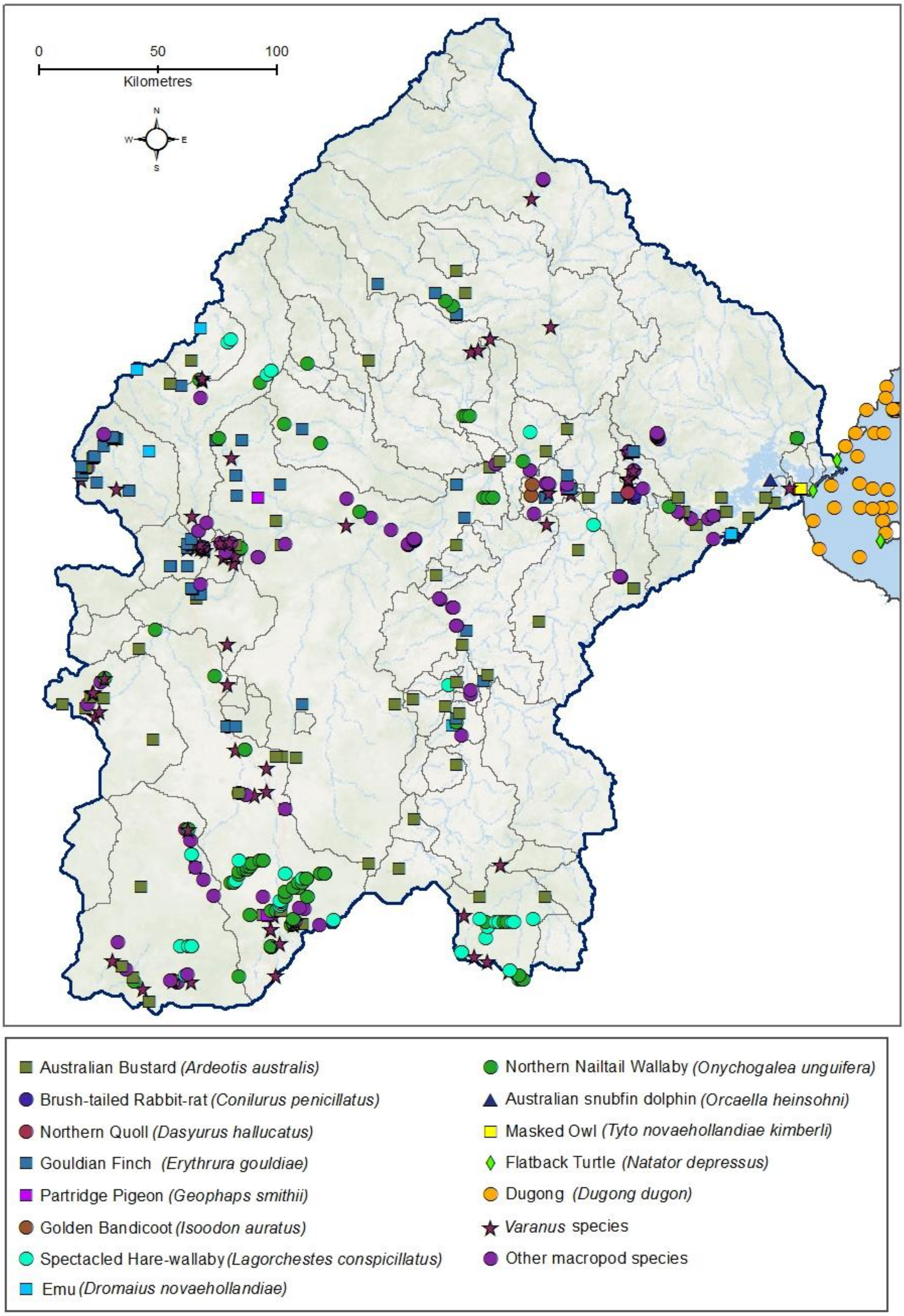

Figure 73: Locations of records of species of particular conservation and customary interest in the Roper River catchment.

Fauna of particular concern in the region include the Northern Quoll and larger varanids vulnerable to cane toads. Species sensitive to fire include the Partridge Pigeon, Gouldian Finch and Brush-tailed rabbit rat. Records are too sparse to indicate the size of local populations or sites where conservation efforts might productively be focused, without supplementation by further survey work, which they would help guide.

12.1.1.3 Flora

12.1.1.3.1 species richness

The total number of vascular plant species recorded for the catchment was 1790, from 32,730 records. Individual subcatchments recorded from 0 to 741 species with a median of 51. Sampling was spatially patchy with a range of 0 to 5140 and median of 78 records per subcatchment. Seven subcatchments (12.5%) had no records. The areas of subcatchment with no records ranged from 694 to 8632 ha.

12.1.1.3.2 notable species

Locations of records for vascular plant species regarded as threatened under Territory and federal law are in Figure 74 and Figure 75 respectively. Records are sparse, arguably illustrating the under-sampling.

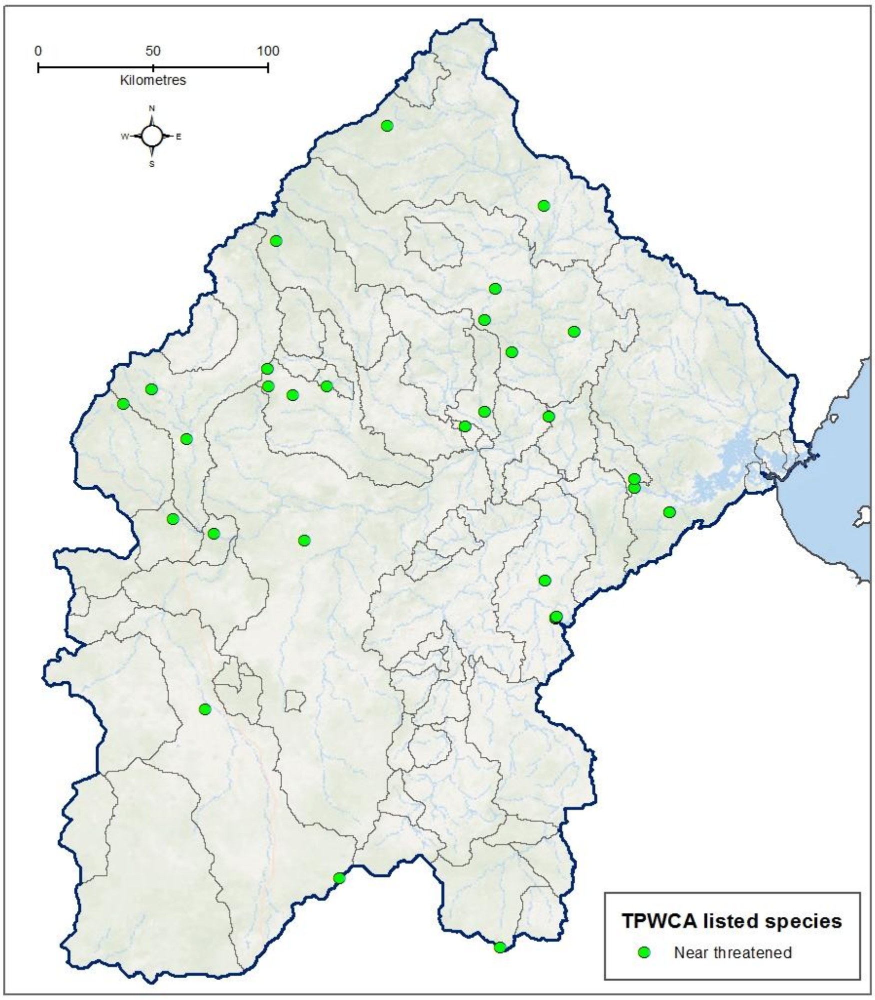

Figure 74: Location of vascular plant species listed as of conservation concern under NT law (*Territory Parks and Wildlife Conservation Act* 1980) recorded from the catchment.

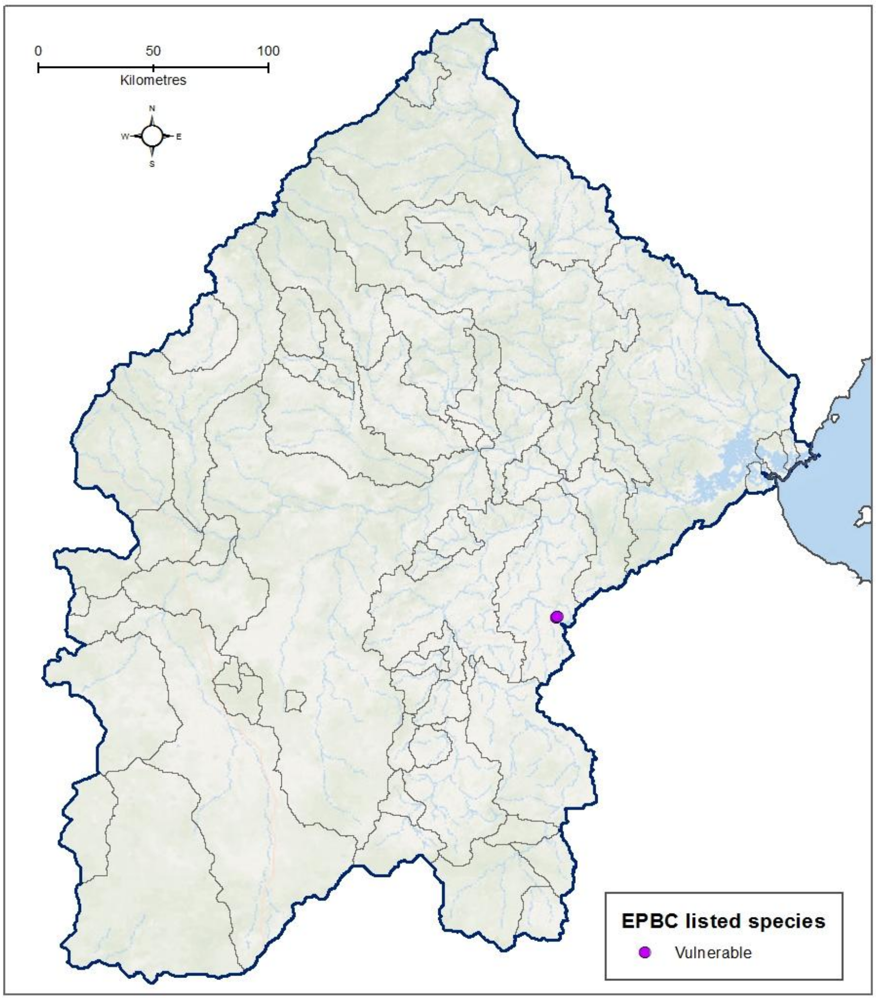

Figure 75: Location of vascular plant species listed as threatened under federal law (*Environment Protection and Biodiversity Conservation Act* 1980) recorded from the Roper River catchment.

There was one threatened plant (EPBCA categorisation) recorded from the catchment, but 17 near threatened species were included in the database.

Figure 68 above also shows the distribution of some individual species and associations that are of conservation interest due to their restricted distribution and potential vulnerability to land use changes and associated processes (e.g. changes in fire regimes associated with disturbance and weed invasions).

12.1.1.4 Summary

Despite the sparseness of sampling the catchment has been recorded as supporting a number of species of conservation interest. Adding to the terrestrial values mentiond here, the SoCS nomination for the Limmen Bight and adjoining area in the eastern catchment was based on migratory shorebirds and marine turtles.

12.1.1.5 Water resources

Availability of groundwater is illustrated in Figure 76. Utility is compromised somewhat by differences across surveys and overlaps within surveys in classification of low rates from bores, and confidence weakened by poor matches of assignments of flow rates at some boundaries. As with the available land system mapping, these idiosyncracies are presumed to result from the history of work being done for local application rather than promote comparisons across sites.

Nonetheless the map does facilitate identification of areas with yields capable of supporting agricultural or mining use. It should be noted that the stated yields reflect the physical capacity to withdraw water continuously at the stated rate under conditions prevailing at the time of survey. They imply nothing about the sustainability of multiple extractions from the same aquifer.

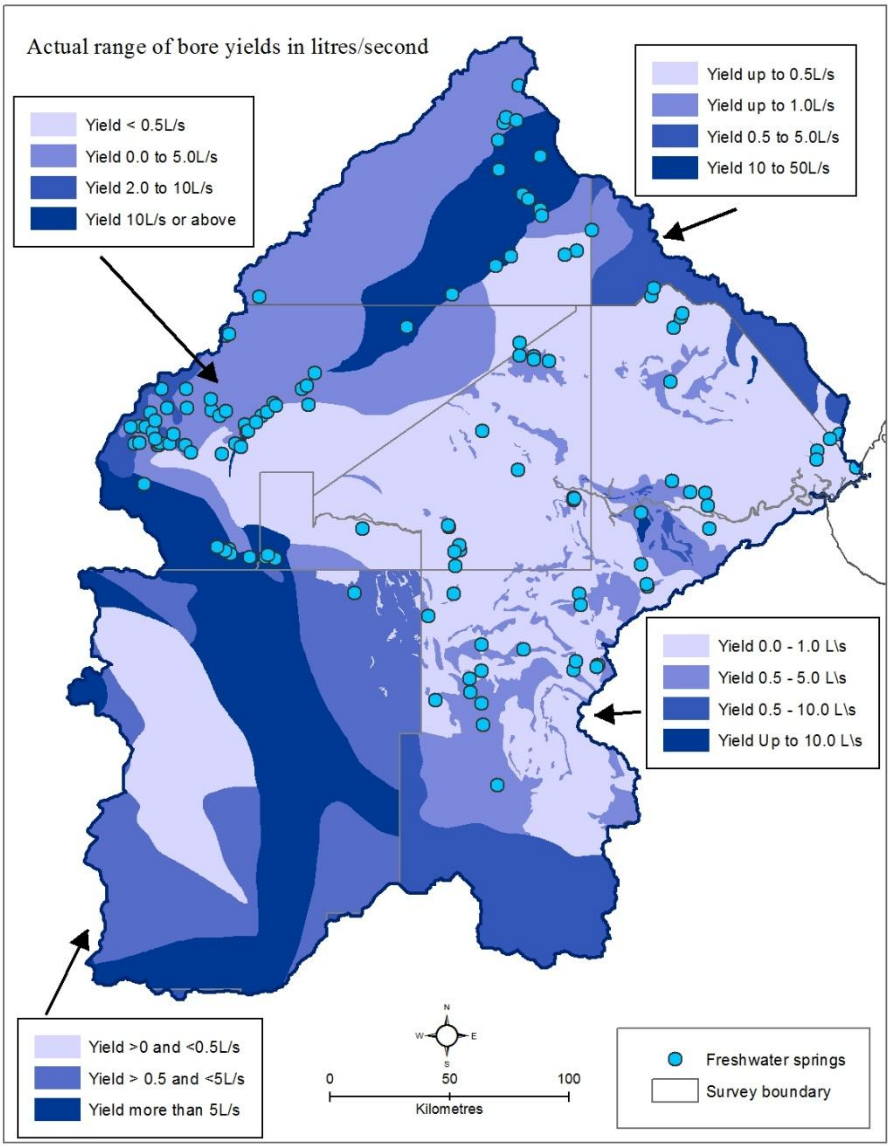

Figure 76: Map of groundwater resources of the Roper River catchment taken from a number of different reports. Different characterisations of flow rates were used in the reports as indicated in legends for the various segments of the map. Sites of freshwater springs that are important to Indigenous people and may be affected by fall in water tables are also indicated.

12.1.2 Cultural heritage values

The Roper River catchment encompasses the lands of a number of Indigenous language groups, most of whom have maintained close connections with their estates. In the east on the Arnhem Land side of the Roper River, are the Wanadarang, Nunggubuyu, Ngandi, Ngalakgan and Rembarmga. South of the river and in the east are Yugul, Marra and Alawa. On the western side of the catchment, Jawoyn, Mangarayi and Yangman are the principal languages. This illustrates the cultural diversity of the region. A proposed Indigenous protected area (Section 12.1.3.10 below) which extends outside the catchment includes Ngalakgan, Ngandi, Yugul and Wandarrang, Nunggubuyu and Ritharrngu language groups.

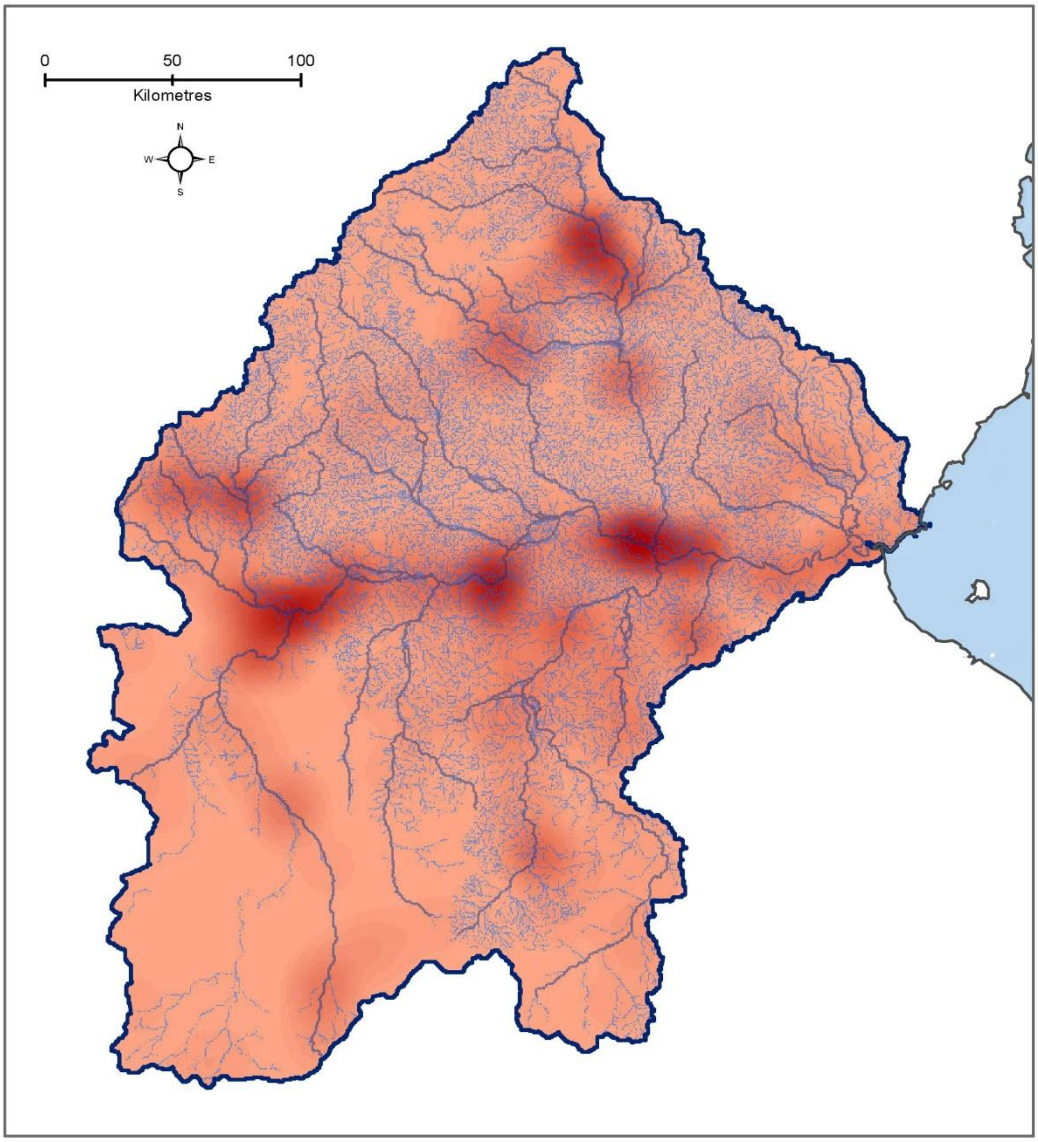

Figure 77 : Density of significant Indigenous sites registered or recorded by the Aboriginal Areas Protection Board in the catchment. There is a strong association of sites with rivers and streams and many sites explicitly assign special significance to water bodies. Many of those sites are located in landscape settings which have little natural protection from impacts affecting water availability or quality.

There are 1188 AAPA registered or recorded sites in the Roper River catchment, with 30.3% of then attributing significance to features associated with water. Most sites, irrespective of features mentioned in nominations, are located close to rivers and streams (Figure 77). For example, 71.1% of registered site had boundaries mapped within 50 m of streamlines[73]. We interpret this result to indicate that issues affecting flows and water dependent ecosystems along the length of the Roper River will require particular attention. Correspondingly, developments that avoid drainage lines will also avoid many (but by no means all) culturally important sites.

12.1.3 Current use values

12.1.3.1 Land tenure and ownership

Some classes of tenure and ownership of lands in the Roper River catchment are summarised in Figure 78 and areas in various tenures given in tables to follow. Indigenous people hold exclusive title to approaching half of the catchment and have had formally recognised or are claiming non-exclusive rights to most of the remainder, so that recognised Indigenous interests may ultimately extend over 94.3% of the catchment (Table 20).

Table 19 :Areas of land under the various tenures and ownership applying in the Roper River catchment. Indigenous landholdings are described in detail in Table 20. Some minor holdings are omitted.

Ownership/tenure	Area (ha)	% catchment	Details
Indigenous freehold	3,566,721	47.1	ALRA
	1,142		NT enhanced freehold
Commonwealth Government	1,421	0.02	
*Northern Territory	42,889	0.6	Held under various tenures including: pastoral leasehold - 3,486,261 Crown leasehold - 423,292 other freehold - 31,899
Local Government	49	negligible	
**Private freehold or leasehold	3,938,942	52.0	
Ownership unknown	575	negligible	
TOTAL	**7,571,335**		

*often through statutory bodies (eg Conservation Land and Development Land Corporations)
** Includes Indigenous Land Corporation holdings intended for divestment

73 Formal mapping of streamlines did not always align closely with recent imagery, so this figure should not be over-interpreted.

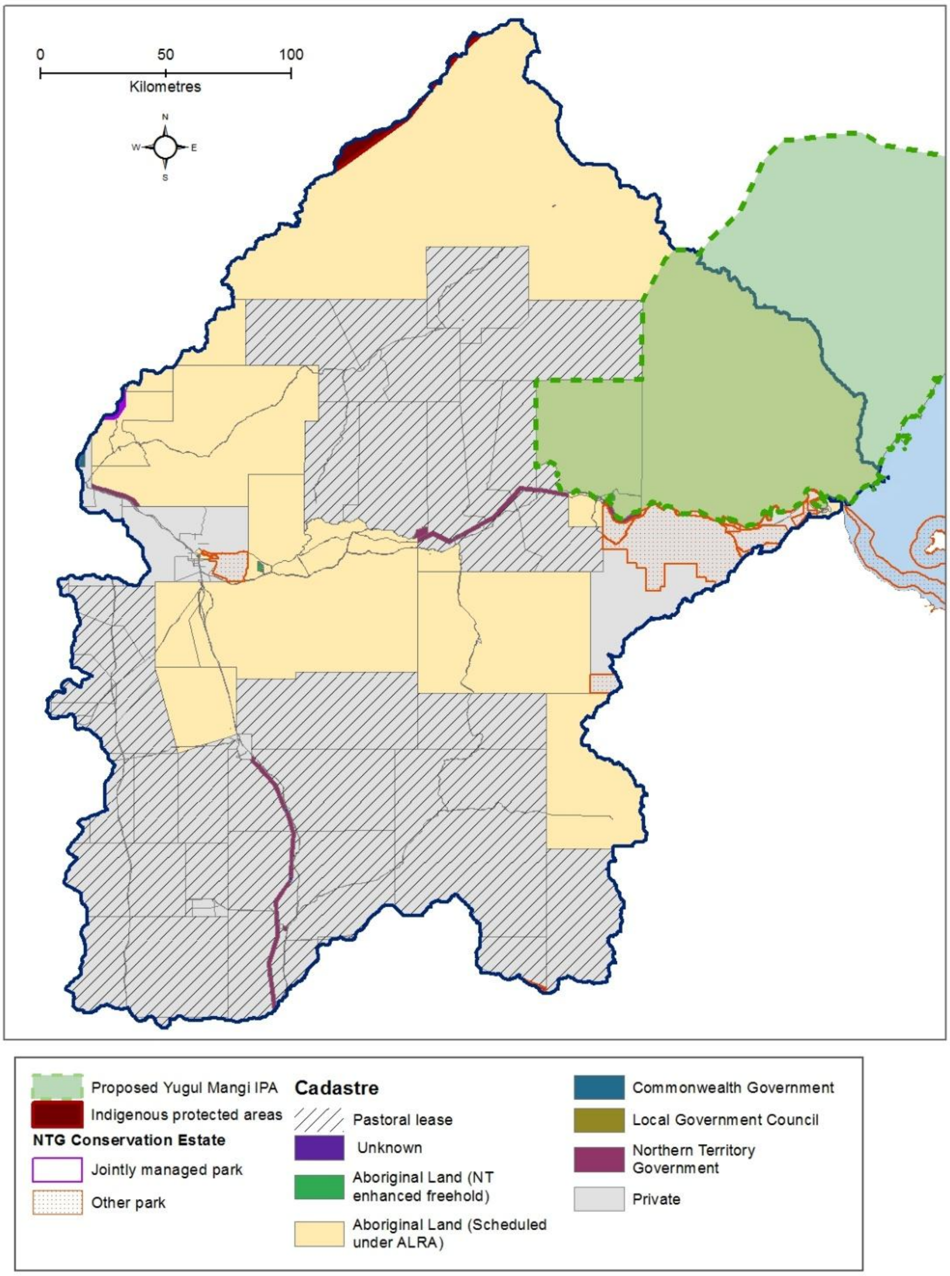

Figure 78: Map of broad categories of land ownership in the Roper River catchment. Area breakdowns are given in Table 19 above and details of forms of Indigenous interest in land in Table 20 below.

The implications of this dominant Indigenous interest in lands are considered further in framing options for offsets and governance arrangements for effective implementation in the Roper River catchment.

Table 20 :Extent and type of Indigenous land interests in the Roper River catchment.

Tenure type	Area (ha)	% catchment	% indigenous interests in land
ALRA scheduled	3,566,721	47.1	65.7
ALRA (yet to be scheduled)	0	0	0
NT Indigenous Freehold	1,142	0.02	0.02
ILC holdings	51,031	0.67	0.9
Native Title determination (exclusive possession)	0	0	0
Native Title determination (non-exclusive)	1,809,348	23.9	33.3
Total all determined interests	5,428,212	71.7	100.0
Native Title applications	1,711,922	22.6	31.5
Total freehold equivalent held	3,618,893	47.8	66.7
Total including applications	**7,140,134**	**94.3**	**131.5 (of existing holdings)**

12.1.3.2 Customary use of wildlife

We are aware of no published accounts of issues in Indigenous harvest of natural resources, including wildlife, specifically for this region. We have assumed that species targeted in other parts of northern Australia will also be exploited here, and generally operate sustainably as they do in other parts of the remote Northern Territory (Brook and Whitehead 2005a,b; Fordham et al. 2008). Concerns have been raised at rates of harvest of dugong in the Torres Strait (Heinsohn et al 2004), although we are aware of no evidence of similar concerns in the Gulf of Carpentaria. Dugong are not regarded as threatened by Northern Territory authorities.

12.1.3.3 Pastoral use

A striking feature of the summaries of domestic stock held on north savannas presented by Bastin (2011) is that he assigns much of the area of the Roper River catchment to levels of usage below the median for the Northern Territory study area (Figure 46). The effective removal of Wolongara from the pastoral estate arguably indicates the marginality of pastoral leases in this region.

And this change is consistent with what Holmes (2010) described as the functional trajectory of the Northern Territory Gulf region (which he defined to include much of the Roper River catchment) from 1976 to 2006 as a movement from production orientation to protection, acknowledging generally low productivity and high production risk.

The extent to which this trajectory might be deflected by a loosening of pastoral lease conditions to include other agricultural uses is considered in Sections 12.1.5.1 and12.1.5.2.

12.1.3.4 Mineral extraction

The largest mine in the catchment was a relatively recent development. Sherwin Iron commenced operations 150 km east of Mataranka during 2013. Large trial shipments of DSO for export were made by road to the port of Darwin under a Mining Management Plan, in advance of a full environmental assessment. The company entered voluntary administration in July 2014 and operations have ceased. There were a number of concerns about impacts, including surface water management and risks to other road users.

Western Desert Resources, another iron ore mine operates just outside the Roper River catchment (in the Towns River catchment) and does not transport its products through the case study area. Its impact is therefore indirect through interactions with people working from the catchment. The Yugul Mangi Development Corporation is enthusiastic about the opportunities created by the mine and is engaged in providing some services to it. Because groups resident in and owning land within the Roper River catchment also have affiliations with the mine site, their interests in land and resources are affected by its biophysical impacts. They are therefore well positioned to assess the need for and offer environmental services including biophysical offsets covering mine impacts. The mine committed in its EIS to a legally binding and auditable environmental offsets agreement to be negotiated with traditional owners and their representatives. However, the federal government[74] did not set offset conditions for this development.

It is significant, in the context of the NTEPA's propositions that environmental offsets should be negotiated as a component of socioeconomic impacts (NTEPA 2013h), that the mine proponent appears to similarly confound social and environmental issues. In its assessment of the project, the Department of Lands, Planning and Environment (the report is dated September 2012, prior to the creation of the present, independent NTEPA) noted that the proponent:

> *has not provided sufficient detail to satisfy requirements of the NT and Australian Government environmental offsets policies. There is no specific statement of residual detriment (as outlined in the draft Guidelines) or actions associated with the residual detriment that will provide clear environmental benefits for matters of national environmental significance.*
>
> and
>
> *The Proponent has put forward an offsets proposal which has been identified as more appropriate for the Community Benefits Package. The Proponent argues that the social benefits that might be created by its proposal could also bring about significant benefits to the physical and biological aspects of the environment, consistent with the principles of ESD*[75]*.*

So far as we are aware, there has been no subsequent agreement to an environmental offsets package designed to address the specific environment detriment caused by the project. There is therefore no clarity about environmental improvements required. This situation provides a highly relevant example of the potential impacts of present Territory policy and practice on capacity to implement a no net loss policy, as discussed in Sections 8 and 9. Indeed the company presents their package as setting a benchmark for future mining operations. We return to this issue in outlining options for new governance arrangements later in this case study.

There have been numerous small mines in the region in the past, now inactive.

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[74] http://www.environment.gov.au/epbc/notices/assessments/2012/6242/2012-6242-approval-decision.pdf

[75] see p. 53 at http://www.ntepa.nt.gov.au/__data/assets/pdf_file/0018/131382/WesternDesertResourcesRoperBarFINAL.pdf

12.1.3.5 Agriculture

Agricultural production (non-pastoral) within the catchment is confined to the western margin near Mataranka. During the period 2003-2013 there were no land clearing approvals on freehold or pastoral leasehold land in the catchment.

12.1.3.6 Petroleum and gas extraction

There is presently no oil or gas production in the catchment, although relevant exploration is occurring in the context of test wells for unconventional (shale) gas in the southern parts of the region.

12.1.3.7 Unconventional oil and gas exploration and extraction

Large areas of the catchment are apparently prospective for shale gas, and this has resulted in substantial exploration activity, ranging from remote sensing to drilling of test wells. There is no publicly available report of environmental effects, but given the locations in which work is occurring risks of disturbance to vegetation like Lancewood is possible (Figure 79) and there have been anecdotal reports to this effect. Wells may intersect important high flow aquifers, but again there have been no reports of difficulties.

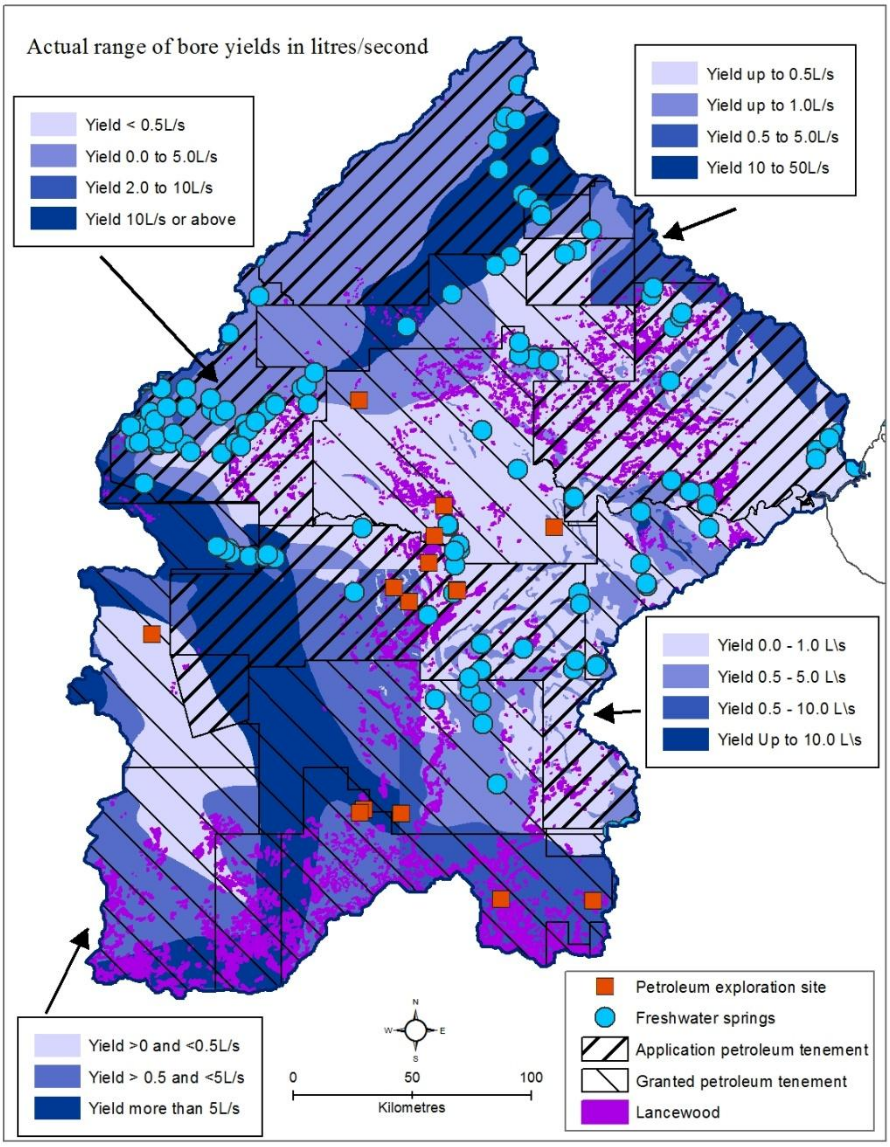

Figure 79: Distribution of petroleum (including gas) exploration wells in the Roper River catchment. Some activity appears likey to intercept important aquifers and to be occurring in and around vegetation that is sensitive to disturbance (Lancewood).

12.1.3.8 Water use

Water entitlements issued to take surface water directly from the Roper River and tributaries are modest, with the largest registered being 201 Ml from Bamyili Spring for the Barunga town water supply. This summary may be incomplete because we found no entitlement for the Ngukkur township water supply in the public record. Allocations from the Tindall Limestone Aquifer, which supports dry season base flows in the Roper River are very substantial. Increases in years of no flow are possible as these entitlements are taken up (Knapton 2009) and there may be additional impacts on groundwater-dependent ecosystems, especially close to the points of extraction. The net effects of existing settings are difficult to predict. Justification for recent large entitlements was based in part on a useful but somewhat arbitrary rule of thumb known as the 80:20 rule, under which 80% of groundwater recharge is reserved for the environment and other public purposes (DNRETA 2006). The local and wider ecological effects of extracting 20% of the water entering this very large and complex aquifer system are unknown. There has been no attempt to specify what sorts of changes are acceptable to local people or the wider community.

12.1.3.9 Commercial harvest of living resources

Indigenous people in northern Australia have a longstanding interest in the sustainable commercial use of wildlife as a source of income that draws on customary skills, and offers alternatives to enterprise like agriculture that requires severe disturbance of landscapes (Whitehead 2012). A number of small scale ventures have been instituted in other parts of Arnhem Land and the Daly River (Griffiths et al. 2003, 2005; Whitehead et al. 2006; Fordham et al. 2007, 2010), most enduringly and commercially successful in the use of native plants in arts and crafts (Koenig et al. 2005, 2011a,b). Whilst we have no measure of the scale of use of such items in the catchment, art-related activities similarly depend on access to wild plants for "canvasses" and dyes[76].

12.1.3.10 Local conservation activities

12.1.3.10.1 Protected lands management

Areas formally designated for conservation are quite limited given the size of the catchment (Table 21 and Figure 78).

The small Elsey National Park (13,840 ha) is at the headwaters of the Roper River and is managed primarily for its tourist attractions in thermal pools, boating and canoeing (PWC 2011). A portion of the large Limmen National Park falls within the catchment and supports more substantial conservation values. Staffing of both of these Territory Parks is lean and effort necessarily focused on visitor and facilities management rather than conservation. A proposal for a substantial new IPA is under consideration[71] in the east (north of the Roper River and coinciding with the NTG SoCS. , with an area of about 907,000 ha. This addition would increase the existing area of protected lands to about 18.2% of the catchment.

The AWC's Wongalara Sanctuary[77] in the north-east of the catchment abutting the proposed IPA is a relatively recent but potentially important centre of conservation activity in the region. Nonetheless, the total amount of formal (paid) conservation work in the catchment remains very small considering the size of the area (3.5 times the area of Kakadu National Park) and the challenges we have outlined.

[76] http://ngukurrarts.net.au/Ngukurr_Art/About_art_center.html
[77] http://www.australianwildlife.org/sanctuaries/wongalara-sanctuary.aspx

Table 21 :Protected areas in the Roper River catchment.

Protected area type	**Total area (ha)**	**Percentage of catchment area**	**Details**
Indigenous protected area	15,164	0.02	Portion of Warddeken IPA
Declared reserve - joint managed	11	negligible	Portion of Nitmiluk National Park
Other declared protected area	162,821	2.2	Portion of Limmen National Park and Bullwaddy Conservation Reserve, all of Elsey National Park
Private conservation area	192,000	2.5	Wongalara, pastoral lease owned by AWC
TOTAL	369,916	4.9	

12.1.3.10.2 Fire management

Fire management is treated by all Indigenous land managers and many pastoralists as a core activity, although their purposes and methods may be quite different (Dyer et al. 2001). Parts of the catchment have very high fire frequencies and an undesirable level of late and consequently more often severe dry season fire (Figure 51 above).

Incentives provided by the Carbon Farming Initiative have been important in driving improvement in several areas of north Australia, including west Arnhem Land and Fish River in the study area. Detailed proposals have been developed by NAILSMA (unpublished manuscript) to extend similar activities to the higher rainfall (>1000 mm) parts of the catchment.

Most of the Roper River catchment falls outside the 1000 mm annual rainfall isohyet which marks the limits of the present savanna burning methodology (DCCEE 2013). However, parameters have been agreed for a new methodology to apply in areas with rainfall as low as 600 mm mean annual rainfall (Whitehead et al. 2014; Russell-Smith, pers. comm.).

Later in this paper (Section 12.2) we consider options to build a savanna burning project as a core component of a suite of offset options in the catchment.

12.1.3.10.3 Feral animal and weeds management

Roper River Landcare Group works on all key natural resource management issues but has been particularly focused on weeds, feral animals and capacity building. An early project was to fence river frontages to protect riparian vegetation from feral animals The group has supported the Mangarrayi to build capacity for employment and stewardship of the land.

The region's other Indigenous Ranger groups are also active in weed and feral animal control, as is the AWC at Wongalara. However, these efforts have not been sufficient to contain major pests such as buffalo and weeds like *Parkinsonia.* As noted in other contexts, the resources available are not well matched to the scale of the landscapes requiring management and the array of problems.

12.1.3.11 Tourism

Most tourist activities centre around the Roper River. Access is gained from the north and south along the Stuart Highway and east along the Roper Highway ultimately linking to Queensland at Burketown. The route is celebrated as a more adventurous part of the Savanna Way[78]. About 170,000 people visit Elsey National Park at the more accessible western edge of the catchment, but about 30,000 pa make it to Limmen National Park at the eastern end.

Although we have indicated that we will not consider tourism in detail as an influence of land use change, except perhaps as a break on more extreme decisions, we raise it again here in the context of understanding government attitudes to offsets. The Northern Territory Government has invited expressions of interest in development of tourism infrastructure within all parks, including Limmen National Park. The profile offered to inform potential investors notes that parts of the park are regarded as highly prospective for gas and iron ore extraction, presumably to alert them to risk of conflicts. It goes on to say that "Offset options benefiting the Park and local communities are being considered[79]".

12.1.4 Society and economy

Based on and approximate matching of census mesh blocks (accessed from the Australian Bureau of Statistics website[80]) to the catchment boundary, the population (usual place of residence) in 2011 was 3552 persons, or a human population density of 1 person in 2259 ha (or about 3500 ha per person of working age (>15 years).

It is more difficult to describe other aspects of the region's economic profile because figures are aggregated at larger scales to protect confidentiality. These do not align well with catchment boundaries. However, some impression of employment status can be gained from figures for larger settlements in which many of the region's people reside. A few details are in Table 22. The median weekly income for Indigenous people in the centres listed was $218 in Numbulwar, $269 in Ngukkur and $268 in Minyerri. The median weekly income in the Northern Territory is $745.

Table 22 :Some statistics on demography of populations of settlements within the Roper River catchment.

Location	Indigenous (total) Population	Indigenous Working age (>15 years)	Indigenous full time employment	Median weekly income ($)	Indigenous language spoken at home (%)
Ngukkur	972 (1056)	624	79	269	98.9
Numbulwar and outstations	624 (687)	424	40	218	96.8
Minyerri	441 (441)	246	27	268	99.3

78 http://www.savannahway.com.au/
79 http://www.parksandwildlife.nt.gov.au/__data/assets/pdf_file/0009/353925/Limmen_NP.pdf
80 http://www.abs.gov.au/websitedbs/censushome.nsf/home/meshblockcounts

12.1.5 *Type extent and severity of potential land use change*

Here we use the available assessments of prospectivity for agriculture and unconventional gas to consider potential land use change and the issues for conservation raised by it.

12.1.5.1 Agriculture

Soils considered suitable for one or more forms of agricultural activity are widely distributed in the catchment although they are often patchy. Soils have not been mapped at the resolution needed to specifiy areas of local development precisely, and so have been identified and mapped relatively coarsely in classes separated on the proportion of the landscape considered likely to contain suitable soils (Pascoe-Bell et al. 2011). The maps to follow indicate the distribution of those soils in conjunction with favourable access to groundwater (Figure 76). In combination these influence the classes of agricultural activty that may be plausible.

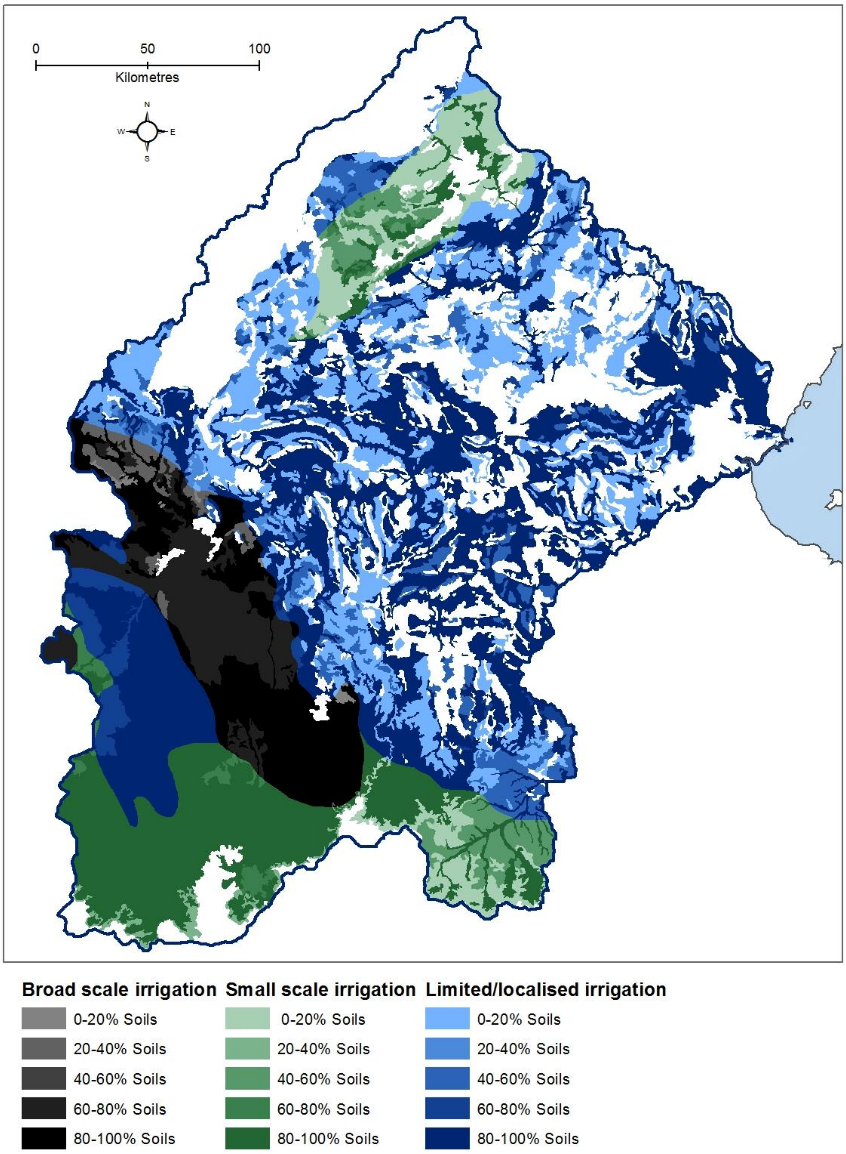

Figure 80: Location of sites in the Roper River catchment considered prospective for annual horticulture, a high value agricultural use. Details are taken from Pascoe-Bell et al. (2011).

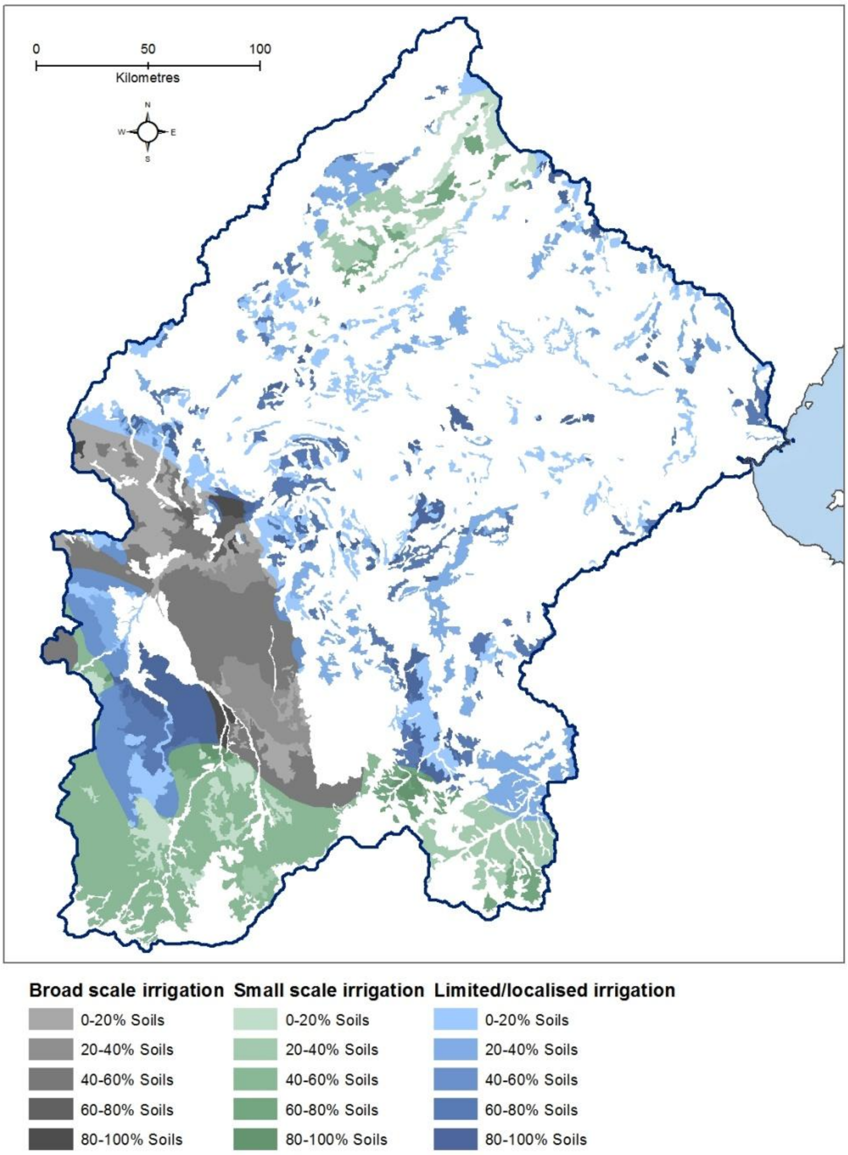

Figure 81: Sites in the Roper River catchment considered prospective for irrigated field crops and perennial horticulture. Details are taken from Pascoe-Bell et al. (2011).

In the annual horticulture category, high quality and abundant water permits cultivation of high value crops like annual vegetables and fruits. Over most of the area the conjunction of soils and waters is too weak to sustain more than local activity. In the south-west, however, there is a wide band of land apparently suitable for broad scale high value uses (the dark gray in Figure 80 and Figure 81. Location south of the Roper River and within a relatively short distance from the Stuart Highway will ease access to transport options that may complicate reliable access to markets for the rest of the catchment. Given already significant horticultural activity in the Mataranka region on the western margin of the catchment and adjacent to these areas, there would appear to serious prospects of agricultural development in at least this area.

Areas classed as suitable for rain-fed cropping were chosen to balance annual rainfall sufficiently high and predictable to produce crops reliably, but not so wet as to confound access for management. Most of these areas occur north of the Roper River (Figure 82) and accordingly suffer greater logistic difficulties in access to services and markets.

Obviously developments of field crops or any other broad scale operations have substantial impacts through land clearing, water use, sedimentation and other agricultural pollution.

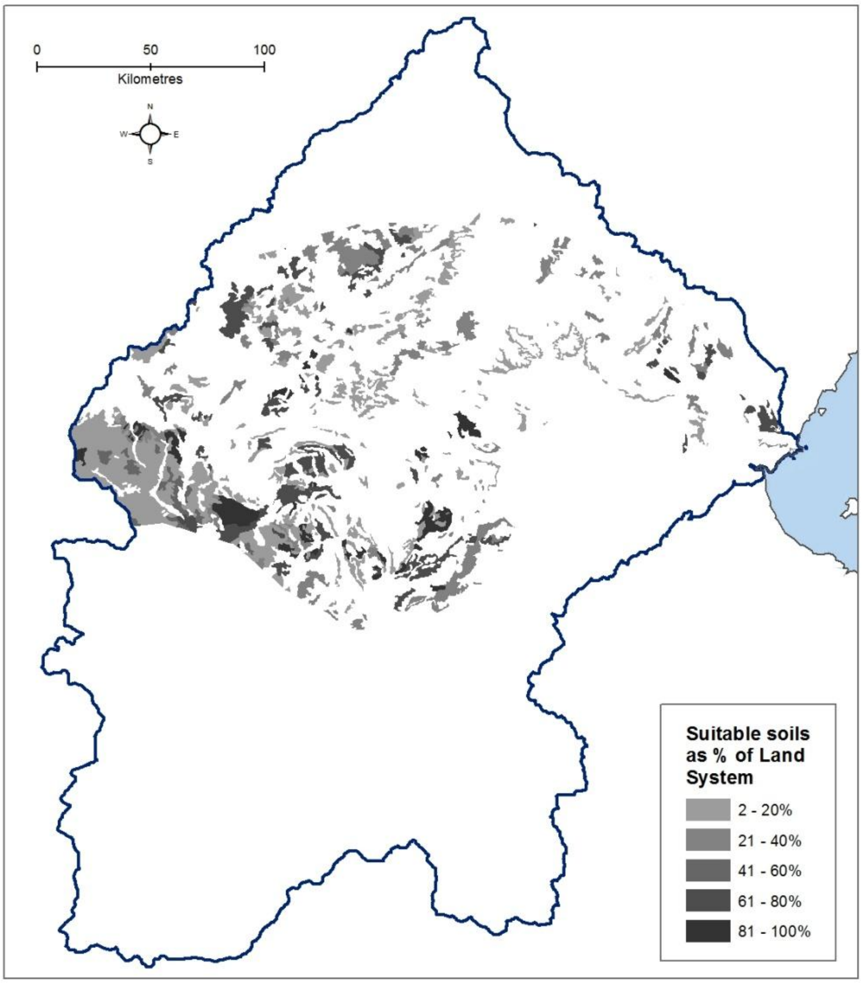

Figure 82: Sites in the Roper River catchment considered prospective for rainfed and irrigated field crops and perennial horticulture. Details are taken from Pascoe-Bell et al. (2011).

In an attempt to simplify presentation, Figure 83 offers an integrated view of agricultural potential based on the highest value at each point in the landscape (Table 10). We did not discount values for distance from roads and other issues of accessibility although this would be an obvious improvement.

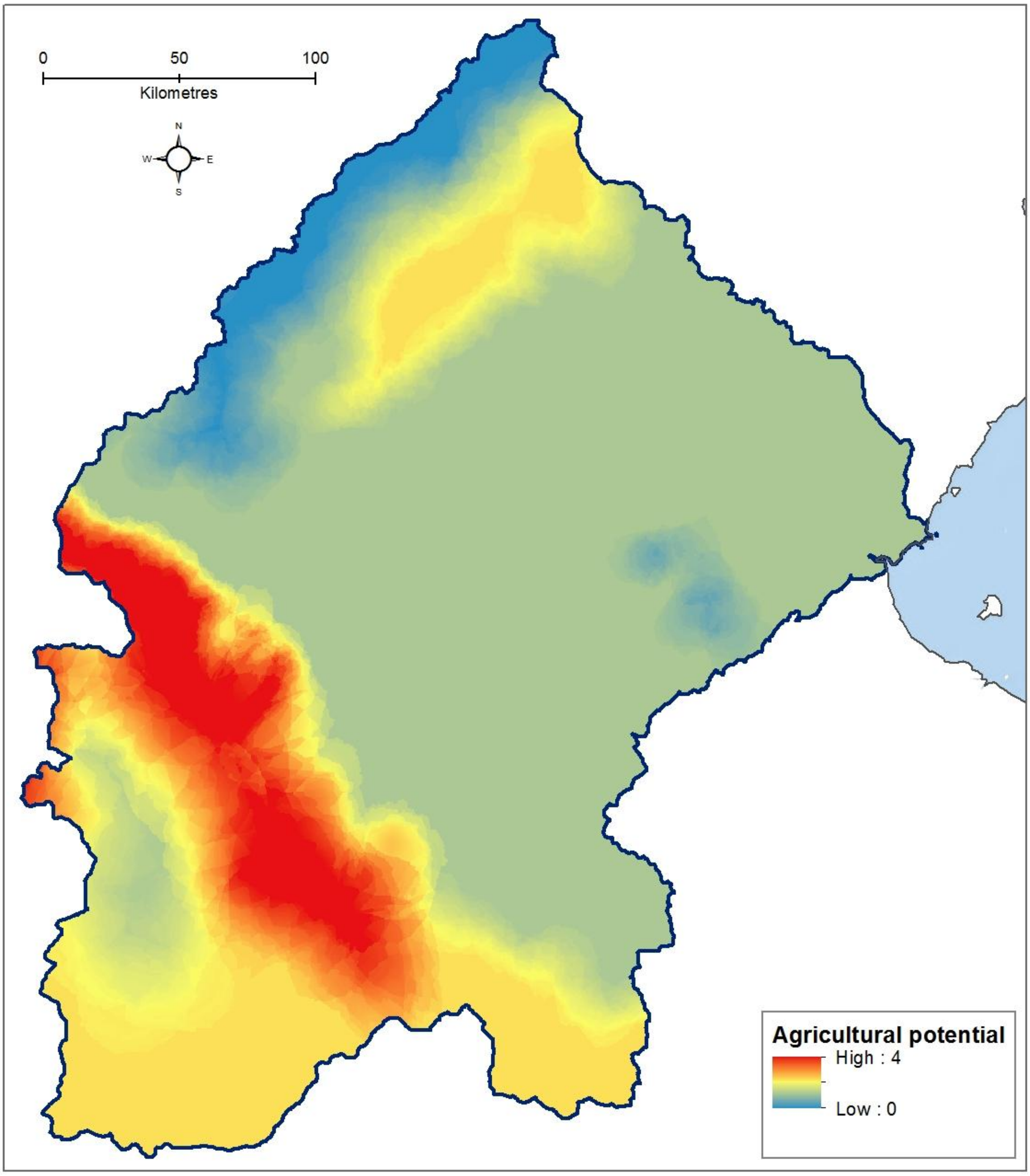

Figure 83: An abstraction of the maps of Pascoe-Bell et al (2012) seeking to integrate the different potential uses based on the index described in Table 10 and taking the highest value at each point in the landscape. Interpolation used ArcGIS kriging The quanta indicated have no particular meaning but are best treated as relative rankings.

12.1.5.2 Pastoralism

Given the substantial existing pastoral estate (Figure 78 above), pastoral lessees may seek opportunities to develop irrigated pastures. Some Indigenous groups may seek similar options, particularly in partnership with other pastoral interest. These sorts of opportunities are potentially captured in the mapping indicating sites with reasonable proportions of favourable soils and substantial water availability: as shown, for example, in the broad scale categories in Figure 80 and Figure 81. It is unclear how applications for entitlements for large volumes of water for this purpose would be viewed by regulators, but in the absence of binding plans and a *laissez faire* approach, owners with areas considered suitable for such use will have great incentive to apply for entitlements which, if water markets are implemented, may become valuable disposable assets should such management prove non-viable in these settings.

Such developments would have similar impacts on native vegetation and water as irrigated cropping plus elevated disturbance associated with high stock densities. Depending on management regimes those impacts could extend off the sites converted directly to irrigated pasture.

12.1.5.3 Mining

In addition to the existing Sherwin Iron mine (now not operating), development of an ilmenite mine has been proposed and been through the environmental assessment process for the Roper Bar area (SIL80 summarised in Attachment 1). That operation may no longer proceed following falls in ilmenite prices that have led to closure of similar mines in other states. The Department of Mines and Energy identify a relatively small carbonate hosted zinc-lead deposit near Bulman in the north west of the catchment that they treat as prospective.

Given the likelihood of continued depression of some commodity prices relative to the recent boom, increases in mining activity may be delayed, and the extent and distribution of new mines and whether the existing closed ones will be properly decommissioned to reduce impacts is difficult to predict. However, the areas affected and probability of development are arguably lower than other potential sources of change like agriculture, pastoral intensification and unconventional gas development.

Should serious proposals be made to develop these or other areas, interests in the catchment should ensure that , given the significance of water resources for other production, biodiversity and cultural values, all potential impacts on water availability and quality should be carefully assessed.

12.1.5.4 Unconventional oil and gas

The Roper River catchment contains large areas regarded as highly to moderately prospective for unconventional oil and (particularly) gas from deep shale deposits (Figure 84).

Development would appear to be most probable initially on the southern margins of the catchment, closer to existing gas pipelines including a spur running east from the Darwin-Amadeus pipeline to McArthur River mine. Subject to successful operations in those logistically favoured sites, there would appear to be options to expand into more or less contiguous areas south of the Roper River.

Areas of high prospectivity overlap with a NT SoCS and the proposed Yugul Mangi IPA. It is important to note that the relevant agency intends to make further releases of land for this activity during 2014. It will be of some interest to see if those tenements intersect with either of these sites or other culturally significant areas.

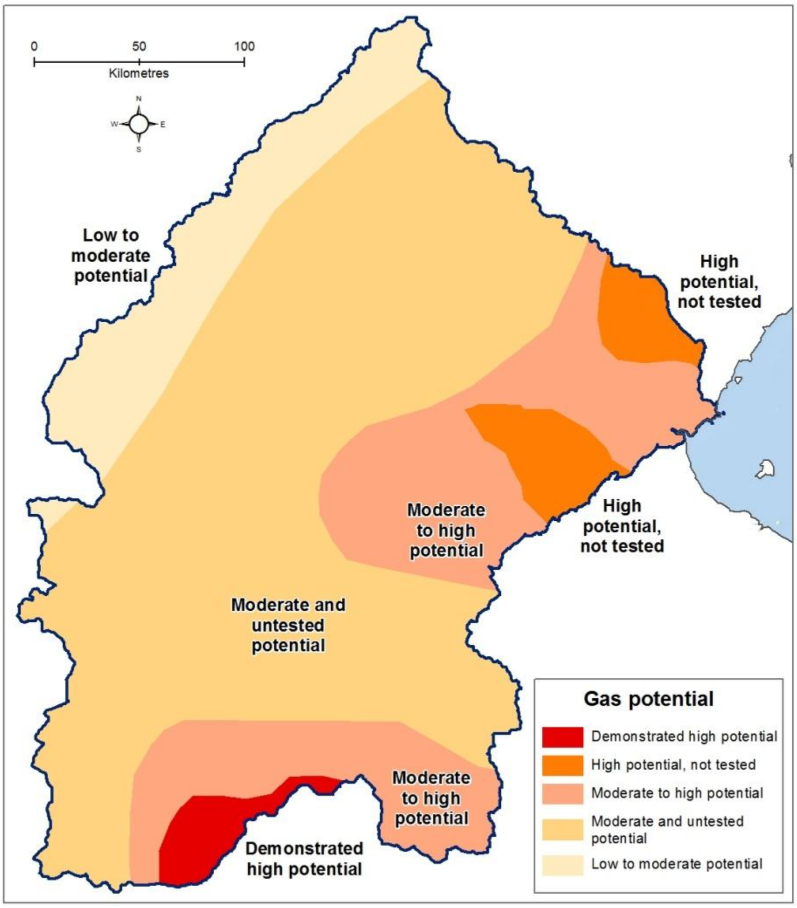

Figure 84: Areas regarded as prospective for unconventional gas in the Roper River catchment digitised from DME presentations. There are several large areas of high potential, including an area in the south of the catchment in which that assignment has been at least partially validated.

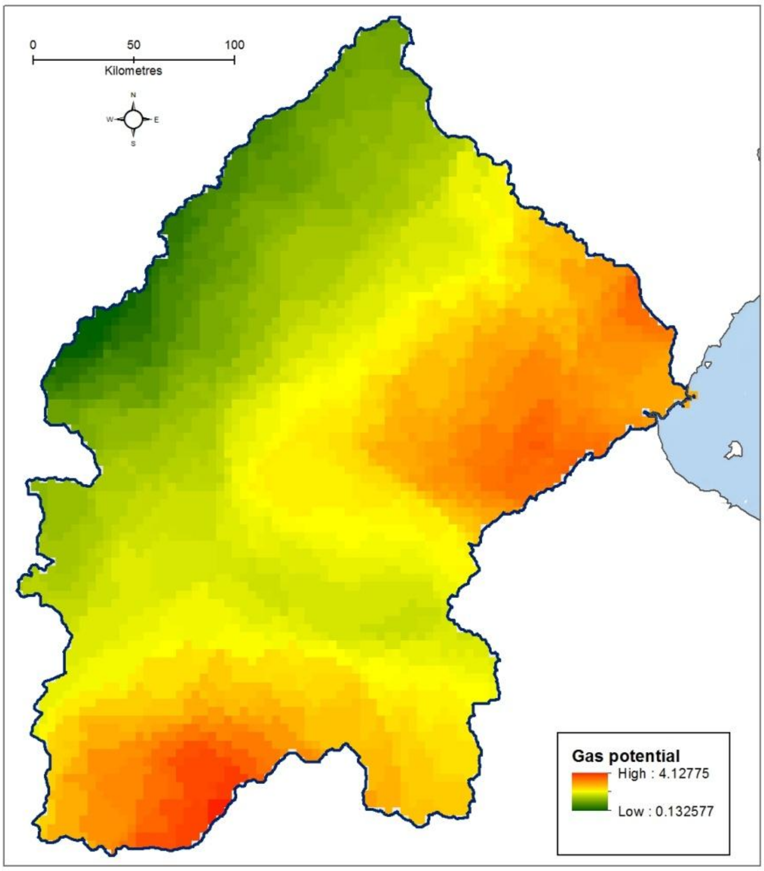

Figure 85: An abstraction of the map above based on an index of prospectivity (Table 11) discounted for broken terrain and interpolated using ArcGIS kriging.

12.1.6 Intersections of values and drivers of change

12.1.6.1 Natural heritage

12.1.6.1.1 Fauna

Of the records of notable fauna identified in Territory law and practice, 79% intersect with areas of some prospectivity for agriculture (including intensified pastoralism) and 89% with areas prospective for unconventional gas ranked at or above moderate potential. Corresponding figures for EPBCA-listed species are 78% and 78%. None of the intersections could be said to indicate a site known to be especially significant for the species concerned (Figure 86 and Figure 87).

These observations may act as triggers for more comprehensive examination of the significance of sites for threatened species when particular developments are proposed at or close to these points. Although the approval of the proposed IPA does not constitute declaration of a park under the EPBCA, it may be an important influence on likelihood of referral and nature of conditions proposed on any development within or close to its boundaries. Activity in and around the SoCS could act as a trigger for NTEPA assessment, including requirements for offsets.

12.1.6.2 Flora, including vegetation types of conservation interest

Point records of notable flora are too sparse to contribute meaningfully to identification of areas of strong potential conflict. 57% of records for Territory listed species coincide with the most prospective areas for agriculture and 88% with sites above moderate potential for tight gas. It should, however, be noted that these records were for near-threatened species.

12.1.6.3 Cultural heritage

Although we have been careful to avoid offering maps of specific locations of sacred sites and other locations significant to Indigenous people, this is not a reflection of the quality of information available. The nature of the listing process under Territory law requires careful consultation with all relevant Indigenous interests and accurate mapping of sites. This is not to suggest that lists are comprehensive but it does appear reasonable to argue that they data used here reflect the priorities assigned to protection of these sites by Indigenous people. The only *caveat* on this conclusion is that people with long term ownership of land and the right to restrict access under that ownership may have been less concerned to seek protection than custodians of sites outside Indigenous land.

There are clear nodes of focus for protection of cultural sites, conspicuously associated with the Roper River mainstream and some other major waterways. Equally conspicuously, there are sites where those nodes intersect with areas prospective for broad scale irrigated agriculture (Figure 88). Clearly development in such areas will require careful consultation and planning.

There are also some important overlaps of areas of substantial cultural significance with sites prospective for shale gas (e.g. Figure 89 below). Clearly traditional owners and other Indigenous people will seek careful negotiation and planning before development proceeds in or around such intersections.

The strong association of many sites, including the high density nodes, with the Roper River channel and valley, together with the large proportion of sites valued for water-related attributes, highlights the importance of maintaining healthy flow regimes in the Roper River.

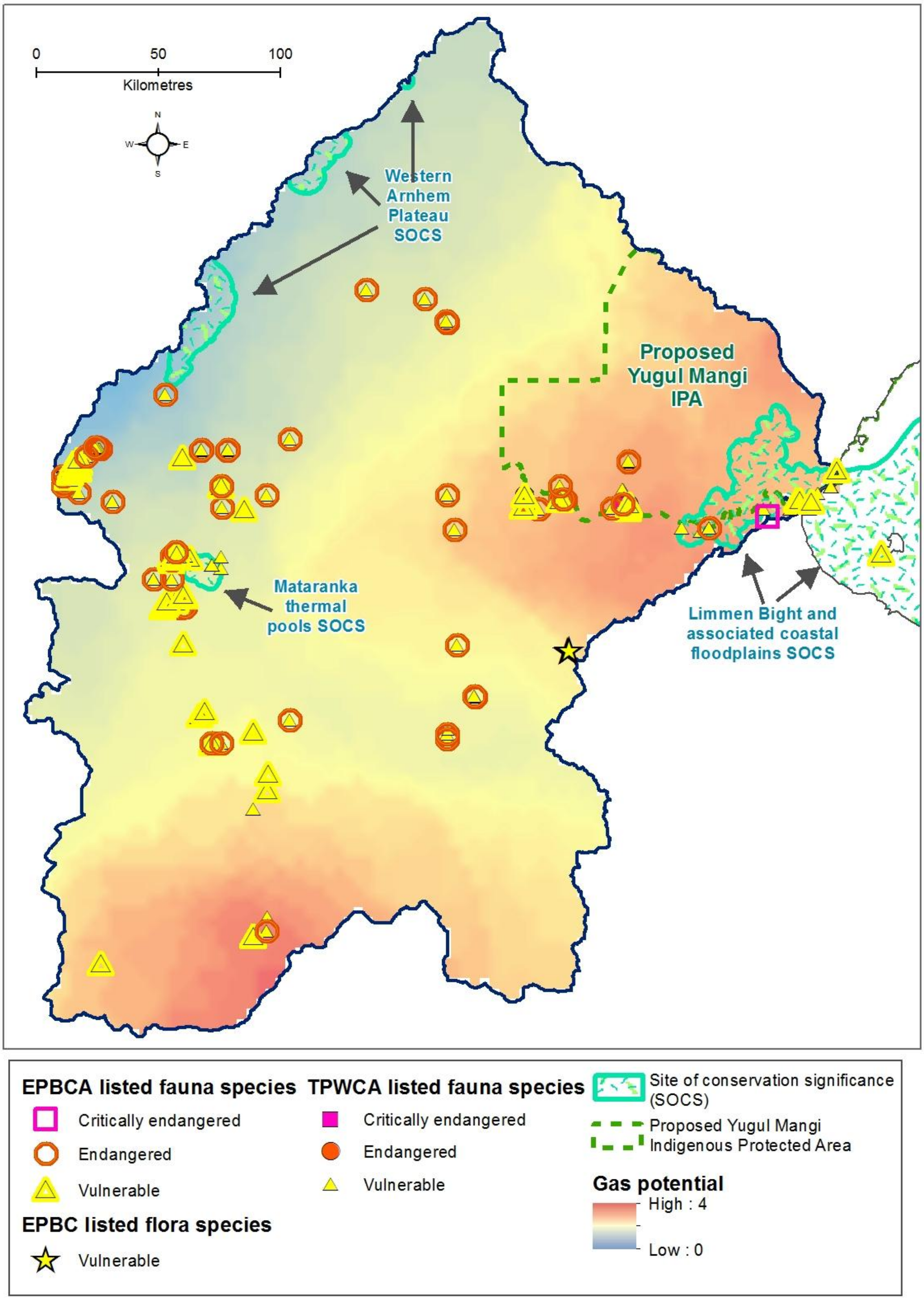

Figure 86: Intersection of listed species records and other areas of special conservation significance with areas of high prospectivity for unconventional gas in the Roper River catchment.

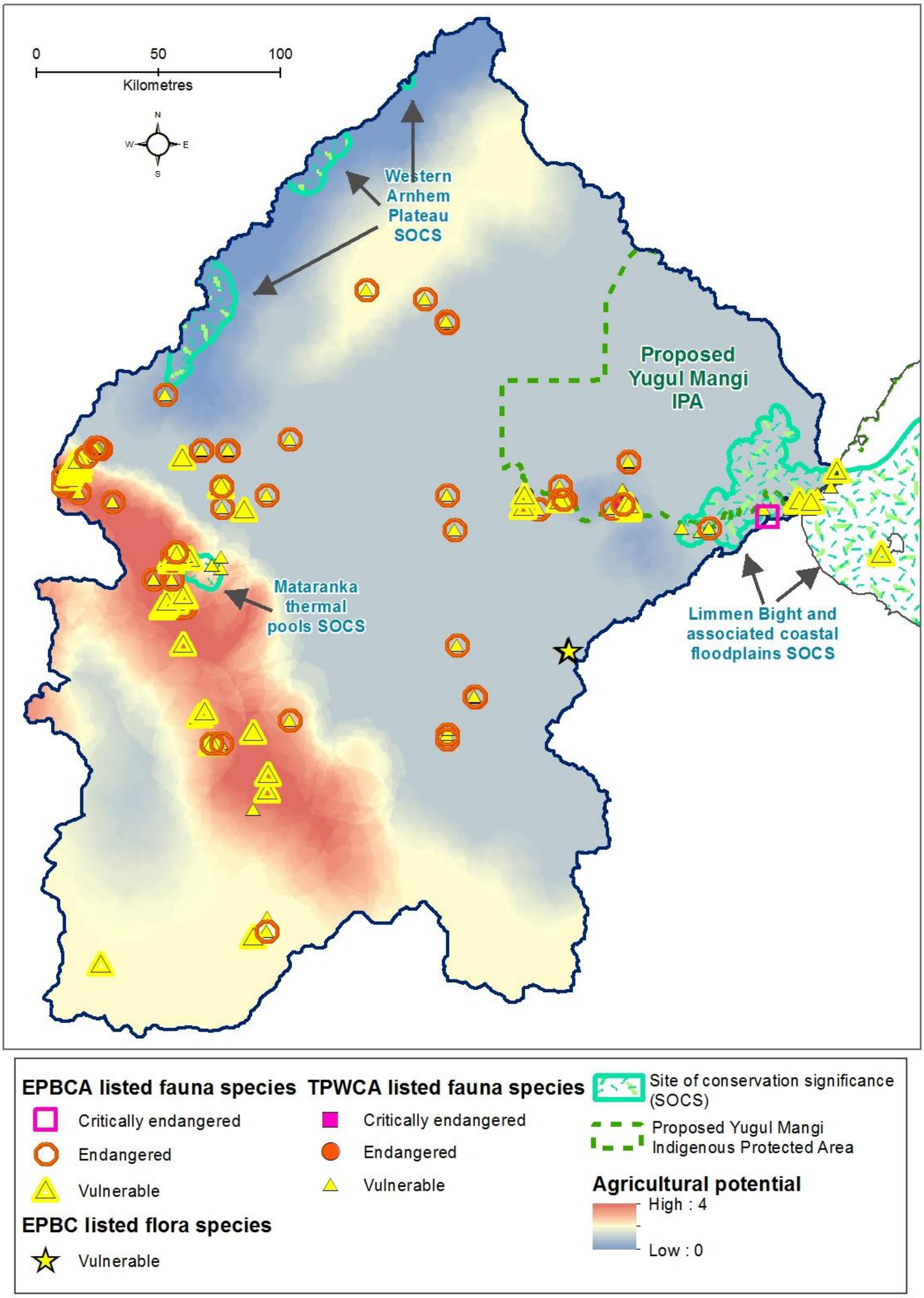

Figure 87: Intersection of listed species records and other indicators of conservation values with areas of high agricultural prospectivity in the Roper River catchment.

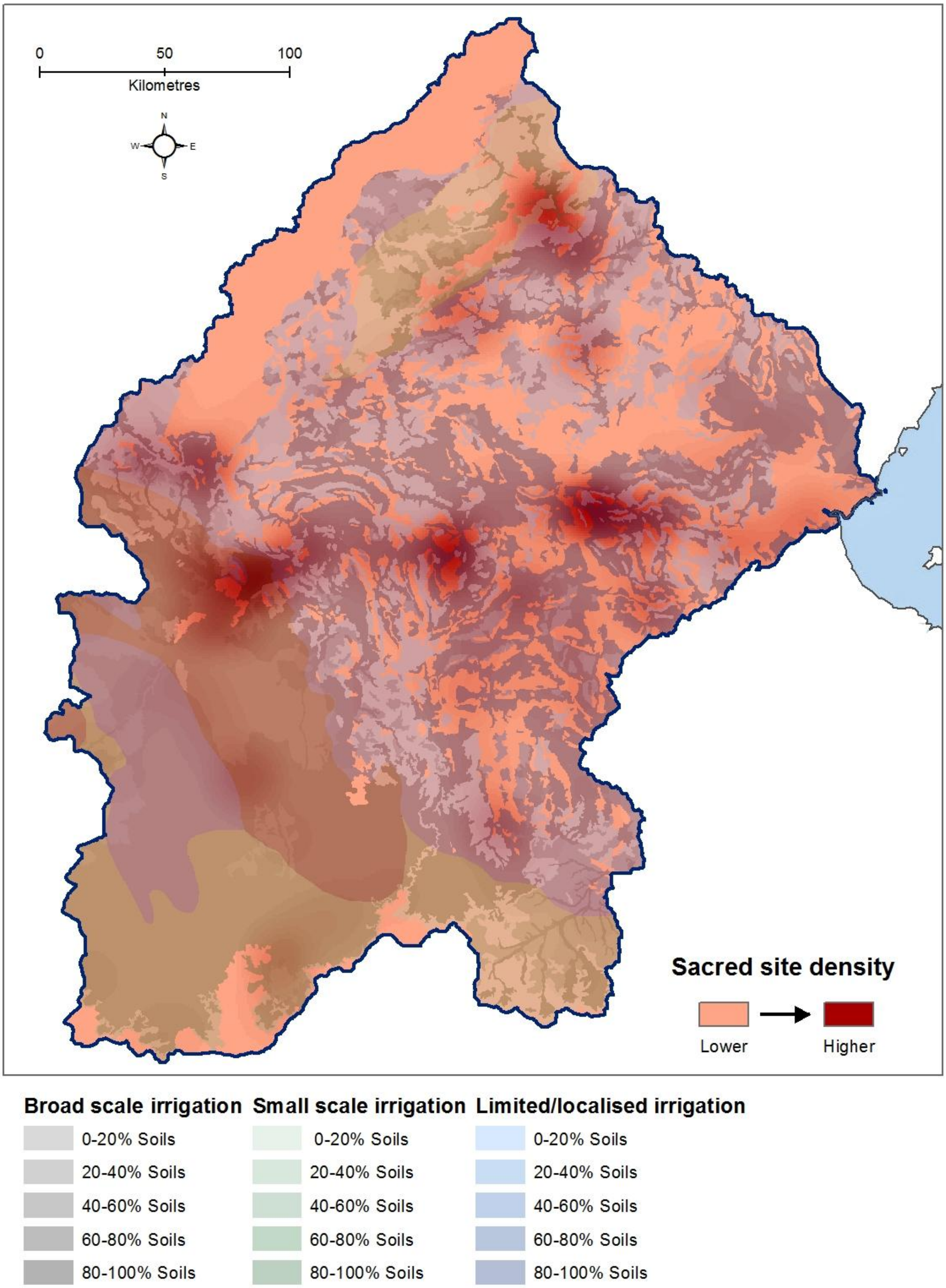

Figure 88: Overlay of relative density of registered and recorded sites over areas of varying agricultural prospectivity. There are clearly areas where a high density of sites coincides with areas considered to offer opportunities for broad scale irrigated agriculture. The conjunction is particularly striking in an area west of Mataranka.

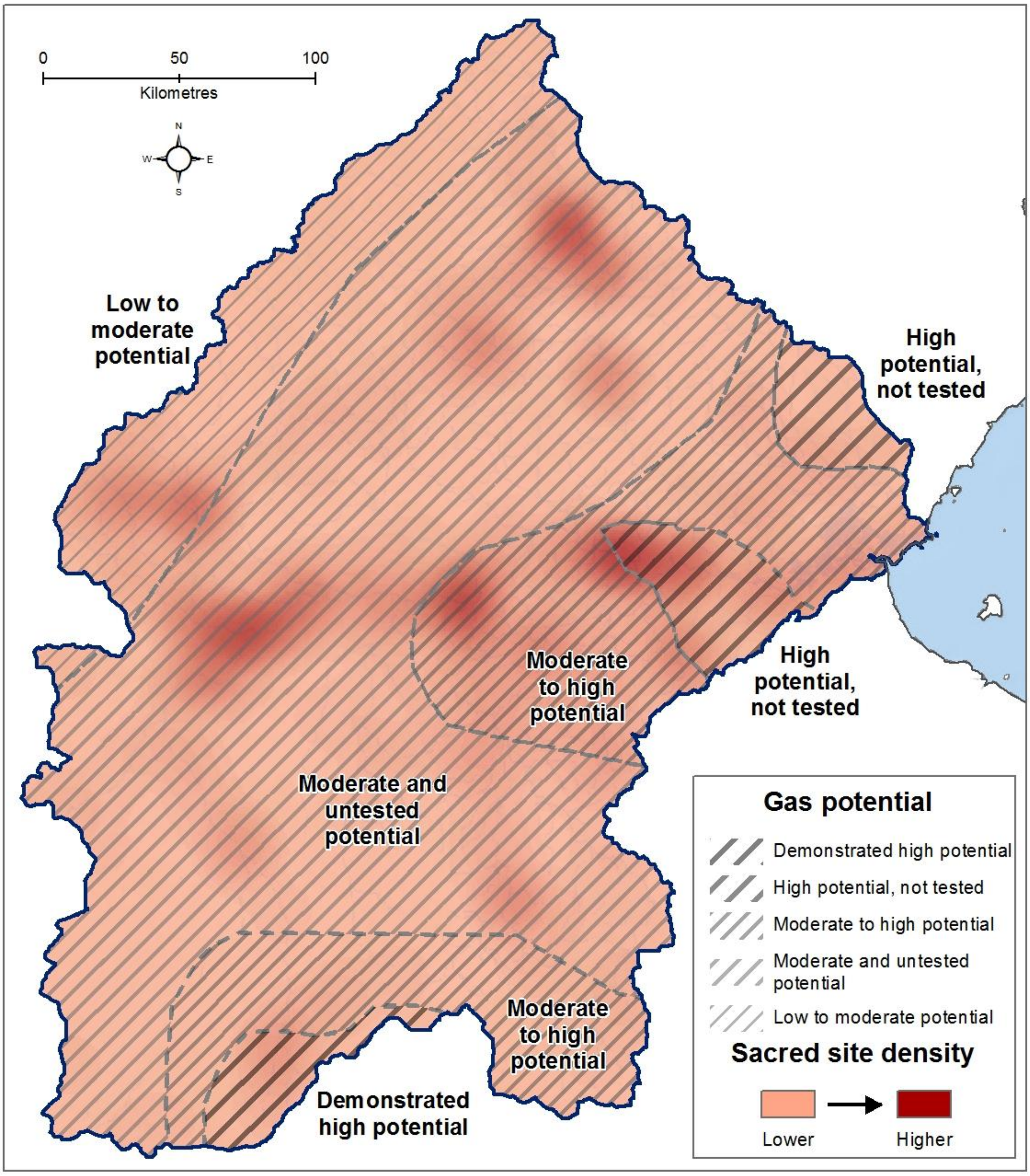

Figure 89: Overlay of areas of elevated Indigenous cultural significance with areas prospective for shale gas. There are intersections of areas of higher density of important sites with areas of high potential, including the site of present activity on the southern margin of the catchment and more strikingly in areas of moderate to high prospectivity around the Roper River.

12.2 Array of potential offset demands and options

Here we identify a number of biophysical offsets useful for dealing with prospective change and of broad community interest. We connect them with cultural values later in this treatment.

12.2.1 Carbon farming - savanna burning

To provide an example of a readily available offset opportunity, we have considered options for a savanna burning project in the area of the proposed Yugul Mangi IPA (Figure 78 above), most of which has annual rainfalls of < 1000 mm and so falls outside the coverage of the existing savanna burning methodology (DCCEE 2013). Using descriptions of eligible vegetation/fuel types and emissions parameters from a proposed new lower rainfall methodology (Russell-Smith et al. 2014b) we have estimated average annual emissions over the period 2000-2009 at 40,600 tonnes CO_2-e. Fire frequency is high but less extreme here than in some other parts of the catchment, with an average of 34.7% of the area burning annually. The fire is mostly late (24.3% of the total project area).

We propose that an ambitious but realistic target would be to shift the fire regime to 20% early fire and 10% late fire (proportion of site burned annually in each case) while reducing the total amount of fire by a little less than 5%. This would realise abatement of about 9,100 tonnes CO_2-e pa. A more aggressive approach might return up to 50% more abatement. We consider that on the basis of experience elsewhere, targets of this order could be achieved by a fire team of 5 and relatively modest use of helicopters to meet labour and operational costs at a price of about $15 per tonne CO_2-e. Whilst a methodology for lower rainfall regions covering carbon sequestration through fire management may be some time in development, the total carbon benefit through enhanced storage in woody vegetation and coarse litter will greatly increase returns.

We, however, consider that the important benefit from establishing a savanna burning project in this region will be strategic: to drive a pan-Arnhem Land fire management cooperative which can build collaboration in other areas. Independent but coordinated groups will be positioned to support each other to achieve shared goals and reduce the risks of severe and unmanageable wildfire in any part of the region.

12.2.2 Loss of native vegetation

We have estimated that 3-5% of an area with a productive shale gas field could be cleared of native vegetation to facilitate access and insert and protect infrastructure. Depending on the level of commitment to impact minimisation, the amount of clearing could be considerably greater. There will be no incentives to reduce clearing on pastoral land, where lessees may welcome removal of dense vegetation like lancewood forests, which have a particularly low grass over.

Operators of gas fields could, however, be required to offset such clearing, which may encourage approaches to design and layout to reduce disturbance to the maximum extent practicable. Indigenous landholders will be in a strong position to provide such offsets to compensate for on site losses of biodiversity value. They may also offer offsets for carbon losses through savanna burning or other carbon farming projects. There may even be options to offset clearing-related carbon emissions by skilled management of fire on development sites (see Section 12.2.6 below).

The situation with clearing for agriculture is less clear, even though environmental impacts may be substantial. Agricultural developments, even when they involve land clearing much greater in area than required by other forms of development have rarely undergone formal environmental assessment. And given an apparent antipathy to offsets, the Territory appears unlikely to seek them for agricultural clearing unless required by federal triggers such as the presence of one or more threatened species.

12.2.3 Impacts on water dependent ecosystems

Despite their great significance for biodiversity through damage to water-dependent ecosystems, impacts of water use either through direct withdrawal from rivers or streams or by drawdown of aquifers are likely to be the most difficult to offset. There will be considerable challenges in demonstrating cause and effect against a background of highly variable rainfall and recharge, measuring impacts, and in finding meaningful compensating actions when impacts are demonstrated. A consideration of an archetypal water dependent ecosystem, namely jungles developing around perennial springs offers some options.

An artificial and high cost mode of compensation of limited scope will be to supplement depleted flow by pumping in additional water from sources distant enough not to exacerbate the drawdown problem. Such approaches are unlikely to be of interest to Indigenous providers. Another and arguably more realistic option will be to protect lower elevation sites less affected by drawdown from feral animals or managed stock and so improve their condition. There would be some challenges in working out acceptable multiples of area improved to area impacted. Less direct options might involve protection of riparian vegetation that contains many of the same elements from fire or weeds. Choice of options may depend on assessment of the significance of the damaged site(s) as sources of water for dependent fauna.

Even more difficult will be compensation for damage to in-stream habitats affected by say, reduced flow and increased turbidity that displace entire in-stream communities. Responses would be necessarily large scale, such as protecting and rehabilitating a substantial length of another (preferably) tributary or (less desirably) independent drainage system previously degraded by stock and/or feral animals.

If such sites are located on Indigenous land , there would be an option to protect them long term from mining and petroleum exploration and extraction which is unavailable on other lands.

We have already alluded to the difficulties under present regulatory practice of surrendering or at least choosing not to use water entitlements and so effectively reducing the size of the consumptive pool. These practical difficulties may be overcome when water markets are in place, but this appears unlikely to occur until systems are approaching or have reached over-allocation. A better process would see offsets deployed early to prevent or help manage the risk of over-allocation.

We assume that gas exploration and extraction will be conducted to minimise pollution risks to groundwaters and hence that acute or chronic impacts on water quality will be treated as unacceptable and hence not be candidates for offsetting. Some level of agricultural pollution is perhaps inevitable if large areas are developed. Again effective control of feral animals may help reduce the total amount sediment entering water bodies and so be considered as offset candidate. Quantification may present challenges.

12.2.4 Weed control

Weeds of national significance were recorded in 32 of the region's sub-catchments. The most frequently reported species are *Parkinsonia aculeata*, *Jatropha gossypiifolia* and *Acacia nilotica*. *Gamba grass*, a severe fire weed, and *Mimosa pigra* are present. Invasion of agricultural and shale gas fields by Gamba grass would greatly exacerbate fire management problems (Setterfield et al. 2013). There will be strong operational and conservation incentives to contain the spread of this species in particular.

Difficulties with weed control are likely to increase under agricultural of unconventional gas development because of the large areas disturbed. Weed control would need to be a component of most land "set aside" type offsets, such as those that might be required to compensate for land clearing. And offset providers may obtain associated work in weed control unrelated to offsets.

We do not have details of areas severely affected by weeds, but it is possible that eradication from sensitive sites (like restoration of riparian fringes) could provide offsets for clearing of dense vegetation in other areas. Weed control is likely to be an important component of the services sought from offset providers in many settings.

12.2.5 Feral animal control

We have already suggested indirect offsetting of impacts from water drawdown by protecting vegetation closer to the water table from feral animal impacts. In addition many other offsets will require that feral animal impacts are minimised even if they are not the principal focus. Impacts of feral pigs, which have been recorded as present in 5 of the region's sub-catchments can have severe impacts on natural systems and are important agricultural pests. In the event that agricultural activity accelerates, demand for feral pig control is likely to increase.

Some of the species at risk in the catchment are likely to be vulnerable to feral cats. Methods of control are mot well developed but may be an important obligation if loss of habitat for small mammals is being offset.

12.2.6 Protection of infrastructure

Protection of gas or agricultural infrastructure (e.g. from fire and ferals) could require some of the same methods used in offset delivery, and so offer an opportunity to expand work. It is also possible that the particular demands of fine scale management to protect such infrastructure over relatively large areas could be coupled with other work (e.g. protection of substantial cat exclosures, management of Partridge Pigeon habitat: Fraser et al. 2003) that would also require fine scale fire management. Within areas intensively managed for particularly tight control over fire to protect infrastructure, it may also be possible to restore Lancewood or other fire sensitive habitats.

12.2.7 Cultural assets

Although not usually considered as environmental assets, the presence of numerous sacred sites protected under Territory law in areas prospective for development could offer potentially powerful triggers for a process like DbD and increase the benefits from its deployment. In areas of high site density incentives to negotiate configurations for development that minimise conflict will be particularly strong, especially but not only on Indigenous land.

In the view of Indigenous interests, impacts at and around sacred sites may be functionally similar to environmental impacts as more generally understood. Many sites will be recognised for their essential connections with native plants and animals and proper protection of those sites regarded as important influences on these species future status (O'Faircheallaigh 2008). It would be productive to consider such issues in tandem with more "mainstream" issues in design to minimise ecological impacts.

And those considerations of the intersection of specific Indigenous concerns with orthodox conservation objectives should also influence the design and delivery of offsets. For example, siting of offsets to protect particular species could be chosen to also offer enhanced protection (e.g. larger buffers) of important sacred sites and the connections between them. And *vice versa*.

12.2.8 Summary and conclusion

This brief scan of options for offsets that may arise in the Roper River catchment is incomplete, but it does demonstrate that at least some of the likely impacts of the most likely forms of development are legitimate candidates for offsets. It also shows that the DbD process is well suited to the form of impacts and their potential spatial expression.

There will be opportunities through careful design for locating both developments and offsets to minimise conflict and maximise environmental benefits. And to address multiple objectives. That process will work best if it combines orthodox perspectives with the obligations of Indigenous people to protect different but related aspects of landscape structure and function.

12.3 Local aspirations

12.3.1 Economic development and livelihoods

The most direct recent statements of ambitions of local Indigenous groups in the eastern catchment come from the Yugul Mangi Development Corporation. The core ambition is to generate real jobs paying proper wages. Their proposal for an Indigenous protected area is considered later. Other aspirations in agriculture, mining services, building maintenance and other community service provision are raised on the organisation's website. Yugul Mangi has sought the support of the Northern Land Council to investigate agribusiness opportunities in particular. Their aspirations provide a good example of the intent of Indigenous regional organisations "to take advantage of every opportunity" to improve socioeconomic conditions for local people.

12.3.1.1 Pastoralism

We do not have access to full details of proposals for pastoral development but the community clearly has ambitions to get some cattle behind wire and under management, initially to engage young men in on country activity and to provide a local meat supply[81]. The organisation also seeks to contribute to development of a regional pastoral industry plan. Communities in the eastern catchment are likely to have similar ambitions.

12.3.1.2 Harvest of feral animals, especially buffalo

Areas of the western catchment in particular support sizeable populations of buffalo and animals are scattered through the area (Rathsmann 2012). The Northern Territory Government is keen to promote export of live buffalo to Vietnam in particular. Yugul Mangi has expressed interest in pet meat harvesting.

12.3.1.3 Wildlife harvest and ranching

There is an interest in crocodile farming, which is successful in major centres in northern Australia but which has a history of failure in more remote areas, due to difficulties in accessing expertise, food for animals and markets. Commercial fishing has been raised as an option.

12.3.1.4 Land management and environmental services

Rolf Gerritsen from Charles Darwin University has done work with some senior men to explore options in carbon farming but so far as we are aware there has been no formal proposal. Yugul Mangi indicates that it seeks to employ up to 40 people in the Yugul Mangi and Numbarindi Ranger organisations, built around the core support and obligations provided by an Indigenous protected area.

It would appear reasonable to conclude that the community and its organisations will be prepared to consider proposals for offset provision, where it can support employment of local people.

[81] http://www.yugulmangidevelopment.com/Yugul_Mangi/Pastoral.html

12.3.2 Conservation management

Indigenous groups in the north eastern parts of the catchment have submitted an application for recognition of their lands as an Indigenous Protected Area[71]. Funds to support preparation of the application were provided under the federal government's Indigenous Protected Areas Program. It is understood that this may be the last nomination processed under that program. Recognised IPAs receive ongoing support to meet some operational costs. Ranger salaries are supported under the Working on country program.

We have not sought to access the proponents' management plan, but it is reasonable to assume that as with other IPAs, goals will encompass those recognised by the IUNC for Category VI reserves (protected area with sustainable use of natural resources). Accepted general goals for such sites (Dudley 2008, p. 22), about which participating groups would have been informed, include:

- To promote sustainable use of natural resources, considering ecological, economic and social dimensions;
- To promote social and economic benefits to local communities where relevant;
- To facilitate inter-generational security for local communities' livelihoods – therefore ensuring that such livelihoods are sustainable;
- To integrate other cultural approaches, belief systems and world-views within a range of social and economic approaches to nature conservation;
- To contribute to developing and/or maintaining a more balanced relationship between humans and the rest of nature;
- To contribute to sustainable development at national, regional and local level (in the last case mainly to local communities and/or indigenous peoples depending on the protected natural resources);
- To facilitate scientific research and environmental monitoring, mainly related to the conservation and sustainable use of natural resources;
- To collaborate in the delivery of benefits to people, mostly local communities, living in or near to the designated protected area;
- To facilitate recreation and appropriate small-scale tourism.

In many important respects, these expectations are equivalent to those outlined in Section 9.1.3 above for socially positive offsets. We take this congruence to imply that at least among participants in the IPA establishment process, there will be positive interest in schemes like DbD that offer the opportunity to supplement livelihoods in compatible ways and through similar activities. It is expected that that a large proportion of an IPA is retained in a natural condition, which would be the case even under management regimes involving development of mosaic agriculture, mineral extraction and oil and gas exploration and extraction. There would be opportunities to develop offsets both within and outside the IPA.

Yugul Mangi Development Corporation, as well as supporting the IPA declaration, has projects operating or under development in tourism, pastoralism, services to miners (concrete batching), and land and sea management. Aside from work to establish the IPA, the Ranger groups (Yugul Mangi and Numbarindi) will be responsible for weed management, fire management, feral animal control, outstation support, quarantine work, fisheries patrols and visitor management in other areas. As noted earlier, pastoral work has included getting feral cattle behind new fences to provide a local supply of meat. The Corporation's ambitions to take a larger role in pastoralism recognise the long association of some of the region's people with the pastoral industry.

The Minyerri Rangers working with Waliburru Station (previously Hodgson River) through the Northern Land Council have sought support to expand activities and over the last few years have worked on weeds, fire and feral animal control.

12.4 Local capabilities

Organisations active in land management operate in both the west and east of the catchment, mostly around the Roper River. There are groups operating from neighbouring sites in the north of the catchment. Local groups have been proactive in seeking to contribute to conservation work through declaration of the IPA and in working with the local landcare group, which claims to have been active in building capability. Yugul Mangi considers that it has a nucleus of skilled workers ready to take on greater responsibilities. Capacity will undoubtedly grow on establishment of the IPA and in pursuing options like savanna burning.

We have not attempted to assess operational capability in detail, but is appears likely to be comparable to other groups who have successfully expanded their roles when offered opportunity and support from a competent organisation (e.g. Djelk, Warddeken, Fish River, Dhimurru).

We are aware of other organisations additional to those we have considered here,.with similar ambitions and capabilities.

However, it should be acknowledged that these organisations are often short of equipment, including such basics as vehicles. They will require strengthening as part of any process to develop large scale offsets. However a nucleus is clearly present and actions already taken such as work on the IPA will ensure that capacity increases.

12.5 Summary and conclusion

We have not sought to establish the aspirations of all Indigenous groups or others in the catchment. Nonetheless, it is evident that significant groups seek change including orthodox development but are at the same committed to sound management of environments, including direct engagement in conservation activities. The DbD concept and process is well-suited to such a situation, where orderly and well-considered development is embraced but risks are recognised and pro-actively addressed, with the goal of no net environmental detriment at the forefront.

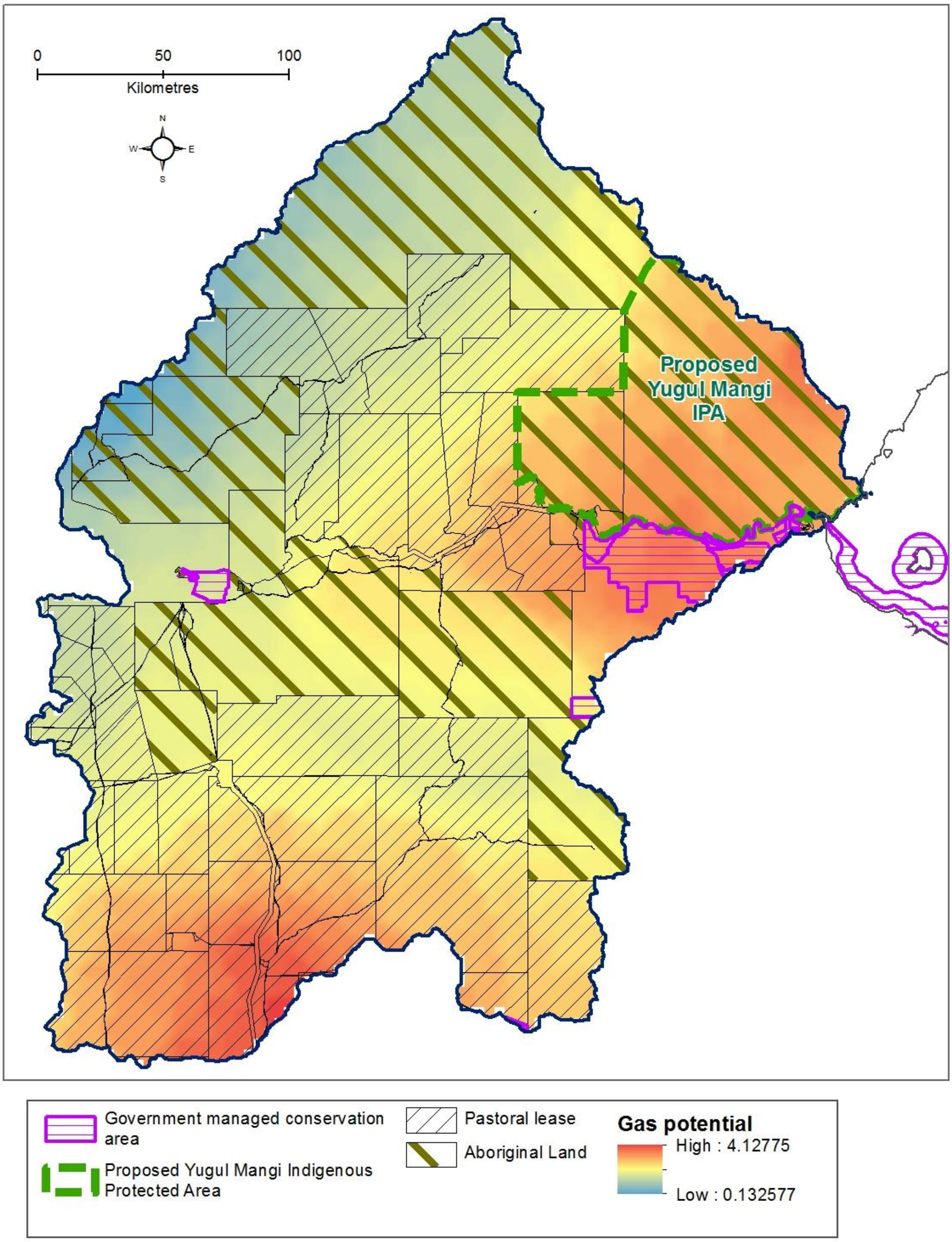

Figure 90: Unconventional gas prospectivity in the Roper River catchment in relation to land tenure, illustrating the substantial interests that both owners of Indigenous land and lessees of the public pastoral estate will have in the way this industry develops.

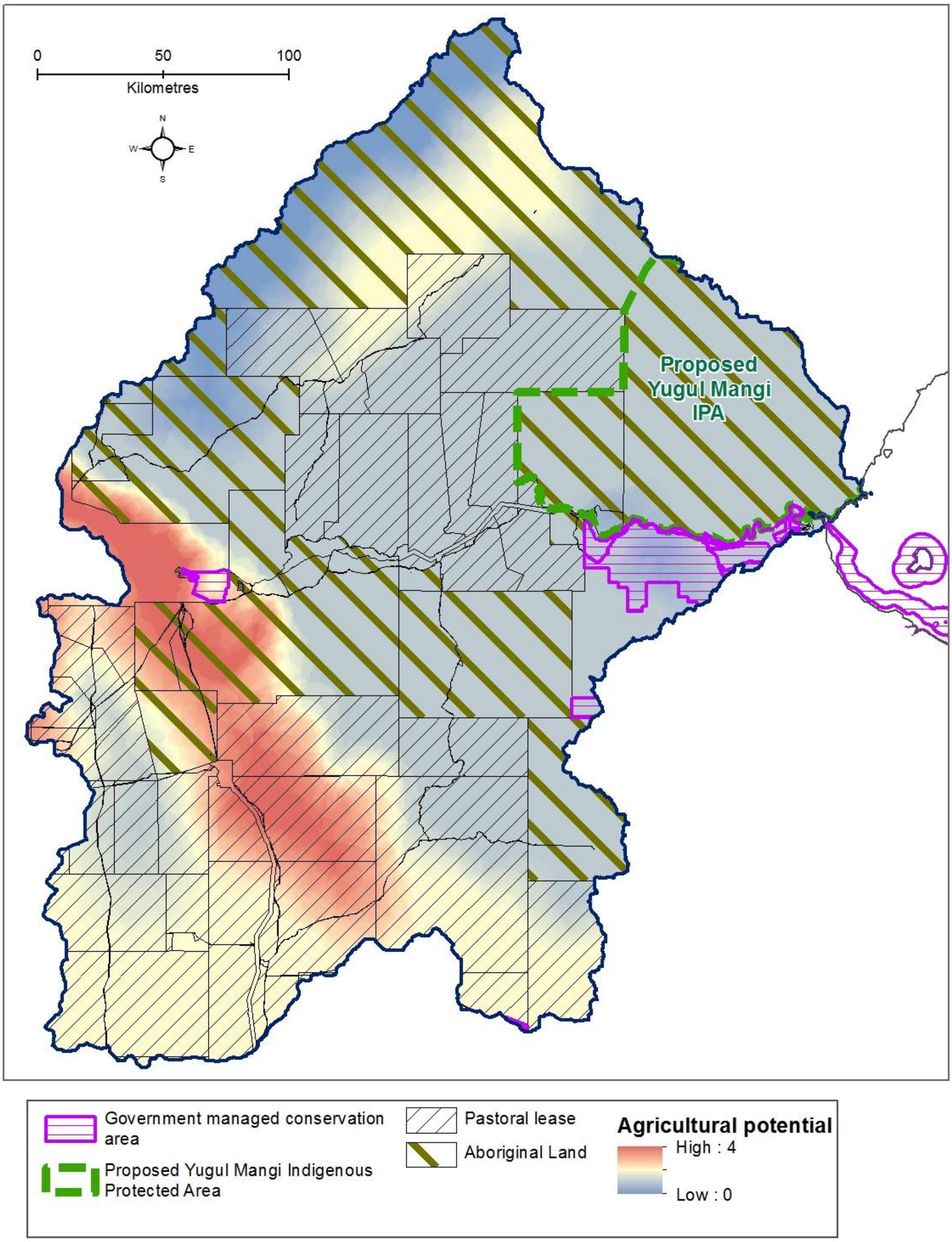

Figure 91: Agricultural prospectivity in the Roper River catchment in relation to land tenure.

12.6 Applying the proposed framework

We have sketched a proposition for and approach to implementation of DbD in the Northern Territory (Section 9.1.4). Assuming that key organisations like those tentatively identified reach agreement to promote application of DbD and develop the basic structures and processes proposed, how might application proceed in the Roper River region? To examine this question briefly we propose a simple scenario involving work on Indigenous lands.

1. The Department of Mines and Energy invites exploration for unconventional gas on highly prospective areas near the Roper River on both Indigenous and non-Indigenous tenures
2. Indigenous and other landowners are concerned at the prospects of such development but agree to exploration on part of the area.
3. Exploration returns favourable results which together with developments in neighbouring sites are sufficient to suggest that the area will ultimately be connected to a gas pipeline network.
4. Developers seek approval to proceed to extraction.

The details are not considered important and an example of an intervention of the sort proposed by the NT government for agricultural development could be substituted. In either case the sequence of actions we suggest might be involved in such a situation are:

(a) The Northern Land Council, acting on the instructions of the local land trust, alerts the relevant agency regarding concerns about issues of acreage and potential impacts.
(b) The Northern Land Council alerts local land trusts and other Indigenous people to the invitation to explore and outlines the nature of the industry its methods and particular risks. That advice will be informed by the considerations put in the NLC's submission to the Hawke's Inquiry into Hydraulic Fracturiing (NLC 2014) which canvassed both socioeconomic and conservation issues.
(c) Land Trusts and Indigenous land and resource management and enterprise development agencies seek further advice on implications for land condition and connected management issues. They may seek advice from NLC, NAILSMA and other parties.
(d) Partners in TOP (Figure 19) alert TOP to the request for support.
(e) TOP makes contact with interested organisations and individuals raising the possibility of impacts on country and wildlife being compensated through offsets, and in particular raising the potential for landowners to influence the layout of exploration and extractive activities and associated facilities through the DbD process.
(f) TOP emphasises the importance of formulating ideas and responses before approval is given to exploration.
(g) When proposals for exploration are received by the NLC and consultations with land trusts and others are scheduled, the NLC seeks advice from TOP on potential impacts and options for managing both exploration and potential extraction to minimise impacts of concern to owners and others.
(h) TOP's preliminary response is based on consultations as necessary with TNC and other technical experts about approaches to choosing development sites to minimise impacts on biophysical attributes that affect both conservation and cultural values, and Indigenous views of damage and appropriate ways of achieving equivalent benefits elsewhere.
(i) Subject to landowner response to initial advice, TOP develops a process for identifying and negotiating nodes of potential development and no-go areas, and offsetting the residual detriment even under optimal design. Offset proposals will emphasise options for employment of local people.
(j) The NLC or other landowner representative makes contact with the proponent to explore options for adjusting exploration plans and issues for minimising operational impacts. Expectations are put regarding avoidance of impacts and the nature and estimated extent of

environmental offsets required to should exploration or extraction proceed.

(k) Subject to initial favourable reaction to parameters put and any necessary adjustments, TOP develops a detailed offset proposal for in principle endorsement by the Land Trust and NLC.

(l) The NLC advises the proponent of its view about the need for biophysical environmental offsets for exploration and/or extraction impacts. And that offsets for environment effects are required independent of any other form of compensation for socio-economic detriment.

(m) The nature and quantum of environmental offsets and mode of delivery required will be specified in contracts executed as a condition of land use agreement and approval to explore.

(n) TOP consults with partners about building local capacity to deliver agreed offsets and implements a capacity-building program in association with partners.

This sort of reactive or *ad hoc* process would be accompanied by ongoing assessment of likely development pathways and emerging major projects and the needs for offsets they raise, linked to support for building regional capacity in relevant areas for a range of purposes, including effective offset delivery.

The details of the process outlined will undoubtedly require adjustments in the light of legal advice and experience. However, we expect that the core principles of:

- maintaining a clear distinction between offsets for biophysical environmental damage delivered in a socially positive way and any other compensation for socio-economic impacts and/or rights to access land
- estimates of biophysical impacts to be based on both Indigenous and non-Indigenous views of the attributes lost and the most effective ways of gaining at least equivalent benefits in another place
- emphasis on the core DbD notion that careful siting of development nodess and of offsets are important and legitimate subjects for public and landholder influence.

will be built into any agreed process.

13 DISCUSSION

Northern Australia has historically been regarded as a place of opportunity; where various riches await harvest by people of vision, energy and ambition. But too often economic visions have foundered and energy has been dissipated on obstacles like a boisterous climate, relatively infertile soils, limited infrastructure and great distance from markets.

The Territory is also seen to warrant special valuation because it has been little modified structurally by modern industry or the forms of agriculture or pastoral development that require removal of huge swathes of native vegetation. There have been repeated calls to protect those attributes through careful planning that matches development trajectories to land capacity (Whitehead et al. 2002; Woinarski et al. 2007).

The history of outright failures or sub-optimal outcomes we have outlined: failure to realise development dreams; to predict or properly manage environmental and social consequences; or to capture benefits of development locally should not and will not stifle ambitions to improve socio-economic conditions. But such a history should engender caution and a particular focus on improving assessment and management of risk: both biophysical and social risks.

Perhaps the Territory is better seen as the land of conflicting options and difficult choices: where a combination of history, culture and biophysical attributes has thwarted attempts to commit the region to particular development paths. Important decisions remain to be taken about the development pathways that will deliver the greatest net benefits regionally and nationally. One feature of this long history of failure that has not changed is the preparedness of many to take those decisions ahead of the people who live and work here.

The apparently determined withdrawal of the Northern Territory government from engagement with offsets and the NTEPA confounding of biophysical impacts with social impacts are surprising and depressing developments, suggesting that government is prepared to move away from well-established best practice. It is difficult to see how the NT can claim to meet national and international standards when it appears to have rejected a powerful tool available to promote no net loss of environmental quality, a target endorsed by industry peak bodies and many large businesses.

Good offset policy and practice implemented through government is an approach to maximising net public benefit from development. Withdrawal of government does not necessarily mean that such goals cannot be pursued. Offsets done well also protect private interests in land and existing forms of production and can generate additional private benefits through employment to deliver them. Private interests in the Northern Territory have the capacity to assert influence that can at least partially replace the coercive powers of government. Indigenous landowners can control access to their land in ways that are unavailable to many other landholders. Other groups do not entirely lack influence either, especially in shaping public opinion. For example, competition between committed food producers and coal seam gas developers has done much to raise public disquiet about unconventional gas. There is potential for competition between shale gas developers and agriculturalists even in the remote Roper River region, as agriculture spreads eastwards from Mataranka (Figure 92).

A loose coalition of groups with shared concern for environments and equity can perhaps fill the gap left by government. The potential benefits from skilled application of DBD principles and process are worth the effort. But there are also some challenges unrelated to the behaviour of governments, or perhaps more accurately, a long term consequence of past behaviour. The information held on environmental attributes is not up to the task of informative comparisons of different parts of the landscape that is an important requirement for effective DbD. This will create uncertainty about the quality of decisions to choose one site over another.

Two obvious solutions to this problem generate additional costs. One is to conduct thorough surveys designed around the impacts to be compensated prior to selection and implementation, which may create unacceptable delays. The second is to design high quality monitoring systems that are capable of picking up evidence of the improvement or maintenance of the values sought. The latter is probably most practical but will certainly add to costs and, if the original interpretation was in error, may reveal unpleasant surprises that put the reputation of the provider at risk. As argued earlier in regard to offset design, risk of underperformance can be reduced by applying a substantial multiplier to area of the offset site, again adding to cost of acquisition and/or management.

There are substantial risks in taking up the "government replacement" option in the way we have suggested, primarily as a stimulus for thinking and discussion. Obvious alternatives to this proposal are too seek to persuade the present or a future government to change the present policy. Aside from the guidance issued by the independent NTEPA there has been no clarifying statement: from relevant agencies or at the political level. This may ease willingness to backtrack and take up offset issues in a relevant agency, despite the decision of NTEPA to play no role.

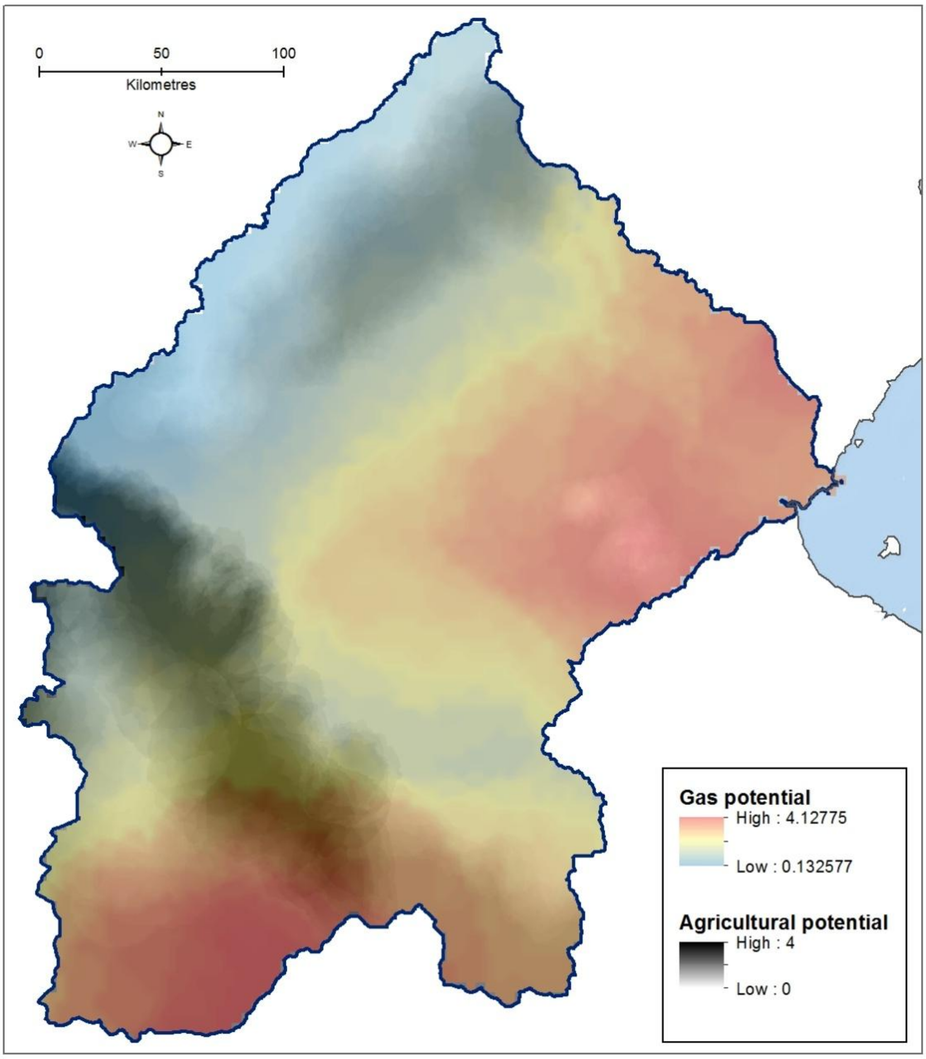

Figure 92: Abstractions of prospectivity for shale gas and agriculture (grey shades) showing possible areas of competition for land and water in the south of the catchment.

13.1 Essential features of a new offsets framework

If there is agreement to proceed with a DbD implementation framework, filling the offsets void requires attention to a number of important issues. Government usually plays several key roles in deployment of offsets:

(1) establishing the intent of the environmental assessment process, as a quest for no net loss
(2) regulating to require offsetting as compensation for losses of environmental quality, and setting real penalties for failures to comply
(3) setting standards for offsets
(4) securing offsets in law
(5) establishing well understood and consistent process.

As already noted, rejection of the role of offsets arguably represents a repudiation of the principle of no net loss from major developments. Fortunately, some industries have endorsed both this principle and the role of offsets in achieving it. Many large companies will expect to engage in offsetting of residual damage. And a critical group of landholders, namely Indigenous people, have considerable leverage in a capacity to deny developer access to their lands if they are unwilling to cooperate in good offsetting practice. If individual landowners, their land trusts and quasi-governmental Land Councils understand and benefit in reasonable ways from the deployment of offsets then they are positioned to promote their use, irrespective of the views of government.

Many non-government organisations have developed environmental standards of various kinds that have been influential in overcomng poor management: these are arguably best developed in regard to carbon farming (Kollmuss et al. 2008), where the remit is often broadened to address wider issues of sustainability, including protection of important ecosystems like forests (CCBA 2008; GSF 2013a,b). Standards for biodiversity offsets have been developed by groups like IUCN in collaboration with industry (IUCN-ICMM 2013). There appears to be no barrier in principle to non-government offset providers and facilitators adopting standards that will be well understood nationally and internationally. The summaries of Territory legislation here can be used to ensure that proposed offsets satisfy regulatory additionality (i.e. they do much more than meet the standards required of all landholders).

Arguably, the most significant problem arising from government withdrawal is the loss of power to formally secure offset sites under law that sets high standards for protection and at least ameliorates some forms of intrusion. (Noting that no site is entirely protected from the mining and energy sectors). A weaker form of security will be available in binding contracts between landowners, offset providers and offset purchasers, with financial penalties for failure to comply. These are arguably sufficient guarantee of long term compliance with obligations to maintain an offset, especially where they are on Indigenous land and backed by a decision to exclude any severe disturbance for the life of the offset.

Government and their public servants are masters of process. Although rote form filling is often criticised, the burden of well established procedures - run to published policy - ease with exposure. And clients know exactly what to expect. In contrast, a system run by a group of organisations of the sort we have suggested may initially appear somewhat *ad hoc.* However, this can be overcome by commitment to well-documented and simple processes. It will be essential to ensure that all parties act to simplify and facilitate process so that landowners can position themselves to make timely but well informed decisions

In our view the real obstacles to a non-government offsets program in the Northern Territory are the linked issues of commitment and resources. All of the organisations named have other commitments and may struggle to get the resources they need to meet existing obligations. Taking on a substantial task like this will probably require access to additional funds.

13.2 The knowledge issue

In addition to these political and operational difficulties, in northern Australia generally and the Northern Territory in particular, DbD faces large gaps in knowledge with no immediate prospects of more than very incremental improvement. Design of any conservation management system on a significant scale depends on several levels of understanding: a description of the landscape at a level of resolution congruent with the intended use; a general understanding of how the landscape functions; and an appreciation of how organisms use the landscape and the resources they need to sustain their presence. In addition to these basic understandings, that could be unique to a particular combination of site and use, a process like DbD requires an ability to make meaningful comparisons among sites.Descriptions of sites are usually captured in maps which seek to divide landscapes into components that are more similar to each other than to other differently classified sites, and where the user can readily grasp the differences between the classes. This trite pre-amble is important for understanding one of the key difficulties for comparative and predictive studies in the Northern Territory.

13.2.1 Mapping

The major vegetation mapping product for the Northern Territory was completed in 1990 at a 1:1,000,000 scale. There has been relatively little coordinated broad scale vegetation mapping since. Advances fall into three types: larger scale mapping at a few locations, often using different methods and to different standards for different purposes. For example, a vegetation map at 1:50,000 was made for the area surrounding the Mt Todd mine, which supported the endangered Gouldian Finch. Detailed maps have been made at a range of scales for particular restricted vegetation types like mangroves and *Melaleuca* forests. Even the World Heritage Kakadu National Park has no large scale vegetation mapping.

Most additional mapping has been done as Land Systems (1:250,000) or Land Units (up to 1:15,000). The difficulty with this form of mapping is that because it was done site by site over many decades, it tends to be imperfectly hierarchical and tailored a particular purpose and to the dominant features of a particular study area. Lynch (2012 and references therein) describes some of the difficulties of translating general descriptions in original surveys to consistent feature descriptions. Efforts have been made to join up different surveys at 1:250,000 scale but comparability across boundaries of original surveys may be problematic. To illustrate, the survey on which the map at Figure 69 was principally based was completed in 1990, but did not cover the whole of the catchment. Other components were mapped at different times in conjunction with other landforms which may have influenced descriptions. It is therefore difficult to compare different parts of the catchment with confidence, or to collapse simply categories to work at different levels of resolution.

Consistent vegetation mapping information is available through the National Vegetation Information System (NVIS) and is usable in the Territory down to Level V. In addition to information on structure this level names 3 dominant species at each of traditional upper, mid and ground strata. Whilst useful for broad comparisons, such mapping will not necessary identify plants that may provide key resources for fauna.

There is no joined up soil map at a scale useful for comparative work, although the land systems and land units mapping contain soils information which could be interrogated with some effort and probably with support from agency personnel. A 3' digital elevation model is available. Rainfall data from stations is very scattered and for many parts of the Territory estimates are taken from surfaces modelled by the Bureau of Meteorology, which acknowledges the difficulties caused by sparse stations (for example in the recent past but now corrected, estimates of monthly dry season rainfalls were sometimes small negative values). Geology maps of wide coverage are very small scale and even regional maps are at 1:500,000 or 1:1,000,000.

13.2.2 Point records of flora and fauna

The number of geo-coded records readily available from the relevant agency is superficially impressive for our study area, exceeding 1.2 million (but including some exotics). But as we have shown the spatial distribution is strongly biased to a few well-sampled areas. Species of conservation concern in our case study area were represented by 1 to a few records.

We have not obtained the quality of information needed to do a systematic examination of the influence of sampling design and sources on apparent patterns of species richness or presence and abundance of particular species. Arguably elements of the patterns observed, such as the Kakadu and Darwin regions appearing as the most species rich regions are influenced by sampling histories. The exponents for the species-area relationship (fauna 0.30; flora 0.37) in sampled sub-catchments (records >0) are higher than summarised for mainland areas in Begon (1996), including for savanna vegetation in Brasil. We suspect that slopes are biased upwards by gross under sampling of many areas. More detailed analysis is outside the scope of this study but warrants attention. The use of vertebrate animals exclusively is clearly also a weakness, but the invertebrate record is likely to be even more biased taxonomically and by variation in sampling intensity.

Under such circumstances it is difficult to analyse associations with landscape features for predictive models or make simple site to site comparisons, no matter how good the thematic mapping of vegetation or other important landscape descriptors. And it would appear that the land unit descriptions that dominate finer scale mapping are not good surrogates for features important to fauna. Attempts to use 1:50,000 land unit mapping to support predictive models for fauna based on comparatively intensive local sampling for reserve planning in the Daly River catchment were disappointing (Owen Price, personal communication; DIPE 2003).

Formal government biological survey programs have greatly reduced over the last decade so the bias and related gaps in meaningful coverage of large parts of the Territory will not be quickly corrected.

We suggest that with the quality of data apparently available, a conservation planning framework of the sort described by Saenz et al. (2013) and used to inform decisions about location of developments to mitigate impacts would depend on expert opinion more than analysis and insight available from the region's fauna and flora records.

13.2.3 Habitat relations and dynamics of individual species

The response of some Territory fauna to habitat fragmentation (Rankmore and Price 2004) has been studied directly, which may be particularly useful in sites under development for agriculture. Some caution may be needed for extrapolating from the relatively high rainfall Daly River - where the study was done - to the drier woodlands of (for example) the lower Roper River catchment.

Enough is known of population dynamics and/or habitat relations of a reasonable array of fauna (e.g. Price et al. 1999; Brook and Whitehead 2005; Firth et al. 2010; Griffiths 2014) and flora (e.g. Bowman et al. 2001; Liddle et al. 2006) or harvest to make reasonable simulations of the impacts of habitat loss or degradation through development. To date this knowledge has been used chiefly for predicting impacts of pressures like fire. We did not test this possibility. In passing we note that it would rarely be possible to base such simulations on a detailed understanding of response to disturbance such as that used by Copeland et al. (2009) in their study of the potential impacts of expansion of the gas industry. More courageous assumptions would be required.

In addition to technical criteria for selection, such indicators of wider impacts of land use change will require a match to the nature of projected change as well public interest in the status of the species or assemblage. A model based on responses of a common fish, the barramundi *Lates calcarifer,* to changes in brackish near coastal nursery habitats or floodplain feeding areas is likely to attract much greater public interest and political response than one based on a rare wetland plant.

13.2.4 Idiosyncrasies of formal classification systems

The Northern Territory's system for allocating species to categories of threat and hence conservation significance uses established IUCN processes and criteria. The additional layers of significance applied in describing some species as endemics are based on less systematic approaches. Federal government assignments of significance and the associated referral triggers are based primarily on international treaties like the Bonn Convention covering migratory animals, which in many cases will be much less vulnerable to projected changes than other elements of the fauna. When such bias is combined with sparse inland records, distortions are inevitable. The NT SoCS appear to be so strongly influenced that a casual examination of the resultant maps could be taken to indicate that there is little of value in the interior and that from a conservation perspective, all is well.

It is important to take account of these sorts of biases in considering the rankings of areas for conservation priority and the choice of offsets that may be promoted by such triggers as the matters of national environmental significance formalised in the EPBCA. The difficulties created by these sources of bias in identifying regions or sites where DbD might be preferentially applied are not entirely resolvable by improved analysis. More important is the fact that idiosyncratic assignments of significance influence the matters that get referred for environmental assessment in the first place, and may then determine the impacts nominated for compensation through offsets. Relevant conservation plans, including those built on DbD processes, will need to deal with such distortions. A critical part of compensating for distortions will be to expand perspectives and insist that they are dealt with by developers on lands in which Indigenous people have an interest.

13.2.5 Culture matters

Our exploration of the quality of information available to support DbD focused on the respect of the dominant culture for assignments of significance based on rarity and/or evidence of vulnerability to change. Uniquely, we also had access to records of the location of registered sacred sites and other sites of significance to Indigenous people, as maintained by the Aboriginal Areas Protection Authority. Those sites are valued for their place in Indigenous cosmology and related customary law, about which we claim no particular understanding. But it is clear that they reflect deeply held beliefs about the significance of living and non-living features of the landscape and their relationships with each other and their surrounds. We suggest that they therefore offer a most useful and compelling surrogate for Indigenous views of the significance of projected land use change: a perspective that is usually inaccessible to conservation planners.

Our summaries for the Roper River demonstrated that there are strong associations of these sites with particular parts of the landscape: in particular rivers that are likely to be vulnerable to agricultural development. We anticipate that networks of extraction wells and connecting infrastructure associated with unconventional gas may also cause concern (NLC 2014). We therefore regard these records as a particularly useful for processes like DbD. Design of development configurations to take account of their significance will, in our view, strongly complement the sparse information held in flora and fauna databases.

To fail to give these records status in such processes would not only be socially inequitable, but also weaken the opportunity to engage the majority of the regional population and major landholders in implementation of sound conservation planning processes and the deployment of robust offsets.

13.3 DbD and planning tools for Indigenous landowners

Indigenous leaders from northern Australia have articulated a pressing need for information and analysis to support decisions about use of their land. However, formal planning processes (e.g. water allocation) most often address such issues in a piecemeal way. Paradoxically, given political rhetoric about engagement of Indigenous people with the mainstream economy, government support is most often confined to conservation planning, like the development of the proposal for the Yugul Mangi IPA. Those sources of planning support may be drying up and there is an urgent need to identify alternatives.

In contrast to most government supported processes, DbD seeks to understand drivers and the patterns of landscape change they will foster in tandem with conservation planning. DbD offers options for integrated planning for sustainable land use that are otherwise unavailable to Indigenous landowners. We have not sought to develop ideas or tools particularly directed at Indigenous users. However, we consider that the very preliminary work done here offers some useful pointers to options to explore in advance some of the implications of propositions about economic development that are likely to be put to them from within their communities or, perhaps more often, from outside them.

13.4 Next steps

We have made suggestions about the options available to fill the gap created by the Northern Territory's withdrawal from the offsets space. Those propositions have been made without consultation and are incompletely specified. Our intention here is to stimulate thinking about the real challenges that have been created not just for DbD processes but the environmental assessment process more generally.

At a more prosaic level, we suggest that work on this issue should continue, including the following elements:

- NAILSMA continue to develop its thinking about the role of DbD and planning more generally in fostering Indigenous livelihoods built on land and resource management, including refinement of the preliminary analyses reported here and ways of building on them
- TNC maintain a dialogue with NAILSMA about these issues
- TNC particularly consider implications of notions of socially responsible offsets in the context of DbD and ways of strengthening partnerships with Indigenous groups more generally.

14 CONCLUSION

Indigenous ownership of a large part of the mega-diverse Australian continent offers globally unique opportunities for new approaches to sustainable development and biodiversity conservation. That opportunity does not originate in notions of stasis that may be thought to inhere in strong and ancient tradition. The knowledge and experience that inform tradition are critical for meeting obligations to land and ancestors, but in contemporary Australian society, so is access to the resources needed to maintain an active presence on lands while meeting fundamental social obligations and accessing services in health and education.

Many in Australian society appear to believe that they know better than Indigenous owners how those large areas of land should be used for national and local benefit. As illustrated by proposals from the Northern Territory, government may seek to press those views by reducing the rights of Indigenous landowners to make land use and management decisions. The proponents of these ideas appear willing to consign Indigenous landowners to passive observers of orthodox development directed by others: and others who have no particular commitment to care for the values of those lands.

An alternative to this bleak prospect has been formulated by the North Australian Indigenous Experts Panel and Forum. They argue that Indigenous landowners should be supported to plan carefully how to deploy land ownership to generate economic returns in ways that also strengthen capacity to discharge important customary obligations. They seek access to and unbiased interpretation of the best available scientific information, as well as the time and resources to consult meaningfully with traditional owners, *djunkai* (traditional land managers), and other community members about customary and other local knowledge for pursuing an optimal mix of benefits from land ownership.

The Development by Design program is entirely compatible with this vision. DbD seeks to accommodate new development by re-directing some resources to areas where they can be used effectively to enhance natural heritage values and maintain net environmental quality. Despite differences in perspective and motivations, there is a potentially powerful synergy between the biodiversity conservation goals of The Nature Conservancy and livelihoods goals of Indigenous landowners in land and sea management, and the mechanisms that both propose to reach them.

But realising that synergy will not be quick or easy. The formal scientific knowledge base is weak in many areas and will require strengthening. Ways must be found to access and apply local and situational knowledge and respect additional perspectives on values warranting protection. Particular challenges arise in building and maintaining capacity and commitment to deliver on long-term agreements that are inherent in offset provision. Building the partnerships needed to secure offsets in a political environment that de-emphasises environmental concerns and is actively dismantling related authority and process is a key contemporary issue. Success will require long-term commitment and direction of significant portions of total investments to building and maintaining relationships and capability.

The Nature Conservancy will need to consider carefully where it is prepared to invest and work in a spectrum of options: ranging from a leading conservation partner in sustainable use of Indigenous land and resources, to lesser roles in financial and/or technical support, chiefly within development structures and processes built by others. The strength of commitment required to take the former role should not be under-estimated.

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16 LIST OF ATTACHMENTS

Summary of mining developments assessed under Northern Territory environmental assessment law

Table 23 :Summary of mining developments subject to formal environmental assessment in the Northern Territory from 1984, including issues identified as significant in assessment reports or in the case of projects presently under consideration, in guidelines or terms of reference for assessments.

Mine name	**Minerals extracted**	**On-site activities and ancillary development**	**Issues**	**Location**	**Year (assessed) operating**
Project Assessed					
Woodcutters	Ag-Pb-Zn	140,000/yr tonnes excavated to produce 50,000 tonnes/yr ore processed by flotation	significant impacts on local vegetation, lowering water table over an area ~75 km^2 elevated and seasonally changed flows in Woodcutters Creek (90Ml/day discharged to WC)	Adelaide River	(1984)
Pine Creek Gold Mine	Au	open cut mine, on-site processing facilities, over-burden dump, tailings dam, process water dam, support facilities removal of 14 million tonnes of overburden and ore	200 ha cleared of native vegetation cultural heritage impacts including archaeological, Chinese and European history soil erosion lowered water table through pit dewatering pit rehabilitation AMD from tailings and overburden seepage from storage facilities increased demand on local infrastructure impacts on threatened species	Pine Creek	1985 (1984)
Woodcutter's Mine tailings dam	Ag-Pb-Zn	construct 80 ha tailings dam for 1.2 million m^3 tailings	adequacy of design to prevent seepage stability of decommissioned dam no specification of discharge water quality	Adelaide River	(1992)
McArthur River Mine	Zn-Pb-Ag	underground excavation of 1.2 Mt pa	mine design and management	Borroloola,	(1995)

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
		ore on site processing producing 350 Kt pa concentrate water rock dump at Barney Creek tailings piped as slurry to storage facility water management ponds barge facility transport of concentrate to coast	water management esp. uncertainty on controls over contaminated water leaving the site and flooding risk groundwater drawdown from mine dewatering impacting river waters tailings disposal and risks of failure through erosion and flooding, risks of seepage not properly assessed erosion management waste management esp. adequacy of measures to inhibit AMD road transport barge transport and associated facilities dredging concentrate and fuel spillage social impacts	Gulf of Carpentaria	
Mt Todd Gold	Au	extract from open pit up to 800 Mt of ore on site processing using 114 ha heap leach facility 130 ha tailings storage 125 ha waste rock dump 70 ha water dam	Gouldian finch - damage to nesting sites, loss of other habitat, drinking at contaminated waters Waste rock AMD Tailings disposal and management - seepage Heap leach facility especially acid formation rehabilitation - uncertainty about methods and prospects erosion management	Edith River	(1993)

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
			mine water management esp. capacity for on-site containment and risks to downstream users heritage conservation and inadequacy of archaeological studies social issues loss of local amenity (views of disturbed sites from adjacent national park)		
Union Reefs	Au	excavate from 1.25 to 2.75 Mt of ore cyanide leach/carbon in leach processing 294 ha of facilities tailings storage 3 waste rock dumps 2 water dams	expanded development surface water management, especially regarding levels of As contamination groundwater management including drawdown over large areas waste rock and residue management, especially lack of detail about locations and design failure to design to contain AMD in surface runoff heritage impact on infrastructure social impact	Pine Creek	1993
Brock's Creek Gold	Au	two open cut pits producing 1 Mt pa of low grade ore for 6 years on site processing using cyanide leach (carbon in leach) tailings dam waste rock dump	limited waste rock characterisation, tailings system operation, lack of environmental commitments wetland filter design (water and habitat quality, insect vectors of disease) waste rock and residue design and management flora and fauna survey	Pine Creek	1995

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
		wetland filter	heritage and Aboriginal archaeological site conservation rehabilitation		
North Point and Princess Louise open cut	Au	1.24 million m^3 of ore by open cut from 3 sites; transport by road train to Burnside for processing at existing facilities 7 M m^3 of waste rock 3.5 year mine life	Waste rock management and AMD left to later development of plan Water management especially surface runoff, containment of seepage to groundwater Rehabilitation through trials	Adelaide River	1997
Rustler's Roost Gold Mine Stage 2	Au	open pit, heap leach, treatment plant, tailings dam	kerosene in tailings dam tailings dam site and design waste rock and AMD cyanide recovery weed management archaeological site damage	Old Mt Bundey Station	1997
Merlin Diamond Project	Diamonds	excavate 6 kimberlite pipes to remove 730K m^3 of ore over 2.5 years 4.8 million m^3 of waste rock processing by gravity separation two tailings dams water storage dam	Water management Weed and feral animal management Tailings management and rehabilitation Rehabilitation, especially uncertainty about stabilisation of fine tailings Heritage management including two Indigenous archaeological sites no details of water source	McArthur/ Glyde River	1997

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
Jabiluka No 2 Uranium Mine	U	excavate underground 90Kt U_3O_8 in 19.5 Mt ore transport ore for processing at Ranger mill, reaching 900K t/yr stockpile ore to 25000 t waste stockpile to 150K t mine backfilled with waste use of waste from Ranger to backfill construction of 22.5 km haul road tailings from Jabiluka stored at Ranger project area 90.5 ha	surface and groundwater management, including risks of seepage from retention pond tailings management: radiation management transport management flora and fauna management infrastructure impacts social impacts cultural heritage	Jabiru	1997
Jabiluka Mill Alternative	U	Mill constructed at mine site rather than using Ranger facilities	surface and ground water management including runoff from stockpiles, effects of mine dewatering effects on water-dependent ecosystems, groundwater interactions with tailings tailings management: chemical stability of cemented paste tailings: formation of leachates contamination of the groundwater aquifer and in the longer term, Swift Creek AMD management Radiation management including radiation from tailings pit and mill Transport Management	Jabiru	1998

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
			fauna management esp. use of tailings pit waters Heritage and Cultural Values - inadequate survey		
Quest 29 Gold Project	Au	open cut mining of three pits at Koolpin, Zamu and Taipan Hill on-site dump leach treatment of low grade oxide ore construction of haul road to Tom's Gully minesite; processing of high grade ore at Tom's Gully trucking loaded carbon from dump leach to Tom's Gully for stripping re-commissioning of CIL processing facility at Tom's Gully pumping tailings to existing Tom's Gully tailings dams 33.5 ha land clearing 1 Mt waste rock	acid generation from mine wastes management of cyanide in dump leach processing, including integrity of liner water management esp. risk of uncontrolled discharge, weak specification of discharge management; inadequate provisions to prevent ARD in pits; tailings containment including structural soundness; rehabilitation information inadequate; and disturbance of pastoral activities	Mary River	1999
Batchelor Magnesium Project [ON HOLD]	Mg	excavate magnesite ore starting at 200000 t/yr for 12500 t Mg product, rising to 50000 t Mg/yr process to Mg metal on site through thermic reduction	stream diversion impacting local floodplain changed seasonal flows drawdown of groundwater up to 2 km from mine polluted runoff from waste dumps cultural heritage including 4 registered sacred sites and 2 recorded sites, one of which is affected by diversion of Coomalie Creek	Batchelor	2000

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
			high power usage from fragile Darwin grid		
Maud Creek Oxide [ON HOLD]	Au	open cut excavation 400,000 m^3 for 56,000 n^3 ore from pit depth 35-40 m Waste rock stockpile adjacent to pit Road train haulage of ore to Union Reef Gold Mine for processing tailings discharged at Union Reef Gold Mine	Water management, especially risk of contaminating Katherine water supply Pit dewatering not considered high risk due to shallowness of pit Uncertainties regarding acid producing potential of deeper unoxidised deposits Haulage especially heavy vehicle movements through Katherine Rehabilitation obligations unclear	Katherine	2000
Alcan Gove Alumina Refinery 3rd stage	Al	new plant and modification of existing plant to increase processing capacity from 2 to 3.8 Mt pa increased excavation consistent with increased production	Social impacts, including ongoing management of potential impacts on nearby populated areas; Continued recognition and respect of the cultural heritage of the Yolngu as traditional owners; management of additional solid and liquid wastes atmospheric emissions from fuel combustion, emission of gases and fine particles from production processes emission of Greenhouse Gases and offset; water supply from site aquifer; management of surface water and refinery discharge; impacts to marine and estuarine environments; community consultation.	Nhulunbuy	2004

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
Bootu Creek Manganese	Mn	excavation by drilling and blasting forming a number of open pits removal and storage of 800,000 pa overburden minor processing on site Transport by road and rail	Water management, including water quality, water lost through seepage from the Tailings Storage Facility (TSF) and disposal of excess water from the dewatering program Impacts on local fauna and flora; Topsoil management and erosion control; Aboriginal and European Heritage Rehabilitation of waste dumps, open pits and TSF	Tennant Creek	2004
Harts Range Abrasive Sands Quarrying	Sands	quarrying ~ 10 ha per year sand sized garnet from fluvial and dune sediments over 20 years sand, clay and oversize material returned to the pit as backfill (no separate tailings dam) on site screening and wet concentration to separate garnet and alumino-magnesio-hornblende sand from waste quartz sand, oversize rock and clay dry separation of concentrate using magnets and screens reject sand returned as fill to produce a post-quarry landform similar to that prior to disturbance (c 80% of quarried material as waste) three to five bores nearby with water delivered through a 15 km pipeline	sustainability of the groundwater resource failure to undertake hydrological investigations potential impacts of groundwater abstraction on existing users inadequate buffers around watercourses risks to (unidentified) archaeological sites limited detail on rehabilitation risks	Harts Range (Atitjere)	2005

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
		and stored in a lined 80 kilolitre dam using 1000 kilolitres per day with 90% of recycled water			
McArthur River Mine conversion to open pit operations	Zn-Pb-Ag	changing existing underground mine to open cut; increase mining rate from 1.6 to 1.8 Mt/y. total reserves increased to 43 Mt and mine life extended by 25 years ore crushed and ground in existing processing plant, then slurried with flotation reagents and pumped to flotation cells for recovery of Zn and Pb bearing minerals as bulk concentrate. 320K dmt/y of concentrate produced concentrate trucked to Bing Bong and barged off-shore for export existing port facilities have sufficient capacity and would not require upgrades	realignment and stability of the McArthur River and Barney and Surprise Creeks performance and long term management of the tailings storage facility (including post closure) location and management of the overburden facility potential reduced water quality in the McArthur River uncertainty of mine pit closure performance of the proposed flood protection bund community consultation methods potential impact on freshwater sawfish (vulnerable under the *EPBCA*). impacts on groundwater (and subsequently to the River, including the Djirrinmini Waterhole) the assessment recommended that the mine not proceed as planned	Gulf of Carpentaria	2005
Browns Oxide	Co-Ni	excavation 3.9 Mt poly-metallic ore processing by crushing, leaching solvent extraction	management of AMD from waste rock and tailings seepage from tailings storage uranium/radiology issues in processing fragmentation of flora and fauna habitats with 11	Finniss River	2006

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
			fauna species listed as 'vulnerable' to 'near threatened' and three species of national and Northern Territory significance groundwater drawdown including effects on ARD generation from Rum Jungle pits interception and management of contaminated groundwater beneath the Rum Jungle area contaminated surface runoff water discharged to the East Finniss River rehabilitation and mine closure		
Andranangoo Creek and Lethridge Bay	Mineral sands	extract zircon and rutile from coastal dunes for export 107,000t of zircon and rutile over four years shipped directly from Port Melville (Melville Is) to China rehabilitation tracking linear progression of disturbance 2-3 months later Processing limited to slurrying and spiral gravity separation on site. Tailings sand separated from the heavy mineral fraction to be pumped back to the mining slot. Stored overlying topsoil used in the rehabilitation of backfilled slot. two or three production bores at	large areas subject to disturbance (heavy mineral deposits consist of multiple strands of mineralization 20 to 250 m wide and up to 5m thick along strikes up to 3.5 km long. loss of biodiversity from land clearing and weed introductions; uncertainties regarding site rehabilitation / revegetation, including vulnerability of rehabilitated areas to storm surge damage; adequacy of buffer zones from inundated areas, water courses and sensitive habitats; potential for acid sulfate soil generation; erosion and sedimentation from alteration of surface water flows; groundwater drawdown impacts on nearby	Tiwi Islands (Melville Island)	2006

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
		each of Andranangoo and Lethbridge sites 307 ML of water per year required for processing and mining activities	groundwater dependent ecosystems; and haul-road access to remote wilderness areas of Melville Island		
McArthur River Open Cut (revised proposal)	Zn-Pb-Ag	fundamentals as in 2005 proposal (above) but changed approach to some key parameters, namely: better design of McArthur river diversion to slow flows and stabilise banks improved bank revegetation strategy modification of alignment and other aspects of Barney Creek diversion stabilisation of flood protection bond improved design to increase stability and reduce seepage from tailings and other water management structures 25 year community consultation strategy	emphasis on remedial actions after problems occur over design to reduce risk risk of transfer of costs to government adequacy of security bond uncertainty about revegetation of diversions inadequate design of TSF, including managing water balance to reduce risk of unmanaged outflows high risk of seepage to river requiring ongoing intervention during operations and beyond inadequate treatment of potential acid forming rock inappropriate triggers for water quality (stock standards set) interventions unresolved issues for water quality in outflows from pit to river community, particularly Indigenous, opposition to diversion inadequate consideration of alternatives based exclusively on financial and technical analysis rather than environmental or social benefits	Gulf of Carpentaria	2006

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
			inadequate monitoring systems weak community consultation processes and generally inadequate social impacts assessment uncertainty about successful closure		
Francis Creek Open Cut	Iron Ore	1.5 Mt of product a year with a project life of three years. about 4 m^3 of overburden for 1 m^3 of ore removed. Overburden stockpiled adjacent to pits. Several ore bodies mined together to facilitate blending as ore crushed and screened on site. A new railway siding (Roney Siding) proposed adjacent to the Alice Springs to Darwin Railway for transport of product to East Arm Wharf in Darwin Port. Export by ship to China.	**c**haracterisation, prevention and management of acid rock drainage (ARD) from waste rock to deal with risks of encountering more fresh acid-forming rock than anticipated and to deal with existing problems in old pit and rockpile **w**ater management proposals appear sound and wet season discharges likely to be benign if existing pit and stockpile issues are dealt with **p**lacement of waste rock stockpiles and overburden require further information. **m**anagement of detectable levels of uranium, thorium and radon gas **r**ehabilitation, in particular the Thelma 2 pit and waste rock stockpile; mine closure and post mine monitoring. no commitment to backfill pits design required to minimise impacts on threatened or near-threatened species weed management archaeological sites require protection rehabilitation to provide local Indigenous employment opportunities	Pine Creek	2006

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
Mt Porter Gold	Au	excavate 574,000 t of ore and 2,400,000 t of waste rock from pit about 4 hectares in area and 115 metres deep. estimated that the total volume of the pit will be one million bank cubic metres no on-site processing	Limited: spring discharge point moved to mine pit surface waters contain moderate levels of arsenic, aluminium, copper, lead, thallium, vanadium and zinc traces of other metals and sulphate; aluminium and iron in colloidal suspension by: mining operations over one dry season, removing requirements to manage stormwater during mining; mine and waste rock dump located at catchment head; situated outside a town drinking-water catchment; groundwater of low yield and potentially disconnected Pine Creek area heavily mined since the 1870s; bulk of acid forming material removed from the site as ore; no chemical processing or crushing on-site		2007
MollyHil	Tu-Mo	produce scheelite and molybdenite concentrates with ~300,000 t ore treated annually onsite expected life of 4 years processing by a combination of magnetic separation, floatation and gravity separation to recover	PER weak in important detail especially design details for diversion channel and settling ponds, liner details for the Tailings Storage Facility and the Waste Rock Dump limited knowledge of leachates from waste rock and tailings proposals to respond to evidence of problems	Jervois Station	2007

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
		magnetite, molybdenite and scheelite respectively using 408 Ml water pa ore transported to the East Arm Wharf in Darwin Port via triple and double road trains Tailings in two separate streams – pyrite concentrate and a combined magnetite concentrate and general plant tailings stream. 8.1 Mt of waste rock: benign waste rock used to construct ROM pad, TSF and road base/ sheeting materials excess n waste rock dumps located to the east and south of the open pit and surrounding the TSF	considered inadequate impact of the use of saline water for dust suppression impact of salinity on clay lining for TSF conflicting information provided in PER erosion and sediment control plan required impact of creek diversion not dealt with management of (saline) sediment from settling pond not specified inadequate recognition of obligations to protect archaeological sites		
Andranangoo Creek Aircraft Landing	Mineral sands	16.4 ha of vegetation clearing to service Andranangoo Creek and Lethridge Bay project	loss of biodiversity from land clearing and weed introductions; encouraging human settlement and development in previously isolated areas; future use and management of the area as a landing site has not been confirmed upon closure of the mining operation	Tiwi Islands (Melville Island)	2007
North Point & Princess Louise Open Cut Project	Au	440,000 t ore transport to offsite processing 1.4 Mt of waste rock	effects on future water supply disposal of mine pit water from dewatering inadequate waste rock characterization inadequate surface and groundwater quality	Adelaide River	2008

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
			information; groundwater impacts from mine pit water quality after mine closure; and rehabilitation information and closure criteria. (note problems identified in assessment 11 years ago not resolved)		
Wonarah Phosphate	Phosphate	399 Mt of 21% Phosphorite (P_2O_5) developed over two stages Stage 1 mines deposits for Direct Shipping Ore (DSO) requiring minimal processing Ore transport by road to Tennant Creek and rail to Darwin Mining during Stage 1 for at least ten years at rates of up to 3Mt pa Stage 2 expands mining and adds processing to treat lower grade ore, subject to separate assessment peak water use up to 9,6 Ml/day piped from borefield 30 km north	clearing of 2326 ha of native vegetation, loss of biodiversity and reduced local abundance of flora / fauna; topsoil loss and degradation, including reduced viability of contained seed bank, reducing potential tore-establish native flora and fauna; risk of overtopping sediment ponds potential for introduction and spread of weeds and feral animals; greenhouse gas emissions; dust generation in a hot, dry, windy environment; revegetation challenges in semi-arid environment; socio-economic impacts; road haulage and road safety, road condition, local fauna, and greenhouse gas emissions; potential effects on groundwater reserves unable to be adequately assessed legacy landscape of the mine, and loss of amenity and land values to traditional owners.	Tennant Creek	2010

Mine name	**Minerals extracted**	**On-site activities and ancillary development**	**Issues**	**Location**	**Year (assessed)** **operating**
Redbank Copper Expansion	Cu	open cut mining to extract ~ 765,000 tonnes of copper oxide over 3 years. ore processed using Solvent Extraction/ Electrowinning (SW/EW) producing 99.99% copper cathode product transported 1300 km by road to Darwin via Wollogorang Road, the Carpentaria Highway and Stuart Highway. Details: mining of oxides only in 3 new pits (Redbank, Azurite and Bluff); waste rock dumps (WRDs) associated with each pit; upgrade processing plant and facilities at Sandy Flat pit; haul road of ~4 km to transport ore to processing plant; use of existing tailings storage facility for vat leach tailings; retention ponds for management and treatment of water on site; commencement of remediation of contamination due to legacy issues subsequent expansion to include sulphide mining subject to separate	management of existing legacy impacts and contamination sources, including: • existing TSF to prevent seepage and meet closure requirements; and • legacy groundwater and surface water contamination through old leach pads and related structures. management of impacts on groundwater levels and quality; increased risks and management issues for site surface water management; prevention/minimisation of AMD into the environment, including management of waste rock and tailings; protection of flora and fauna in an area listed as a Site of Conservation Significance (EPBC *Act* listed species) rates of "new" water usage not specified Shortcomings include: limited data to support claims that the vat leach tailings would be benign and not add to existing water contamination *via* seepage; an outstanding requirement to finalise and validate the conceptual hydrogeological model; decommissioning and rehabilitation plan for the existing TSF not provided not determined whether a low permeability layer	Wollogorang	2010

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
		NOI.	is required as capping to reduce future mobilisation of metals; information on Threatened Species offsets not provided to the satisfaction of the Australian Government.		
McArthur River Mine - Phase 3 expansion	Zn-Pb-Ag	increase extraction to 5.5 Mt pa expansion of open pit from current footprint of 145 ha to 210 ha and to a depth up to 420 m from 210 m; addition of a new cell on the existing tailings storage facility (TSF) to create additional tailings storage capacity; expansion of the existing north overburden emplacement facility (OEF) and the construction of new OEFs to the east and south of the open pit to store an additional 530 Mt overburden; and construction of new gas fired power station to double output from 20 MW to 45-50 MW.	unresolved risks around the Phase 3 Project. adds to existing impacts on the mine site; potential for increased groundwater contamination identification of viable contingencies to manage contamination and prevent contaminated seepage into local waterways and the McArthur River in the short to long term; creation of a significant pit lake with declining water quality and consequential impacts on local groundwater aquifers and ecosystems; risk of long-term acidification of tailings, when buffering capacity in tailings is exceeded; generation of fugitive concentrate dust emissions with increased ore-crushing and processing rates; uncertainty whether proposed design of TSF 4 will prevent contaminated seepage; and requirement for revised groundwater monitoring. The key risk presented by the current operations and exacerbated by the Phase 3 proposal is the site-wide build up, long-term storage, and release of contaminant loads. Data shows elevated metals	Gulf of Carpentaria	2012

Mine name	**Minerals extracted**	**On-site activities and ancillary development**	**Issues**	**Location**	**Year (assessed) operating**
			and sulfates have entered, and will continue to accumulate in water bodies (groundwater and surface waters), soils and aquatic sediments; are potentially bioaccumulating in aquatic fauna (macroinvertebrates and fish); and may be affecting macroinvertebrate populations.		
Roper Bar Iron Ore (Western Desert)	Iron Ore	Open pit mining of DSO iron ore reserves; estimated reserves of 311 Mt of which 24Mt is DSO Waste rock and/or overburden stockpiles; ~15 Mt/yr of ore and waste excavated for up to 3 Mt/yr ore; on-lease haul roads and light vehicle access roads; crushing plant; power generation; ancillary infrastructure; 165km haul road to Bing Bong port traversing eight major rivers and numerous streams; ore stockpile 2-3km from Bing Bong; covered conveyor to barge load out facility at Bing Bong port; and trans-shipment by barge to ocean going vessels	Risks of significant impacts to the downstream environment of the Towns River; inadequate information regarding the geochemical characteristics of the overburden and waste material to produce AMD; realignment of the Towns River through an engineered channel to facilitate mining with part of the channel to flow through a mine pit potential impacts on downstream aquatic health through habitat loss, changes in hydrology and contamination potential for floral and aquatic fauna species listed under the *EPBCA* to be significantly impacted by construction of a 165km long haul road; potential for listed aquatic fauna impacts, in particular freshwater sawfish (*Pristis microdon*); potential impacts on marine species at the Bing Bong Port; uncertainty regarding stability of post-closure landforms and long-term impacts from above ground disposal of potentially acid forming wastes.	Ngukurr	2012

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
		clearing of native vegetation 500 ha for haulage road and 450 ha at mine site			
SILL80	Ilmenite	excavating ilmenite rich soil from large shallow pits removal of 0.4 to l.0 Mt of overburden washing through trommels for up to 300 000 t concentrate pa extracting up to 1649 ML/y of water from Roper River trucking concentrate to Darwin mine life 20 years	rehabilitation of numerous refilled pits 12 km water pipeline storage of waste impacts on Roper River water availability (in combination with other projected uses) impacts on Ngukurr township water supply 800 ha land clearing	Roper Bar Numul Numul Station	2012
Katherine to Gove pipeline	Al	To deliver gas for reducing costs of refinery operations at Pacific Aluminium site at Gove construction of a buried, 324mm high-tensile steel pipe in 30m wide ROW within a 100m wide pipeline corridor running 600+ km. To deliver 34PJ/year, operated to a maximum operating pressure of 15.3MPa : design life of 50 years. Individual pipe lengths welded together onsite, field coated and buried to minimum depth of cover of 750mm. facilities required at intervals for safety, maintenance of pipeline	size and scale of the proposal; potential impacts on protected flora and fauna; potential impacts on biodiversity from land clearing activities (totalling 7000ha); potential disturbance to areas of conservation significance; increased demand and/or impacts on existing services and infrastructure, including roads, railways and water supplies; uncertainties associated with crossings of potentially significant habitats, watercourses, roads and infrastructure corridors; potential impacts of surface and/or groundwater	Nhulunbuy	2013

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
		integrity, including: meter station, compression station, main line valves; cathodic protection stations; and scraper stations.	extractions for water supply to the project; impacts from sourcing suitable rock, gravel and fill; potential risk to public and environmental health from localised discharges into watercourses and aquifers; potential impacts to stakeholders, including land holders and traditional owners; and potential social, cultural and economic impacts, including the risks of the project not realising its projected economic and social benefits.		
Projects under assessment					
Mt Peake	Va/Ti/Fe	mining of a polymetallic ore body, beneficiation and hydro metallurgical processing to hematite powder (Fe_2O_3), vanadium pentoxide flake (V_2O_5) and titanium dioxide (TiO_2) at Mt Peake At full capacity the processing plant may produce 15,000 tpa V_2O_5, 1.11 Mtpa Fe_2O_3 and 375,000 tpa TiO_2 mine access road for transport of products to a new railway siding and load-out facility on the Alice Springs to Darwin railway near Adnera; and rail transport Darwin's East Arm	Environmental risk and proposed risk reduction measures are yet to be defined with respect to: Waste rock dump (WRD) and dry stacked tailing cell, or conventional Tailings Storage Potential for AMD from the WRD, TSF and other infrastructure; Handling, storage and transport of mineral products transport alternatives to railhead (slurry pipeline vs. road train) Risk of product concentrate spills, as from ruptured pipelines, traffic and transport accidents, and wind	Mount Peake 280 km NNW of Alice Springs	(2014)

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
		Wharf for export mine site facilities include: gas and water pipelines; waste rock dump (WRD) and dry stacked tailings cell, or conventional TSF; beneficiation plant; hydrometallurgical plant including acid plant and oxygen generation facility; concentrate stockpile; leach and salt residue storage cells; product stockpiles for titanium dioxide and hematite (or magnetite); water treatment ponds or tanks; water and waste water treatment plants; gas fired power station; explosives and detonator magazines; construction camp and accommodation village; administrative, control, laboratory, workshop and storage buildings; gatehouse and weighbridge; bulk fuels storage area and water storage tanks; workshops and offices; At rail siding at Adnera; product rail load-out facility including hard stand storage shed for containerised vanadium and product stockpiles for titanium dioxide and hematite (or magnetite)	and water erosion of product stockpiles; Alternative hydrometallurgical plant locations; Handling, storage and transport of reagents and/or hazardous materials (including hydrochloric acid, organic solvent, sulphuric acid, sulphur, sodium hydroxide, sodium chloride, calcium carbonate, oxygen, sodium hypochlorite and flocculent) Closure and Rehabilitation. Potential for impacts to Sites of conservation significance downstream of the Project Area Sites of Aboriginal heritage significance; Sites of cultural heritage (Indigenous and non-Indigenous); species of conservation significance; Local communities; Workers, such as from inhalation of product dust; and Livestock at neighbouring pastoral properties not yet demonstrated sufficient water will be available for the Project; ground and surface water resources will be protected from contamination; or that Sensitive receptors to mine impacts have been identified. Impacts include: groundwater drawdown (cone of depression) associated with pit dewatering , potentially affecting groundwater dependent ecosystems, livestock; nearby communities or other users of shared potable aquifers; dust (including product dust) at all		

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
			locations; power station emissions; erosion and sedimentation; and groundwater and surface water contamination social and economic impacts clearing of native vegetation		
Ranger 3 Deeps underground mine	U	to extract ~34,000 t of uranium oxide from underground continuation of Ranger Pit 3 resource will continue to be defined through an exploration decline under construction mine accessed by a 3km decline to working depth >400m, mined in series of stopes excavated by drilling/blasting to total length 17km for all workings processing at existing plant and related facilities at Ranger Uranium Mine total feed expected to be similar to existing operations planned that Ranger 3 would not alter the operating or closure and rehabilitation timeline for Ranger (rehabilitation 2021 to 2026)	Issues of concern include: uncertainty around the relationship to and impacts on current operations, including closure activities, at Ranger; potential impacts on regional water resources, and dependent ecosystems creation of new radiation health risks to employees, the public and the environment; transportation risks (uranium, explosives and consumables, including dangerous goods, on public roads; localised impacts from the ventilation and fan exhausts noise, amenity, and areas of deposition and accumulation of dusts and contaminants from the underground operations on surface soils and vegetation, including bush foods; uncertainties associated with processing and management of water, tailings and waste streams.	Jabiru	(2014)
Chandler Salt Mine	NaCl	construction of underground rock salt mine using cut and blast;	construction, operation and visual impacts to sites with Indigenous and non-indigenous cultural or	Maryvale Station (south	(2014)

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
		processing and packaging plant with capacity 1 Mt/y edible and industrial salts; mining site infrastructure, including buildings, stockpiles, borefield and airstrip; 26 km haulage road to Darwin-Adelaide railway and 26-27 km access road connecting to existing road; mine rail siding (2 km) on the Adelaide-Darwin railway line; bore fields for 8.5 ML/year potable and 2800 ML/year salt processing water; power supply by hybrid “diesel/ solar-salt battery” power station; complementary waste storage business using above ground and underground rooms created by mining activities. construction and operation of a speciality processing and packing plant in Alice Springs including a training school and visitor centre.	archaeological significance; clearing and loss of potential habitat and individuals of a number of species listed as threatened under the EPBC A and TPWCA; increased risk of environmental damage or degradation to the site. In the absence of suitable mitigation, ongoing degradation resulting in significant impacts to the environment, in particular flora and fauna and remnant vegetation; ongoing impacts to groundwater resources through establishment and abstraction of water from two bore-fields; uncertainty around the scope of the project in relation to the scale, size and complexity of all components; the potential for ongoing land degradation and impacts associated with management and disposal of brine, sulphates, wastewater and other contaminants; reviewing engineering and environmental barriers and waste protocols and procedures for complementary secure storage business in mitigating and managing potential risks; social and economic impacts associated with changed alignment of transport routes along existing roads/rail infrastructure near local communities	of Alice Springs)	
Kilimirika Mineral Sands	mineral	surface mining of a sand dune	Issues identified include:	Tiwi Islands	(2014)

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
Project	sands	system using open cut dozer trap methods processing of ~ 56.2 Mt of mineralised ore over a mine life of 8 – 10 years. heavy mineral sand extracted (1.6%) and remaining silica sand and clays (98.4%) placed back to reinstate the original landform produce an estimated 890 000 tonnes of Heavy Mineral Concentrate (HMC), consisting of zircon and titanium-based products, for the Chinese market	potential impacts on threatened flora and fauna; water management risks including groundwater extraction and potential spills to surface water; risks and lack of information associated with rehabilitation and closure of the mine site; potential impacts of the mine on coastal morphology and processes; uncertainty regarding transhipment options for transport of product; potential impacts on local transport; noise and dust; Potential socio-economic changes for local communities; and mining method.	(Bathurst Island)	
Nolan's Project	REE & Phosphate	open cut extraction, processing for ore concentration, transport of ore resource of 18.6 Mt at 3.1% rare earths, 14% phosphate and 0.02% of uranium oxide. The Nolan's mineralisation contains apatite, a phosphate rich mineral with one third of the rare earths. Cheralite, a REE rich mineral, contains the remaining two thirds REE.	transportation of radioactive ore to a processing facility (potentially in Darwin), long-term, on-site, safe management of radioactive tailings; management of mine waste water; supply, management and protection from contamination of water resources; waste rock and tailings management, and rehabilitation.	135 km north of Alice Springs	(2014)

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
			[from EIA guidelines]		
Mt Todd Gold Mine re-establishment (Vista Gold)	Au	extension of the existing pit from 114m to ~ 471m deep and surface area of 40 ha to 100ha; extension of the existing Waste Rock Dump (WRD) from height 24m to ~ 140 – 170m and surface area 70ha to ~ 200ha with 16 Mt expanding to ~214Mt of waste rock; Existing Tailings Storage Facility (TSF1) raised from 16m to ~34 m; new Tailings Storage Facility (TSF2) (~420ha, 80m high); rehabilitation of the existing heap leach pad no longer required for gold production (40ha); construction and processing of low grade ore stockpiles (~40ha); new Water Treatment Plant; clay borrow area (~12ha, 15m depth); administration and plant site buildings (32ha) anaerobic Treatment Wetlands (10ha); and	Issues of concern include: Acid and Metalliferous Drainage (AMD) seepage and runoff from the waste rock dump, ore stockpiles and tailings storage contaminating surface and ground waters continuing long after operations cease; contamination of surface water from AMD with adverse impacts on downstream water quality, environment and water users; contamination of groundwater from AMD including outside the mineral lease, or release of contaminated groundwater expressing to surface water; potential groundwater drawdown affecting flows in the Edith River and production bores; management and treatment of a large quantity of acidic and metal laden water already on the site; design of greatly enlarged waste rock structure as safe, stable, not prone to erosion, minimising AMD seepage and runoff and meeting stakeholder expectations as a final land use structure; biodiversity impacts associated with disturbance footprint of mining activities and infrastructure; challenges of successful mine closure and rehabilitation; and	Edith River	(2014)

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
		limestone quarry (~150m x 150m at ~25m depth) and access road ~20km west of mine site.	potential social, economic, transport and heritage impacts. The NTEPA noted in its assessment that key issues associated with water and AMD management remain "substantially unresolved"		
Sherwin Creek Iron Ore	Iron Ore	excavation from open pits potential DSO resource in first deposit to be exploited 18.2 Mt at 58.3%Fe DSO will be mined, crushed, and stockpiled on site transport by road to Darwin mine life six years.	the size and scale of the proposal; potential impacts on biodiversity, including listed flora and fauna, from land clearing activities and weed incursion as a result of the development; uncertainties regarding in-pit rejects disposal and rehabilitation of the mine areas; unknown potential for acid and metalliferous drainage; uncertainties associated with water resources and potential impacts from the water extraction Water quality may be impacted by spills to surface water and runoff containing acidic leachate, hazardous substances or elevated sediment concentrations; Surface and groundwater volumes and flow patterns may be altered with potential impacts to riparian vegetation and groundwater dependent ecosystems. supply dam; potential adverse changes and disturbance to	150 km east of Mataranka	(2014) 2014 trial shipments

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
			riparian corridor habitats, aquatic habitats and other currently unknown habitats from construction of the haul roads; and potential social, cultural and economic impacts.		
Twin Bonanza	Au	construction and operation of: series of open pits (including cutbacks) to a maximum depth of ~100m using drill, blast, load and haul techniques; associated water storage and tails dams; gravity processing equipment for refining ore; ancillary infrastructure, including: generators/power plants, staff accommodation, workshop and office areas; reverse osmosis plant for producing potable water; upgrading and lengthening of the existing Bonanza airstrip; upgrade of existing, and construction of new, access roads around the proposed mine site; and sourcing of water initially from within MLA 29822 from two bore	potential to impact sites with Indigenous and non-indigenous cultural or archaeological significance; clearing and loss of habitat and individuals of a number of species listed as threatened under the EPBCA and TPWCA; potential ongoing impacts to groundwater resources through the establishment and abstraction of water from at least two bores and a borefield; uncertainty around the scope of the Project in relation to the scale, size and complexity of all components potential for ongoing land degradation and impacts associated with management and disposal of wastewater and other contaminants; and based on the information provided in altering current social and economic attributes of the region.	Tanami Desert	(2013)

Mine name	Minerals extracted	On-site activities and ancillary development	Issues	Location	Year (assessed) operating
		locations and a borefield.			
Jervois base metal project	Cu	four new and existing open pits onsite processing to produce copper sulphate concentrate by flotation road haulage to Alice Springs rail terminal and then to Darwin for export local power station, airstrip, accommodation camp for 110 staff 2 Mt ore pa for 7 years Does not require EPBCA assessment	Potential impacts on biodiversity from land clearing and mining activities Rsks and mitigation measures have yet to be adequately addressed, especially in relation to the identification and protection of threatened species Control of declared weeds Risk to the Jervois Range Site of Bioregional Significance; the quality of and accessibility/ availability of shared regional surface and groundwater resources from development, operation and closure. Uncertainties regarding extraction and processing of the ore and associated management of water, tailings and waste streams, including potentially acid forming material. Increased risk of soil erosion and dust generation: soils of the Jervois Ranges are highly sensitive to disturbance and have poor recovery potential once disturbed Potential for disturbance to heritage places and objects and potential social, cultural and economic impacts.	270 km ENE of Alice Springs	(2014)

Statutes and other legislative instruments relating to management of natural and cultural assets in the Northern Territory

These brief summaries are intended to indicate the range of matters covered in land and resource management and are not intended to be comprehensive. Some emphasis has been placed on duty of care imposed under these various laws that control access to and use of land and resources. These provide some guidance for recognising actions that go beyond legal obligations and hence might be recognised as legitimate (additional) offsets.

Agricultural and Veterinary Chemicals (Control of Use) Act 2004 *(and Regulations)*

- requires that users of chemicals (including pesticides, fertilisers or stock-foods) "must take all measures that are reasonable and practicable to ensure that use does not result in harm to the … environment."
- reasonable use is use in accordance with on-label requirements or if off label use has been approved, compliance with conditions applied by the approving authority
- actions exceeding statutory requirements might include more stringent criteria for avoidance of use around sensitive environments or flora or fauna, adoption of standards for "organic" produce, or avoidance of exposure at all even where risks to human or environmental health are thought minimal

Animal Welfare Act 1999 *(and Regulations)*

- prohibits neglect or cruelty to domestic animals and requires that persons in change of animals exercise reasonable care, control or supervision
- defines reasonable action to prevent suffering as including obtaining veterinary treatment or killing the animal in ways that avoid unnecessary suffering
- provides for preparation and adoption of codes of practice relating to animal welfare
- no direct role in selection of offsets except setting obligations in design involving any interactions with animals (e.g. feral animal control programs, captive rearing of threatened species etc)

Biological Control Act 1986

- control of organisms must be for the public benefit, but the public benefit is undefined
- control may proceed if control of the target organism would not cause harm to a person or the environment or the harm caused is less than the harm arising from failure to control
- control agents should satisfy the same basic test: that harm caused by the agent's release is less than harm from failure to control the target organism
- the principle that benefit should exceed harm is potentially an important one, but the absence of guidance for matters that must be taken into account and ways of measuring them perhaps limits utility

Biological Resources Act 2006

- provides for use of biological resources for commercial purposes
- makes no specific provisions about avoiding environmental or other harm, except avoiding inclusion of information on permits on the register established under the Act that might cause such harm (such as providing information that might encourage illegal harvest)
- requires sharing in benefits with those providing access to biological resources
- marginal relevance

Bushfires Act 1980

- provides for use and prevention of fire in rural settings
- obligations imposed are prescriptive about the acts that may or may not be done and the conditions under which they may be carried out, but do not for example, require preventative burning
- emphasis on protection of property and obligations to maintain firebreaks
- there are no provisions requiring “reasonable” or “practicable” responses to fire risk
- no emphasis on protection of environmental values
- relevance confined mostly to influencing fire management options available to improve environmental condition and obligations to seek approvals for active fire management

Crown Lands Act 1992 *(and Regulations and other minor laws)*

- provides for government to grant fee simple title or lease
- makes no provisions regarding obligations of government or lessees regarding land condition, although the Minister may specify the number of stock which may be “depastured”
- trustees of lands reserved for various purposes have a range of specific obligations imposed on them, which are not illuminating regarding basic duty of care but relate mostly to fostering continued recreational access
- conditions of lease may be relevant if offset sites are on leases issued under this Act

Dangerous Goods Act 1998 *(and Regulations)*

- controls use, transport and storage of dangerous goods, including chemicals used in mining and agriculture and some products of mining or petroleum extraction
- concerned with direct effects on persons or property rather than environments
- no specific provisions regarding effects on lands, soils, vegetation, wildlife or water
- marginal relevance to offsets

Emergency Management Act 2013

- provides for protection of life and property from emergencies, including natural and man-made disasters
- environmental catastrophes may not trigger Act unless property and lives also threatened
- Emergency Management Council has such powers are as necessary to perform its functions, which may sometimes have environmental implications (e.g. in control of exotic disease capable of being carried by native wildlife)
- relevance marginal and confined to risk of damage to offsets as a component of emergency responses, particularly in control of animal or plant disease

Energy Pipelines Act 1982 *(and Regulations)*

- provides for construction, operation, maintenance and cessation of use or abandonment of pipelines for carrying energy-producing hydro-carbons
- establishes environmental nuisance as an offence and defines it to include adverse effects on amenity, including “unsightly or offensive conditions”
- a person engaged in operation of a pipeline must not take an act or fail to take an act that releases contaminants that cause environmental nuisance or more significant environmental harm

- other provisions about risk of more severe environmental harm qualify offences to require that the actor knows or could reasonably be expected to know that damage would result
- rehabilitation and management of pipeline corridors may provide options for offset delivery, depending on obligations accepted at the time of construction.

Environmental Assessment Act 1982

- requires that any matter that could reasonably be considered to have an effect on the environment be considered in formulating and implementing development proposals and in reaching associated agreements and arrangements
- definition of environment is broad, including the physical, biological, economic, cultural and social
- recognises the role of the independent NT EPA and Minister's obligations to give reasons for not acting on EPA recommendations
- makes no specific provisions regarding role of offsets in the assessment process
- makes no provisions regarding obligations to quantify residual damage which might support offset design to ensure environmental equivalence.

Environmental Assessment Administrative Procedures 1984

- establishes processes for preparation and consideration of reports under the *Environmental Assessment Act*
- neither Act deals directly with obligations of developers or the standards they should adopt in managing environmental issues
- there are no provisions for consideration of the suitability or otherwise of environmental offsets

Environmental Offences Penalties Act 1996

- sets environmental offences at 4 levels with penalties ranging up to $250,000 in fines and 2 years gaol
- there is no commitment to use proceeds from fines to repair environmental damage

Northern Territory Environment Protection Authority Act 2012

- objectives of the NT EPA are …. :
  (a) to promote ecologically sustainable development;
  (b) to protect the environment, having regard to the need to enable ecologically sustainable development;
  (c) to promote effective waste management and waste minimisation strategies;
  (d) to enhance community and business confidence in the environmental protection regime of the Territory.
- functions of the NT EPA are:
  (a) to advise and report to the Minister; and
  (b) to undertake functions associated with environmental assessments and the management of waste and pollution; and
  (c) to perform any other functions conferred on it by this or any other Act.
- NT EPA has the powers necessary or convenient to perform its functions. In exercising powers and performing functions, the NT EPA must:
  (a) encourage community involvement and engagement; and
  (b) ensure transparent processes and provide certainty to business
  (c) integrate both long term and short term economic, environmental and social equity considerations in its decision making

- NT EPA is not subject to the direction or control of the Minister in the exercise of its powers or the performance of its functions.
- A member is not subject to the direction or control of the Minister in the exercise of the member's powers or the performance of the member's functions.
- guidance and other statements made by the NT EPA do not have the status of legal instruments but indicate how the authority will exercise its independence
- guidance issued to date dismisses a role in considering or applying offsets as a component of its assessment processes.

Fisheries Act 1998 *(and Regulations)*

- requires management of fish stocks and marine ecosystems in accordance with principles of ecosystem management
- takes obligations beyond sustainable use of the resource to require appropriate management of habitat
- requires stewardship of aquatic resources that promotes fairness, equity and access to aquatic resources by all … groups
- defines ecologically sustainable development to require increase in the "total quality of life" now and in the future
- regulations prescribe the number of persons (licence holders) who may take fish and the methods that may be used to take them
- provides for creation of fisheries reserves for protection of aquatic life that may have a role in securing offsets in marine or freshwaters
- fisheries management plans prescribe details of methods and limit fishing effort and so set baselines for beyond compliance actions from licence holders

Geothermal Energy Act 2009 *(and Regulations)*

- promotes exploration for geothermal energy resources and production of geothermal energy in the Territory by:
  (a) giving suitably qualified persons the right to occupy areas of land to conduct activities necessary for exploration and production; and
  (b) protecting the environment during exploration and production.
- provides a general duty to take care of the environment plus formal definitions of and penalties for environmental harm
- similar to other law covering extractive industry, provides for reservation of "blocks" (for which exploration or exploitation licences may otherwise be issued) from use for these purposes
- may provide some options for securing offsets although levels of protection are weak because entirely at Ministerial discretion.

Heritage Act 2011 *(and Regulations)*

- provides a system for the protection of natural and cultural heritage
- provides automatic protection for Indigenous and Macassan archaeological sites and objects
- criteria for establishing significance include whether it:
  - is important to the course, or pattern, of the Territory's cultural or natural history;
  - possesses uncommon, rare or endangered aspects of the Territory's cultural or natural history;
  - as potential to yield information that will contribute to an understanding of the Territory's cultural or natural history;
  - is important in demonstrating the principal characteristics of a class of cultural or natural places or environments;

  - is important in exhibiting particular aesthetic characteristics;
  - is important in demonstrating a high degree of creative or technical achievement during a particular period;
  - has a strong or special association with a particular community or cultural group for social, cultural or spiritual reasons, including the significance of a place to Aboriginal people as part of their continuing and developing cultural traditions;
  - it has a special association with the life or works of a person, or group of persons, of importance in the Territory's history.
- has nothing to say about basic obligations of persons holding or having heritage places or objects on lands under their control
- obligations may, however, be specified in heritage agreements which can provide for:
  (a) restricting the use of the heritage place or object;
  (b) carrying out, or restricting the carrying out, of work on the place or object;
  (c) opening of the place for public inspection and regulating charges for admission;
  (d) financial, technical or other professional advice or help to the owner of the place or object.
- heritage agreements are registrable on and so run with title, making them potentially useful instruments for securing offsets.

Marine Pollution Act 1999 *(and Regulations)*

- object to protect the marine environment from intentional or negligent discharge of ship-sourced pollutants
- environment is designed to include amenity values and human well-being
- defines degrees of harm and harm includes risk of harm or future harm
- like other related law, provides that offence occurs when actor knows or might reasonably be expected to know that harm may result
- provides for adoption of standards or codes of practice under regulation
- perhaps some relevance for establishing baselines for common practice and hence beyond-compliance actions

Mineral Titles Act 2010

- establishes a framework for granting and regulating mineral titles that authorise exploration for, and extraction and processing of, minerals and extractive minerals;
- landholders wishing to refuse preliminary exploration need reasonable grounds, and once mineral title is granted have no rights to refuse access
- Territory parks and reserves are not automatically protected from issue of mining licences but special conditions may be imposed on holders' operations
- provides for reservation of areas from exploration or mining, but entirely at discretion of Minister and so not necessarily offering long term protection: declared parks and reserves are not preferentially reserved from mining
- Minister may reduce the area of a title on grounds "beneficial to the Territory" which include protection of flora and fauna or water conservation
- some scope for use reservation and area reduction to "secure" offsets but relatively weak form of protection and would most often seek other forms of protection under other law unless mining was the only plausible threat

Mining Management Act 2001 *(and Regulations)*

- to ensure mining to environmental standards consistent with best practice in the mining industry

- would appear to inhibit the Territory from specifying higher than prevailing standards
- environmental nuisance is defined to include adverse effect on the amenity of the land, including effects of noise, smoke, dust, fumes or odour or unsightly or offensive condition of the land
- it specifies a general obligation to “take care of the environment” (without specifying what this means)
- provides that compliance with the act does not mean that there has been no breach of a common law duty of care
- provides security bonds for mine-site rehabilitation and for establishment of a mining remediation fund for:
  (a) the identification of environmental harm caused by unsecured mining activities;
  (b) the assessment of the risk of that harm;
  (c) investigations and scientific studies relating to that harm;
  (d) the preparation of remediation plans necessary because of that harm;
  (e) carrying out both long-term and short-term remedial works required because of that harm;
  (f) engaging persons with appropriate skills.
- the remediation fund is funded by discounting remediation bonds by 10%, appearing to trade off short term capability to fix existing failures against long-term environmental condition
- the operator of a site may be required by the Minister to provide social and economic benefits to communities outside the site who are directly affected by the mining activities on the site
  - a narrow provision ("directly affected") that does not appear to go to a general obligation to protect the public interest in environmental and other conditions.

National Trust (Northern Territory) Act 1986

- establishes the Northern Territory arm of the National Trust
- the Trust's role is to for the preservation and maintenance … of lands and buildings of beauty or historic, scientific, artistic, or architectural interest and …(for lands) the preservation of their natural aspect, features and animal and plant life
- may play a role in long term management of some forms of offsets, particularly with a strong cultural component
- emphasis on built heritage confines relevance chiefly to non-Indigenous values.

Northern Territory Aboriginal Sacred Sites Act 1989

- object to effect a practical balance between the need to preserve and enhance Aboriginal cultural tradition in relation to certain land and the aspirations of the Aboriginal and all other peoples of the Territory for their economic, cultural and social advancement by:
  - establishing a procedure for the protection and registration of sacred sites
  - providing for entry onto sacred sites and conditions of such entry
  - establishing a procedure for the avoidance of sacred sites in the development and use of land
  - establishing an Authority for the purposes of the Act and a procedure for the review of decisions of the Authority by the Minister
- it is an offence to cause damage to a site or distress to a custodian of a site
- the process for registration of a site is based on long-standing significance and could not reasonably be linked to protection as offset for actions elsewhere
- relevance lies chiefly in formal recognition of Indigenous values and perspectives on issues in protection and as evidence of the cultural significance of a site not recognised in the array of other laws

- important for assigning priorities to sites chosen for protection or for offsets offered additional layers of protection under other laws

Nuclear Water Transport, Storage and Disposal (Prohibition) Act 2004

- no relevant provisions

Parks and Reserves (Framework for the Future) Act 2004 *(and Regulations)*

- provides a framework for negotiations between the Territory and the traditional Aboriginal owners of certain parks and reserves for the establishment, maintenance and management of a comprehensive system of parks and reserves
- a comprehensive system of parks and reserves is one that –
  - is developed in partnership between the Territory and the traditional Aboriginal owners of the parks and reserves;
  - benefits those traditional Aboriginal owners by recognising, valuing and incorporating indigenous culture, knowledge and decision making processes;
  - protects biological diversity;
  - serves the educational and recreational needs of Territorians and visitors to the Territory; and
  - enjoys widespread community support
- formalises broader view of the role of parks and recognition of additional (Indigenous) values in management frameworks

Parks and Wildlife Commission Act 1999

- establishes the Commission with powers to:
  - to promote the conservation and protection of the natural environment of the Territory –
    - by managing or participating in the management of –
      - parks, reserves and sanctuaries established under the *Territory Parks and Wildlife Conservation Act* or any other Act of the Territory or the Commonwealth; and
      - other land by agreement with the owners or occupiers of that land; and
    - by the promotion, and the enforcement where necessary, of the protection, conservation and sustainable use of wildlife, whether on such parks, reserves or sanctuaries or elsewhere in the Territory; and
  - the management, for a purpose approved by the Minister, of other land, and such other functions as are conferred by this or any other Act
- has nothing to say about standards of management
- relevance lies in source of powers to provide long term protection to sites identified as offsets.

Pastoral Land Act 1992 *(and Regulations)*

- prescribes conditions for management of a large proportion (~42%) of the Territory land area under pastoral lease, with objects including:
  (a) monitoring of pastoral land so as to detect and assess any change in its condition;
  (b) prevention or minimisation of degradation of or other damage to the land and its indigenous plant and animal life; and
  (c) rehabilitation of the land in cases of degradation or other damage;
- a general duty of pastoral lessees is provided:

  "It is the duty of a pastoral lessee:

  (a) to carry out the pastoral enterprise under the lease so as to prevent degradation of

the land;
(b) to participate to a reasonable extent in the monitoring of the environmental and sustained productive health of the land; and
(c) within the limits of the lessee's financial resources and available technical knowledge, to improve the condition of the land."

(degradation means a decline in condition of the natural resources of the land)

- the lessee must take all reasonable measures to conserve and protect features of environmental, cultural, heritage or ecological significance
- the Pastoral Land Board is to report at least once a year on the general condition of pastoral land and operate systems for monitoring the condition and use of pastoral land
- the Board may direct a pastoral lessee to control declared feral animals on his or her pastoral land
- a pastoral lessee is not responsible for the expense of rehabilitating or restoring land to the extent that the degradation or other damage was or is beyond the pastoral lessee's reasonable control (and was not or is not caused or aggravated by his or her activity)
- the Act is consistent with many other laws in invoking "reasonable measures" and reasonable expectations about control of damage, but unusual in specifying monitoring and reporting on condition as key obligations
- lessees must also provide access to waters and other features of public interest nominated by the Minister
- recent amendments (late 2013) offer greater freedom to use leases for non-pastoral purposes
  - permits travel with the lease
  - extension material scrupulously avoids any reference to conservation activities or biodiversity, carbon or other offsets, but nothing in the legislation would prevent application for such use
- the Pastoral Land Board will have a pivotal role in determining whether significant areas of pastoral lands are used for offsets of any sort.

Petroleum Act 1984

- provides a framework to encourage exploration and production of petroleum to return "optimum value of the resource" to the Territory
- risks to human health and environment are to be reduced "so far as is reasonable and practicable"
- definitions of environmental damage are consistent with those in related legislation (*Energy Pipelines Act* and *Petroleum (Submerged Lands) Act*) in specifying degrees of harm and including environmental nuisance
- it is a defence against prosecution for environmental offences to have exercised "reasonable" diligence
- as with other resource extraction law, provides capacity to reserve titles from exploration or extraction, again at the discretion of the Minister.

Petroleum (Submerged Lands) Act 1981 *(and Regulations)*

- provides for exploration and petroleum production on submerged lands
- the Minister for Parks and Wildlife may make directions for management of exploration or production causing substantial disturbance in or adjacent to (declared) parks and reserves
- holders of permits may be required to make good damage to sea-bed and subsoil to the satisfaction of the relevant Minister
- references to environment relate mostly to working environment (occupational health and safety)

- as with other resource extraction law, provides capacity to reserve titles from exploration or extraction, again at the discretion of the Minister.

Planning Act 1999

- provides a framework of controls for the orderly use and development of land:
  (a) planning of land use and development and sustainable use of resources
  (c) controls for appropriate use of land, within capabilities and limitations
  (d) control of development to protect the natural environment
  (e) minimising adverse impacts on existing amenity and, wherever possible, enhancing amenity
- amenity, in relation to a locality or building, means any quality, condition or factor that makes or contributes to making the locality or building harmonious, pleasant or enjoyable
- in general, developments are not to affect the amenity of adjoining or nearby buildings or places
- in theory the array of frameworks and controls could be used for broad-scale land use and conservation planning throughout the Northern Territory, including securing offsets.

(*Northern Territory Planning Scheme*) (last amended 7 May 2014)

- a key instrument for implementing the *Planning Act* and:
  - (a) contributing to a built, rural and natural environment supporting diverse lifestyle and social, cultural and economic development promoting:

    vi. best practice environmental management;

  - (b) contributing to sustainable use and development of land and water resources consistent with the principles of sustainable development, avoid pollution and minimise degradation of the environment
  - (f) assisting in conservation of areas and sites of environmental, cultural or heritage value as identified by Government
  - (j) valuing land for its inherent ecosystem functions in protecting native flora, fauna, soil and water resources.
- establishes areas zoned conservation within which the primary purpose is to conserve and protect the flora, fauna and character of natural areas and development is to be sensitive to the natural features and habitats of the zone and be sited and operated to have minimal impact
- vehicle for controlling land clearing, with controls that emphasise soil and landscape stability and maintenance of biological diversity
  - given emphasis in planning law on general amenity, oddly makes no reference to protection of amenity in land clearing decisions.

Land clearing guidelines issued to give effect to NT Planning Scheme (2010)

- guidelines covering areas available for clearing and specifying features requiring protection, buffers around such features and the like
- applications to clear native vegetation must show how the guidelines have been followed
- conditions of land clearing permits require observance of guidelines
- includes specific guidelines for the Daly River with larger buffers and maximum areas available for clearing at scales ranging from the property to the catchment
- relevance to offsets in establishing baseline for regulatory additionality in standards for management of protection and management of native vegetation on all lands
- surrender of permit to clear could conceivably be treated as offset, depending on conditions set in permit and response of approving authority

- application to offsets is complicated by existence of separate consent authorities for freehold and pastoral leasehold land.

Soil Conservation and Land Utilization Act

- provides for the prevention of soil erosion and for the conservation and reclamation of soil
- the emphasis is on reacting to problems or actions of landholders, as distinct from establishing basic obligations of landholders
- the CE of the relevant agency may issue a soil conservation order where there is a "danger" of soil erosion, which may prohibit certain actions or require reductions in stock densities
- potential preventative measures include declaration of areas of erosion hazard within which uses may be restricted
- some potential for a role in securing offsets, particularly those seeking to rehabilitate damaged landscapes.

Territory Parks and Wildlife Conservation Act 1980

- provides for establishment of Parks and Reserves and the study, protection, conservation and sustainable utilisation of wildlife
- establishes interference of protected wildlife (plants and animals) as an offence, defining interference as:
  - harm, disturb, alter the behaviour of or otherwise affect the capacity of the animal or plant to perform its natural processes; or damage or destroy the habitat of the animal or plant
- interference with wildlife requires a permit from the Director of Parks and Wildlife that may impose conditions
- provides principles of management for wildlife that promote survival in natural habitats, and special attention to areas of habitat important for wildlife
- it is defence to a prosecution for interference with wildlife (s66) if it occurred as a result of "reasonable use and enjoyment of the land" where the wildlife was located and was not the result of negligence
- requires management plans for parks and reserves which are to cover:
  - (a) the encouragement and regulation of the appropriate use, appreciation and enjoyment by the public
  - (b) preservation in natural condition and the protection of special features, including objects and sites of biological, historical, palaeontological, archaeological, geological and geographical interest
  - (c) protection, conservation and management of wildlife; and
  - (d) protection against damage.
- provides for agreements with landholders to protect specific values and provide related financial support, but without specifying eligibility criteria or levels of support that might be warranted in different circumstances
- provides for declaration of feral animals and of control areas where there is reason to believe that wildlife or landscapes are threatened by feral animals: landowners may be directed to control or eradicate feral animals within a control area
- provides for declaration of essential habitat on which specified activities may be excluded, applying to pastoral and other leased public lands and Indigenous freehold, but not non-Indigenous freehold
- provides arguably the most robust available mechanisms for securing offsets.

Waste Management and Pollution Control Act 1998

- objectives are –
  - to protect, and where practicable to restore and enhance the quality of, the environment by
    - preventing pollution;
    - reducing the likelihood of pollution occurring;
    - effectively responding to pollution;
    - avoiding and reducing the generation of waste;
    - increasing the re-use and re-cycling of waste; and
    - effectively managing waste disposal;
  - to encourage ecologically sustainable development
    - establishes a general "environmental duty", which requires that potential polluters must take all measures that are reasonable and practicable to –
      - prevent or minimise pollution or environmental harm; and
      - reduce amount of the waste.
    - this duty is, however, qualified to require attention to the sensitivity of the receiving environment, technical constraints and costs
    - failure to observe environmental duty is not an offence, but a pollution abatement notice may be issued
    - provides for recognition of codes of practice as ways of complying with general environmental duty
    - provides for setting environmental protection objectives in regard to air, water and soil quality
  - defines best practice environmental management as management of an activity in a cost-effective manner that, has regard to national or international practices to minimise the actual or potential environmental impact of the activity
  - establishes a best practice licence that recognises activities that go beyond compliance, including:
    - implementing a program of voluntary environmental audits;
    - implementing an improvement plan;
    - implementing a system for environmental management;
    - implementing a program for reporting to the community, and
    - involving the community in environmental performance and management
- the best practice licence is unusual in establishing formal recognition of an array of activities that go beyond strict compliance obligations
- language implying preparedness to accept less than best practice in apparent conflict with usage in other (e.g. mining) laws

Water Act 1992 *(and Regulations)*

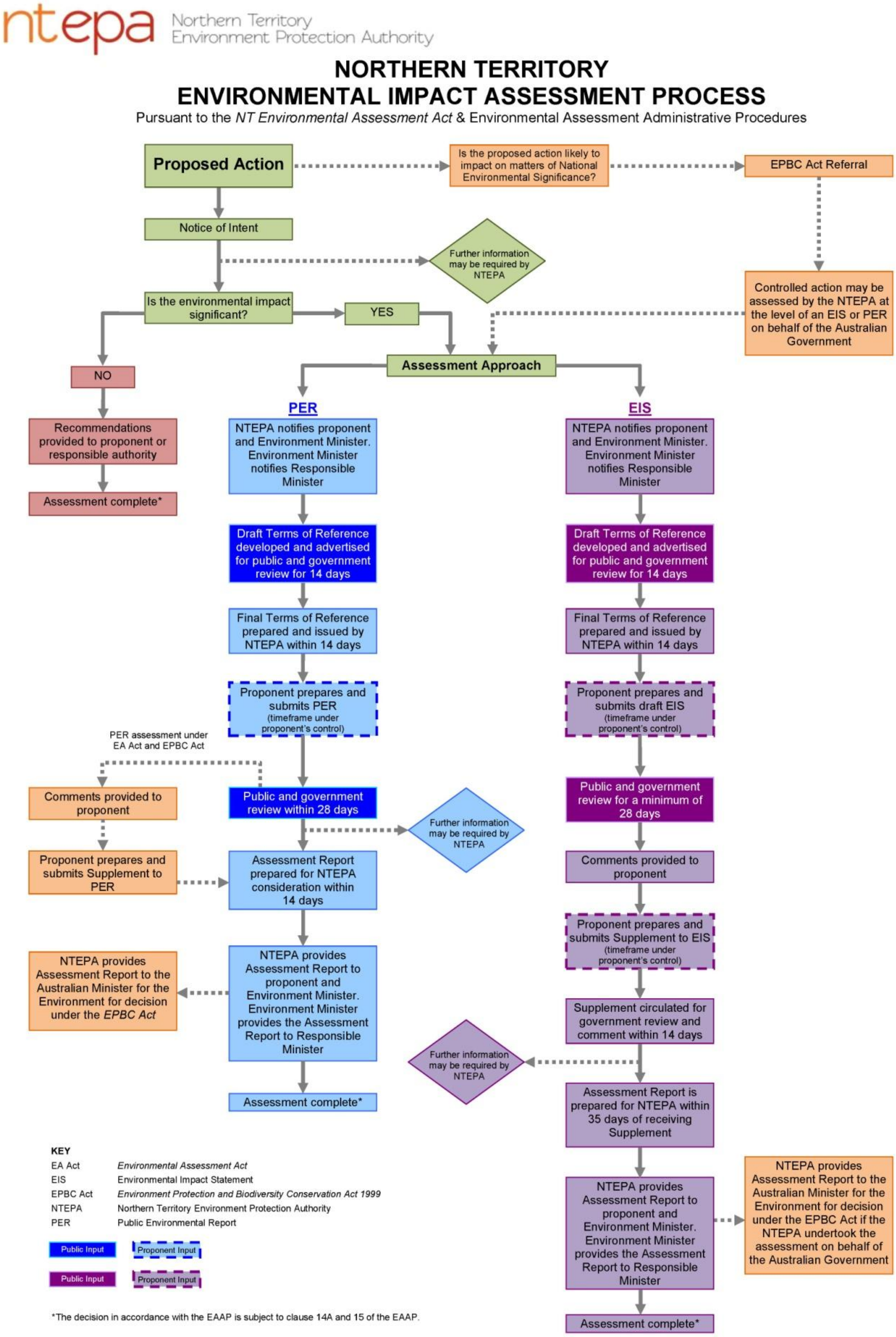
- provides for investigation, allocation, use, control, protection, management and administration of water resources
- allocation through recognition of beneficial uses, including environmental (to provide water to maintain the health of aquatic ecosystems) and cultural
- total water use to remain within sustainable yields
- environmental harm is defined broadly to means any harm to or adverse effect on, or potential harm to or adverse effect on, the environment
- environment is broadly defined to cover all aspects of the surroundings of man, including the physical, biological, economic, cultural and social
  - **material environmental harm** is not trivial or negligible;
    - results or is likely to result in >$50,000 being spent in preventing or minimising the harm or rehabilitating the environment; or

        - results in other actual or potential loss to the value of <$50,000
    - **serious environmental harm** means environmental harm includes environmental harm that:
        - results or is likely to result in >$50,000 being spent in prevent or minimise the harm or rehabilitate the environment;
        - results in actual or potential loss or damage >$50,000;
        - damages an aspect of the environment that is of a high conservation value or of special significance; and
        - is irreversible or otherwise of a high impact or on a wide scale.
- specified offences dealing with environmental harm relate to waste and pollution
- may be options to redirect water entitlements to environmental or cultural use as offsets, but mechanisms that might be available to secure long term change are obscure.

Weeds Management Act 2001 *(and Regulations)*

- purpose to -
  (a) prevent the spread of weeds in, into and out of the Territory
  (b) ensure community consultation in weed management planning; and
  (c) ensure community responsibility in implementing weed management plans.
- prescribes general duties of owners and occupiers of land who must:
    - take all reasonable measures to prevent land being infested with a declared weed and to prevent spread to other land
    - notify the presence of the declared weed
    - comply with a weed management plan
    - not bring a declared weed into the Territory
    - not propagate or scatter a declared weed
    - not sell or offer to sell a declared weed or any thing that contains or carries a weed
    - not hire any equipment, device or thing that contains or carries a declared weed or potential weed
    - not purchase or offer to purchase a declared weed or any thing that contains or carries the weed;
    - not store, grow or use a declared weed or any thing that contains or carries the weed
    - not transport or carry a declared weed or anything that contains or carries the weed.
- provides that weed management plans may specify criteria for obtaining assistance to carry out obligations imposed under the plan and the extent of the assistance
    - one of few laws providing explicitly for examining and establishing modes of support for actions warranting special treatment, but without specifying what sorts of actions would quality or the type or level of support that might be applicable
- offsets involving weed control would need to go well beyond obligations in weed management plans
- examples of beyond obligations performance might include commitment to local eradication when legal obligations are to prevent spread.

Flowchart for Northern Territory environmental assessment process



Terms of reference - Inquiry on hydraulic fracturing for hydrocarbon extraction [82]

Hydraulic fracturing for hydrocarbon deposits in the Territory, including the assessment of the environmental risks and actual environmental impacts of hydraulic fracturing and the effectiveness of mitigation measures, and more particularly the matters mentioned in the following clauses:

1. Historical and proposed use of hydraulic fracturing (exploration, appraisal and production) of hydrocarbon deposits in the Northern Territory (number of wells; locations; timeline).
2. Environmental outcomes of each hydraulic fracturing activity for hydrocarbon resources in the Northern Territory (number of wells; frequency of types of known environmental impacts).
3. Frequency of types and causes of environmental impacts from hydraulic fracturing for hydrocarbon deposits in the Northern Territory and for similar deposits in other parts of the world.
4. The potential for multiple well pads to reduce or enhance the risks of environmental impacts.
5. The relationship between environmental outcomes of hydraulic fracturing of shale petroleum deposits with geology, hydrogeology and hydrology.
6. The potential for regional and area variations of the risk of environmental impacts from hydraulic fracturing in the Northern Territory.
7. Effective methods for mitigating potential environment impacts before, during and after hydraulic fracturing with reference to:
    - the selection of sites for wells
    - well design, construction, standards, control and operational safety and well integrity ratings
    - water use
    - chemical use
    - disposal and treatment of waste water and drilling muds
    - fugitive emissions
    - noise
    - monitoring requirements
    - the use of single or multiple well pads
    - rehabilitation and closure of wells (exploratory and production) including issues associated with corrosion and long term post closure
    - site rehabilitation for areas where hydraulic fracturing activities have occurred.

[82] www.hydraulicfracturinginquiry.nt.gov.au

Landholder obligations under Northern Territory law as relevant to offsets

Table 24 Examples of actions that might and probably would not be treated as exceeding basic obligations of landholders to protect land and resources, given provisions of statute law in the Northern Territory.

Source of threat or pressure	Actions forgoing established rights or exceeding statutory or common law expectations	Actions pursuing established rights or meeting basic obligations
Grazing	grazing pressure reduced below levels needed to ensure sustainability of production or avoid deterioration of natural resources of the land	
	retaining over the long term areas of native woody or other vegetation that is potentially available for clearing under prevailing controls and guidelines (e.g. improving public amenity by avoiding clearing of sites near roads or other observation areas or extending wildlife corridors)	
	retaining wider than mandatory buffers around vegetation types or other features that must be retained under prevailing land clearing controls	
	eschewing introduction or use of “permitted” exotic plants capable of reducing the abundance of native pasture species in sites that are suitable for “improved” pasture establishment	replacement of native pastures with exotic plants, even if these are used in efforts to rehabilitate a previously-damaged site
	removing or suppressing existing areas of exotic pastures and replacing them with native pastures	suppressing declared weeds, unless part of an agreed land rehabilitation program
	adopting grazing regimes and associated management practice that increase levels of carbon sequestered in native vegetation and soils above baseline levels	sequestration of carbon or containment of greenhouse gas emissions at levels similar to long-term baselines
	adopting grazing regimes and stock management systems that	

Source of threat or pressure	**Actions forgoing established rights or exceeding statutory or common law expectations**	**Actions pursuing established rights or meeting basic obligations**
	reduce levels of greenhouse gas emissions from pastoral lands	
	restoring areas of native vegetation that are not essential for avoiding further deterioration in the condition of the land, but may improve amenity or quality of ecosystem services, including protection of regional biological diversity	
	active monitoring and reporting of features of natural or cultural assets that would not be regarded as particularly revealing the condition of natural resources of the land	monitoring of the condition of pasture or linked attributes directly related to conventional measures of the condition of pastoral land unless the intensity of monitoring greatly exceeds established protocols
	fencing to protect features of natural or cultural assets that would not be regarded as critical measures of the condition of natural resources relevant to grazing management	
	management to improve quality of wildlife habitat and so increase viability of local and regional populations of fauna of concern	
	actions protecting features of environmental, cultural, heritage or ecological significance using methods that clearly fall outside conventional pastoral management practice • application of hot fires to areas of pasture to exclude undesirable woody or other plants • exclusion of stock from natural waters by fencing or reduced pressure	basic measures to protect features of environmental, cultural, heritage or ecological significance using methods that are typically employed in pastoral management
	providing public access to sites that have not been formally recognised as features of public interest but are regarded by conservation, recreation and/or environmental and education authorities as contributing usefully to regional networks	providing publicly access to sites of public interest that have been formally recognised under the *Pastoral Land Act*
	positioning watering points explicitly to exclude some otherwise productive areas from access by grazing animals	

Source of threat or pressure	Actions forgoing established rights or exceeding statutory or common law expectations	Actions pursuing established rights or meeting basic obligations
Water use and extraction, water quality	sustained reduction in water use from aquifers otherwise used at or near sustainable yield and conversion of related entitlements from the consumptive pool to environmental flows (e.g. supplementation of flows to strongly water-dependent ecosystems at risk from generalised draw-down of aquifers)	
	re-configuration of water extraction points to minimise impacts on other values, whether from effects of water drawdown or impacts of stock on quality of surface waters and associated soils and vegetation	
	arrangements to enhance actively aquifer recharge	
	prevention or reduction of tidal intrusion where there is evidence of recent change in predominantly freshwater wetland systems	prevention or reduction of tidal influence where there is no recent evidence of change and sites have been subject to tidal influences over long periods
	conversion of water entitlements from the consumptive pool to cultural flows (e.g. to maintain sites for recreation use or Indigenous cultural values otherwise affected by water exploitation)	
	reductions in water use and water entitlements by practice or technology that substantially exceeds prevailing industry standards and “saved” water is allocated to environmental or cultural pools	measures to improve efficiency of water use employing readily available and widely used technology or methods
	use of part of a water entitlement to protect wetland or related values (e.g. pumping to a spring-fed rainforest threatened by a general drawdown of a large aquifer subject to heavy use in a long-established borefield)	design of new water extraction arrangements to avoid impacts on sensitive communities
	use of wetland filters to minimise sediment loads reaching rivers when additional to other measures complying with prevailing standards (avoidance of slopes, fragile soil types etc as set out in guidelines)	measures to limit erosion that meet but do not exceed prevailing standards and guidelines
	contributions to water quality monitoring arrangements that exceed mandatory obligations, including extension to off-site concerns	

Source of threat or pressure	Actions forgoing established rights or exceeding statutory or common law expectations	Actions pursuing established rights or meeting basic obligations
	fencing to protect riparian and wetland systems from grazing impacts and maintain on- and off-site water quality	
Mining and petroleum extraction	on-site repair or rehabilitation of pre-existing damage from prior land use (e.g. grazing or mining)	restoration or rehabilitation of sites to prevailing industry standards where the requirement is part of an approved mine management plan or associated agreement
	off-site repair or rehabilitation of pre-existing damage from prior land use (including other mining)	
	adoption of risk (probability of occurrence) thresholds for potential impacts well below industry standards in design and operation of facilities	
	supporting application of fire regimes favouring biodiversity generally or specified taxa on leases or mine sites that exceed requirements of regional fire management plans or obligations for protection of life and property	
	on-site control of weeds or feral animals at levels that go beyond impact reduction to seek local or regional eradication	
	management of wildlife habitat on site to improve suitability and viability of local populations of wildlife of concern	
	on-site application of emerging or new technology (including conduct of experiments) to minimise mining impacts	compliance with national, local or industry standards or codes of practice in regard to maintenance of environmental health, including land condition, biodiversity protection and water or air quality
	financial or other support to improve off-site management of places or phenomena of regional or wider natural or cultural heritage conservation interest	
	financial or other support to improve off-site protection of sites registered under the *Northern Territory Aboriginal Sacred Sites Authority Act* or *Heritage Conservation Act* and at risk from pressures	on-site protection of sites registered under the *Northern Territory Aboriginal Sacred Sites Authority Act* or *Heritage Conservation Act*

Source of threat or pressure	Actions forgoing established rights or exceeding statutory or common law expectations	Actions pursuing established rights or meeting basic obligations
	unassociated with the mining operation	
Fire regimes	reduction of greenhouse gas emissions below baseline levels by reducing fire frequency and extent	
	increased biosequestration of carbon deriving from changed fire regimes, provided biodiversity or other environmental values are also enhanced or adverse impacts are shown to be minimal	regimes that maintain the *status quo* and deliver no improvements in GHG emissions, carbon sequestration, biodiversity or other measures of landscape health
	fire regimes that improve soil and landscape stability and contribute to maintenance or improvement of water quality and differ from prior regimes on the same site or typical regimes on neighbouring sites	
	regimes that improve habitat suitability for nominated wildlife species, but do not unacceptably increase GHG emissions or cause on- or off-site changes detrimental to landscape condition or viability of other regionally significant wildlife populations	managing fire to avoid damage to mature woody vegetation
	on-site actions that exceed local requirements and also contribute to capacity of neighbours (and Government) to reduce risks to environment, property and human safety	fire management actions required under recognised regional fire management plans
	regimes that reduce risk of impacts on human health from particulates (smoke) below historical levels	managing fire to reduce risk to life and property from burning to acceptable levels
Land clearing	significantly larger than mandatory buffers around environmentally significant or sensitive vegetation or culturally significant sites	strict compliance with current land clearing guidelines avoiding damage or disturbance of sites registered under the *Northern Territory Aboriginal Sacred Sites Authority Act* or *Heritage Conservation Act*
	configurations of native vegetation that directly connect similar wildlife habitats or particular wildlife populations within properties to	configuration based mostly or entirely on non-use of sites that are regarded as unsuitable for clearing under prevailing guidelines

Source of threat or pressure	Actions forgoing established rights or exceeding statutory or common law expectations	Actions pursuing established rights or meeting basic obligations
	increase resilience of retained vegetation and viability of wildlife populations o subject to the caveat that arrangements must perform better than would randomly selected sites of equivalent area or sites rated as unsuitable for clearing under prevailing guidelines	
	configurations of native vegetation that directly connect different wildlife habitat types within properties, where connections are considered useful to increase resilience of retained vegetation, meet seasonal shifts in resource distribution or to supplement other connections o arrangements must perform better than would randomly selected sites of equivalent area or sites rated as unsuitable for clearing under prevailing guidelines	
	configurations of native vegetation that directly connect the same or different wildlife habitat types across boundaries of neighbouring properties o arrangements must perform better than would randomly selected sites of equivalent area or sites rated as unsuitable for clearing under prevailing guidelines	
	configurations that maintain or improve visual amenity o substantial (wider than mandatory) buffers around property boundaries o retention of vegetation on ridgelines or points conspicuous from outside property boundaries	
	preferential retention of native vegetation that is in unusually good condition o including retention of old growth in preference to regrowth of any age	
	retention of habitat recognised as unusually important for one or more species of flora and fauna of regional significance, if not recognised as essential habitat under the TPWCA	avoiding damage to areas of declared essential habitat

Source of threat or pressure	Actions forgoing established rights or exceeding statutory or common law expectations	Actions pursuing established rights or meeting basic obligations
	o areas supporting unusually high densities of resources important for wildlife (including older hollow-bearing trees) o areas free of or suffering little impact from invasive plants or animals	
	retention of areas supporting unusually dense populations of one or more species of flora and fauna of particular regional significance	
	retained areas specifically designed to buffer against other prevailing pressures and threats	compliance with soil conservation orders or plans or guidelines required under other law (e.g. *Planning Act*)
	preferential clearing of regrowth or otherwise degraded native vegetation when combined with retention of old-growth or other high quality areas that are otherwise particularly favourable for the intended use	
Weeds	management actions taken prior to declaration of species or enactment of management plan where in the view of management authorities those actions facilitate more effective control	
	activities that are not required under approved relevant weed management plans but that facilitate improved control by others (especially neighbours), including Government o commitment to local eradication (as distinct from containment or control) when not obligatory under approved weed management plans o voluntary offsite control (e.g. on neighbouring tracks and roadsides) complementing mandatory on-site control	strict compliance with control obligations and practices recommended in approved weed management programs
	avoiding use of plants that although not declared as weeds regionally have been identified as causing problems elsewhere	
	avoiding use of approved herbicides in areas where there are verifiable conservation or other public benefits in doing so and other effective (albeit more expensive) methods are available	adoption of non-chemical or other more expensive control options where no particular environmental benefit is associated with the method chosen

Source of threat or pressure	Actions forgoing established rights or exceeding statutory or common law expectations	Actions pursuing established rights or meeting basic obligations
	active coordination of regional control efforts that although individually within requirements are more effective because complementary	
	acquisition and sharing of equipment that facilitates more effective control on key sites or among key groups	
	weed control efforts of any sort on lands covered by conservation agreements recognised under Territory law or areas declared as essential habitat where those agreements or laws require that lands are taken out of production or production is substantially reduced	
	repair of long-standing pre-existing weed problems involving any species that favour re-establishment of native vegetation where repaired land is managed to retain native vegetation cover	
	organised intensive monitoring programs involving local or regional collaboration	
	making site(s) available for vehicle hygiene facilities usable by neighbours	routine weed hygiene procedures associated with stock or vehicle movements
	any control of declared weeds on land from which owners or managers earn no income, where control is in the wider public interest to inhibit spread or aid eradication	
Feral animals	actions to control exotic animals not declared as pests where there is reason to believe that this will nonetheless deliver environmental benefits	routine control of pest animals to meet obligations under pest control or other land management law (e.g. *Pastoral Land Act*)
	commitment to local eradication when control is mandated where this will assist neighbours or government to assert greater control	
	levels of control that exceed those necessary to protect production values but are clearly useful to protect other nominated values of public interest (e.g. amenity of water bodies and fringing vegetation)	

Source of threat or pressure	Actions forgoing established rights or exceeding statutory or common law expectations	Actions pursuing established rights or meeting basic obligations
	landholder control of feral animals at any level on sites subject to formal conservation agreements or declared as essential habitat made under Territory law where sites are taken out of production or production is substantially reduced	
	fencing to exclude feral animals from sites subject to formal conservation agreements or other sites recognised for special values where protection of values would not be reliably achieved by routine feral animal management	fencing required for stock management that incidentally also excludes feral animals
	collaboration in regional or district control programs where coordination and joint action is essential but generates costs that would not otherwise be incurred in meeting routine control obligations	
	adoption of control methods that decrease likelihood of non-target impacts when a site is regarded as particularly vulnerable to some lower cost or more effective approved methods	
	levels of control of species not declared as pests that prevents continued commercial exploitation of the species	control undertaken pursuant to
Gaseous pollutants	use or disposal of residues from land clearing that slow rates of release of greenhouse gases or particulates below rates from burning	reduction of greenhouse gas emissions from land use activities and in sectors that require purchase of permits or credits under mandatory schemes (like the CPRS)
	early adoption of technologies that substantially reduce emissions in land and resource use sectors of industry not covered by mandatory liabilities for emissions (e.g. the proposed Carbon Pollution reduction Scheme)	
	forgoing use of fire for customary hunting in situation where any active fire use is regarded by other interests as undesirable or damaging	

Source of threat or pressure	Actions forgoing established rights or exceeding statutory or common law expectations	Actions pursuing established rights or meeting basic obligations
	improved land management practices that increase sequestration of carbon in soils or vegetation	
Erosion and sedimentation	precautionary avoidance of situations at measurable risk from erosion and sedimentation where use would nonetheless comply with guidelines or standards applying in the Territory	compliance with mandatory standards or soil conservation control orders for particular sites
	effective implementation of erosion control plans targeting outcomes exceeding requirements of prevailing codes of practice or other standards and prescriptions	
Biocide use	adoption of alternatives to chemical treatments in situations where prevailing practice is to depend on biocide use	routine compliance with requirements of approved control plans, biocide label instructions and related law compliance with off-label approvals by regulators) of registered biocides
	use of higher cost or less effective approved biocides where risks of non-target effects, accumulation or significant residual effects are known to be lower	
Consumptive use of native wildlife	forgoing harvest of species under new or emerging threats (e.g. goannas affected by cane toads)	unmodified continuation of customary practice in selection and securing of target species
	forgoing harvest of species that have been classified as threatened, where harvest is considered likely to add significantly to pressures on the species	
	forgoing native title rights in regard to harvest in particular sites (where not covered by an existing Indigenous Land Use Agreement under the (Cwlth) *Native Title Act*	
	modifying extent and location of harvests or features of harvested wildlife (sex, age, reproductive condition) to minimise impacts on	compliance with relevant provisions of existing management plans and

Source of threat or pressure	Actions forgoing established rights or exceeding statutory or common law expectations	Actions pursuing established rights or meeting basic obligations
	threatened species	laws in regard to customary and commercial harvests
	increased harvest of exotic species that are damaging environmental values	harvesting of exotic species for commercial benefit that bring populations down to levels that fail to substantially reduce important types of environmental damage
	development of new commercial harvests of secure species from the wild where commercial interest can provide incentives (e.g. crocodile egg harvests) to protect habitats from more destructive land or resource use	
	choice of harvest methods from approved approaches that minimise target or non-target effects (e.g. use of non-toxic shot)	use of non-toxic shot in areas where use of toxic shot is banned
	voluntary observance of lower than mandatory limits on take	reduction of hunting effort by recreational hunters
	development of systems to use rates of customary or commercial harvest (catch per unit effort), or records taken incidental to customary harvest activities, as indicators of health of wildlife populations or habitats	

REVIEW OF THE WATER ACT 2007 (Cwlth)

TERMS OF REFERENCE

2) A review of the *Water Act 2007* (the Act) will be carried out in 2014 in accordance with section 253 of the Act, which specifies the following mandatory terms of reference:
   a) having regard to the extent to which water resource plans are in transition, the review will conduct an assessment of the extent to which:
      (i) the management objectives and outcomes of the Basin Plan are being met; and
      (ii) long-term average sustainable diversion limits are being met; and
      (iii) targets in the Basin Plan[83] are being met; and
      (iv) water trading is occurring effectively and efficiently; and
      (v) other key elements of the Basin Plan are being implemented;
   b) an assessment of:
      (i) the level of Basin-wide consistency in water charging regimes; and
      (ii) the contribution made by those charging regimes to achieving the Basin water charging objectives;
   c) an assessment of the extent to which water is being used in higher value uses;
   d) an assessment of the progress in the implementation of improved water information systems, including the National Water Account.
3) In addition, the review will examine and report on:
   a) the effectiveness of the Act in achieving its objects, as set out in section 3 of the Act; and
   b) opportunities to reduce or simplify the regulatory and/or reporting burden while maintaining effective standards.
4) The review will also recommend appropriate future review points for the Act and Basin Plan, noting the 2019 implementation date of the Basin Plan.
5) The review will be undertaken in consultation with state and territory governments and stakeholders.

[83] Basin means the Murray-Darling Basin plan for water allocation and management. The Basin straddles 4 political jurisdictions (New South Wales, Victoria, South Australia and Queensland) and produces a large proportion of Australia's food for local consumption and export.

BRIEF DESCRIPTION OF DATA SOURCES

Dataset Name: Australian Hydrological Geospatial Fabric (geofabric) contracted catchments

Dataset Description: Hydrological catchments

Custodian: Bureau of Meteorology, Australian Government

Web link: weblink

Associated information: weblink

Accessibility: Public availability

Provided: Yes

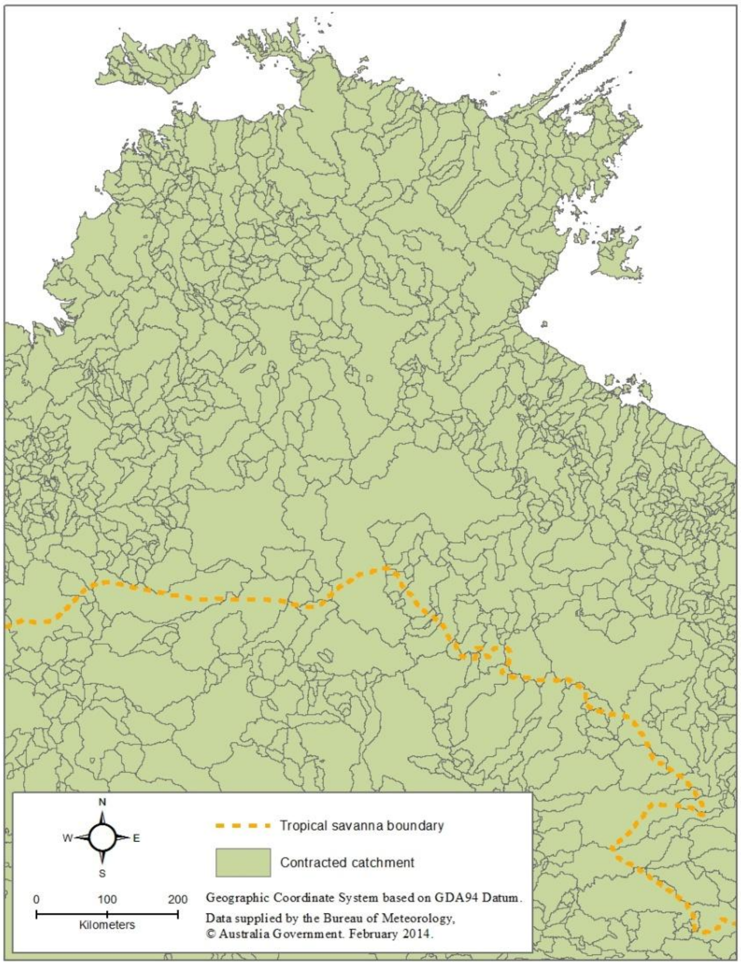
Metadata link: weblink

Format: ESRI geodatabase

Data version/date of creation: Version 2.1 – November 2012

Overview: The geofabric data is an information framework for water data in Australia. It provides a permanent identifier and allows for hydrological features to be linked. There are several levels (scales) of catchments. There are also vector stream networks.

The catchment data allows for aggregation based on upstream relationships.



Dataset Name: Digital Cadastral Database of the Northern Territory

Dataset Description: Northern Territory portions and lots

Custodian: Department of Lands, Planning and the Environment, Northern Territory Government

Web link: weblink

Associated information: Can be viewed via google earth at weblink

Accessibility: Via data agreement at cost

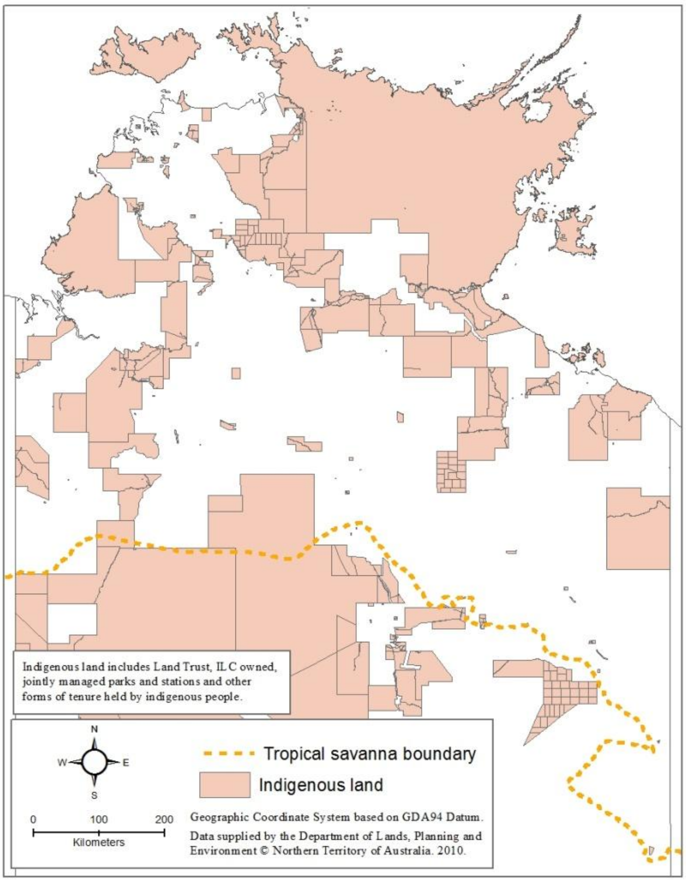
Provided: No

Metadata link: weblink

Format: Various GIS formats – polygons

Data version/date of creation: Updated continuously. Data from 2010 was used for this project.

Overview: This is a simple dataset which separates out the NT into tenure parcels. It provides information such as parcel details, tenure type, property name (if applicable) and categorised ownership (ie Private, Aboriginal freehold, Government Owned, Crown etc.). Aboriginal land that was granted under ALRA or NT Aboriginal Land Act area are defined, however it is difficult to separate out other lands held by indigenous organisations or granted under different acts.



Dataset Name: Road network and pipelines with NT

Dataset Description:

Custodian: Department of Lands, Planning and Environment

Web link:

Associated information:

Accessibility: Via data agreement and a cost

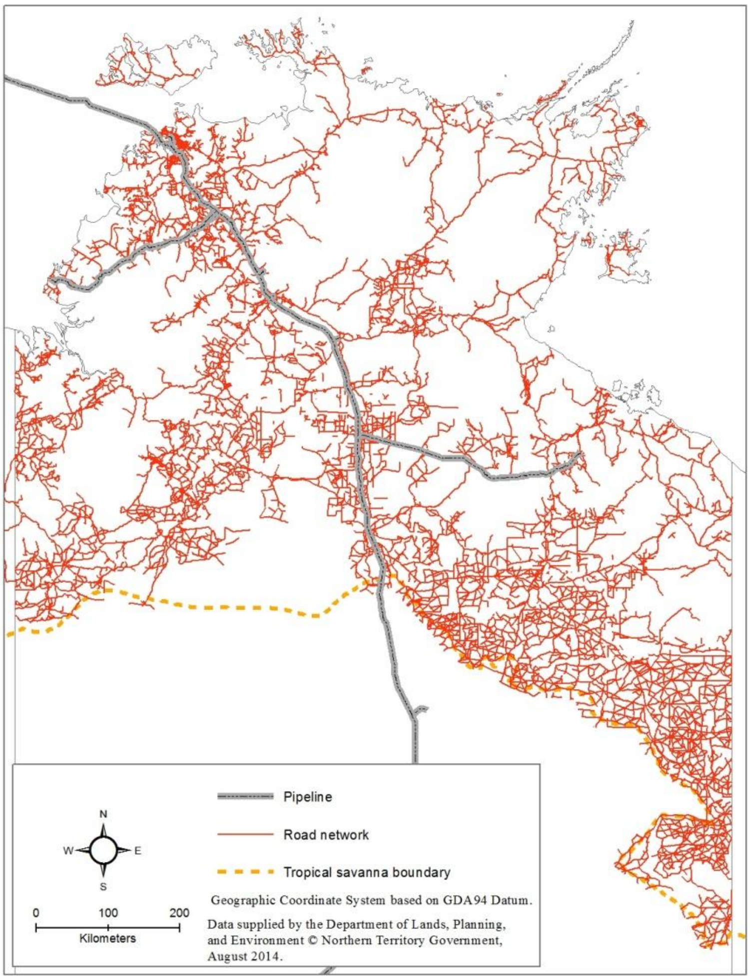
Provided: Yes

Metadata link:

Format: ESRI polyline

Data version/date of creation: Extracted 19/8/2014

Overview: Basic information is provided by the road network such as name, type and surface (if applicable).



Dataset Name: Identification of Potential Land for Long-term Sustainable Food Production. Stage 1: Identification of Soil and Water Resources

Dataset Description: Identifies suitable land and water resources for further long-term and sustainable food production.

Custodian: Department of Land Resource Management, Northern Territory Government

Web link: weblink

Associated information: weblink

Accessibility: Available via data agreement with DLRM

Provided: Yes

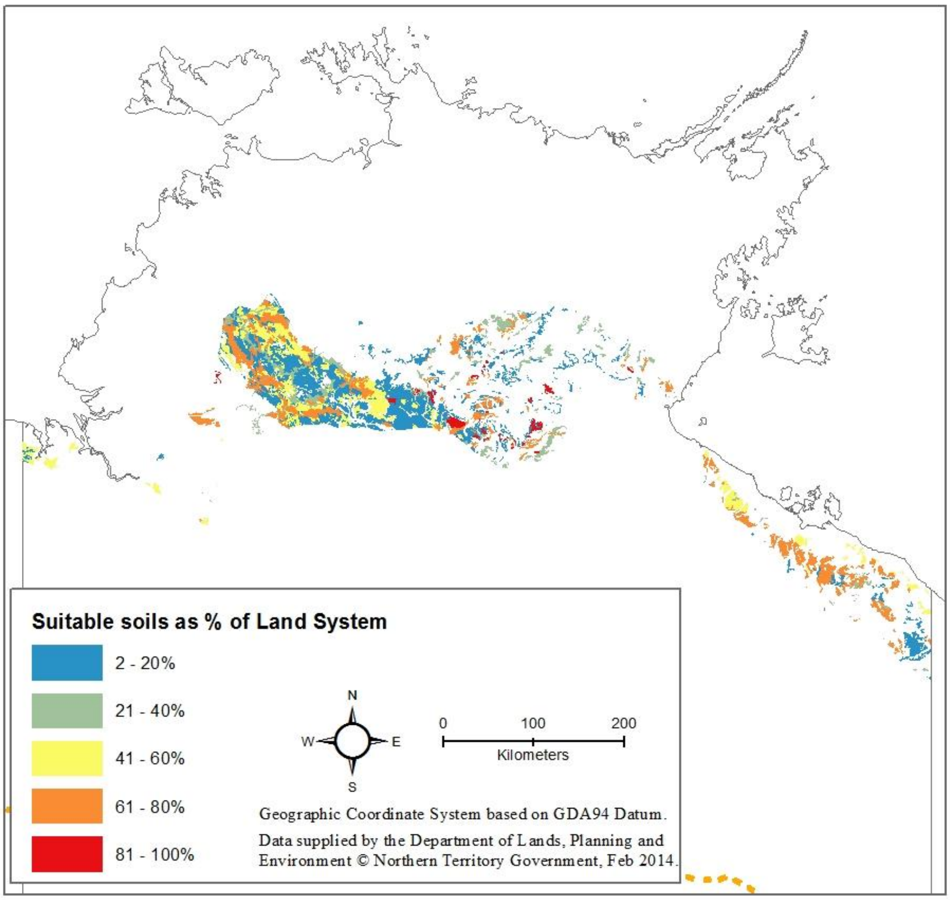
Metadata link: weblink

Format: ESRI grids and layers

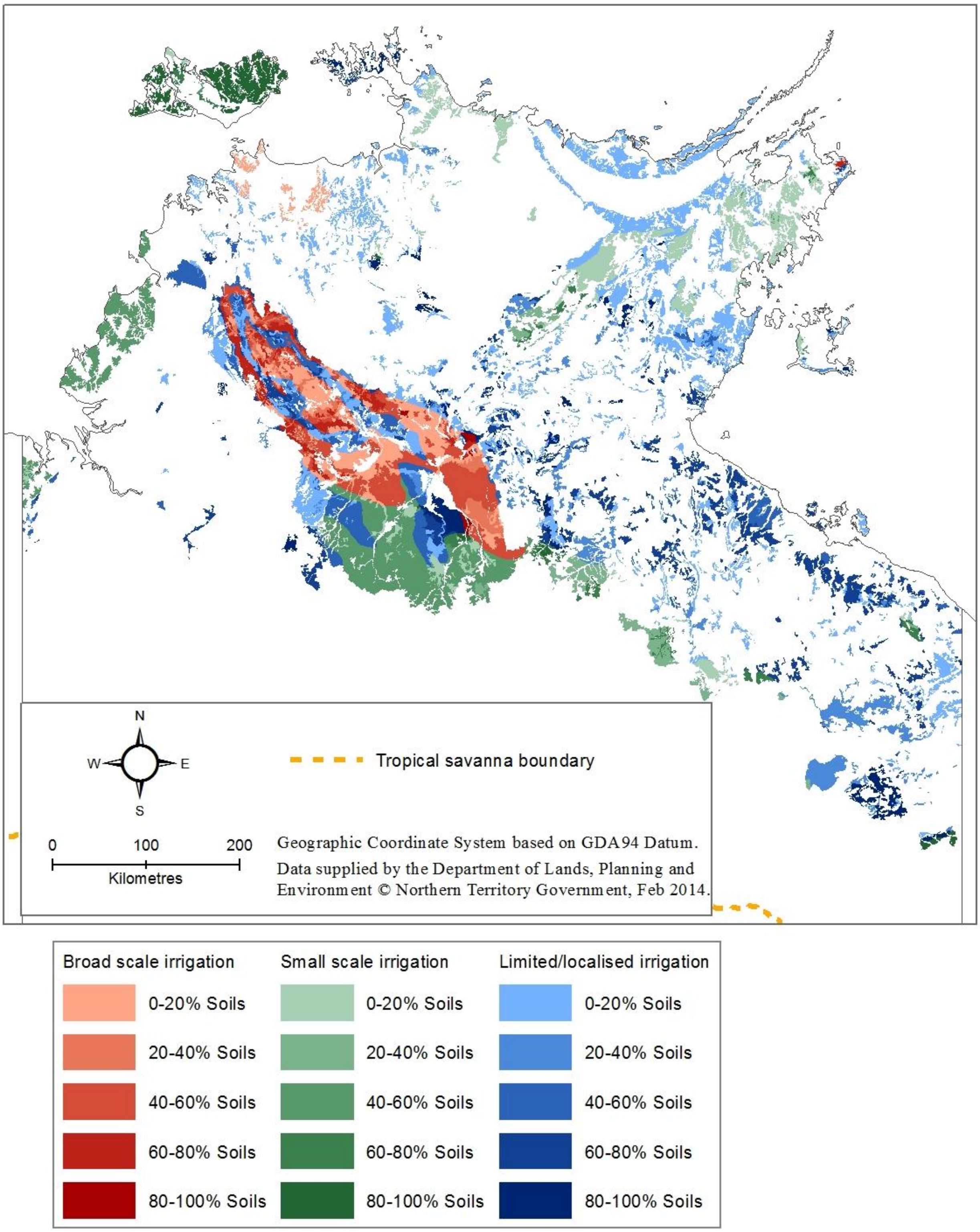
Data version/date of creation: Sept 2011

Overview: This data was created quite recently. It identifies the percentage land units that are suitable for various forms of agriculture. It is broken into two scales of data based on the scale of land resource mapping that is available, one for the northern region and one for the southern region.

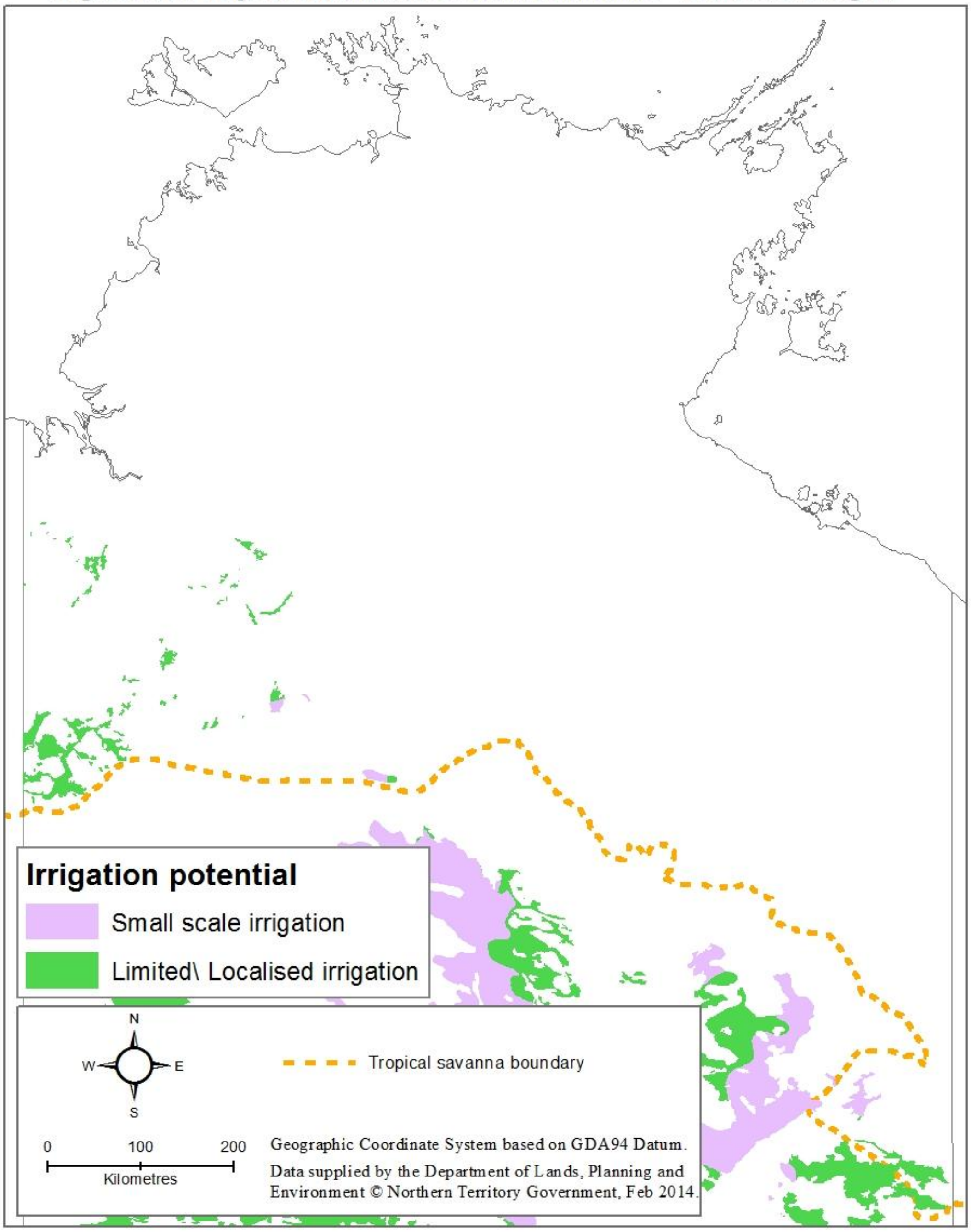
Rainfall and Suitable Soils for Field Crops (rain fed and irrigated) and Perennial Horticulture



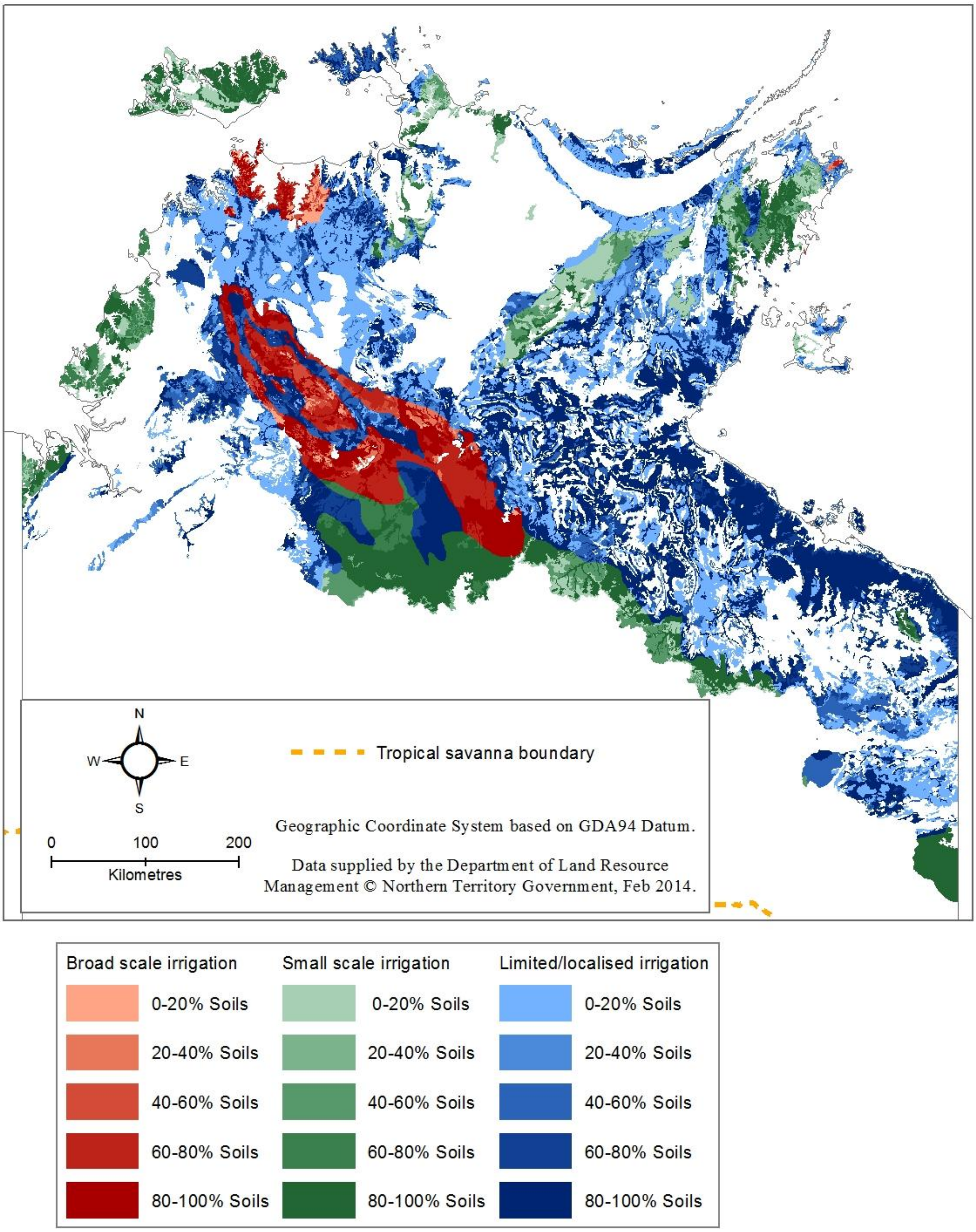
Field Crops (Irrigated) and Perennial Horticulture Suitability



Irrigated Field Crops and Annual and Perennial Horticulture - Southern NT Region



Annual Horticulture Suitability



Dataset Name: Mining Titles

Dataset Description: Boundaries of Tenements including; petroleum titles, mining licences, geothermal exploration permits, mineral exploration licences, extractive exploration licences and Offshore Mineral Exploration

Custodian: Department of Mines and Energy, Northern Territory Government

Web link: weblink

Associated information:

Accessibility: Public availability

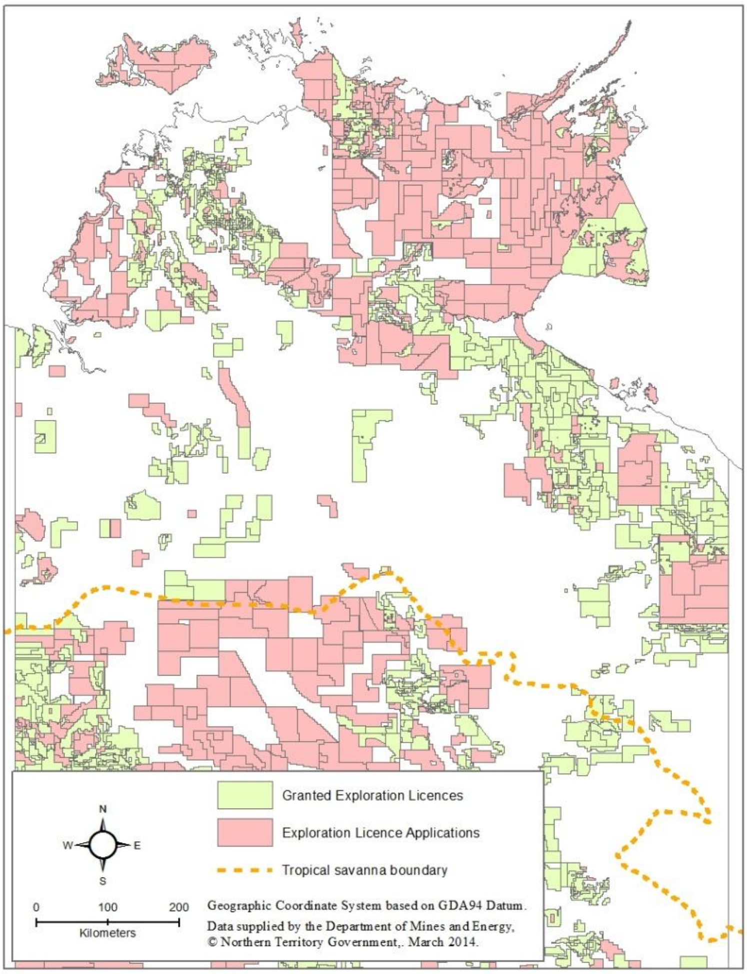
Provided: Yes

Metadata link:

Format: ESRI shapefile and Mapinfo TAB files – polygons

Data version/date of creation: March 2014

Overview: A comprehensive dataset which is constantly updated. Only current data is available.



Dataset Name: NT Mine Locations

Dataset Description: Point location of old, existing and feasible mine locations

Custodian: Department of Mines and Energy, Northern Territory Government

Web link: weblink

Associated information:

Accessibility: Public availability

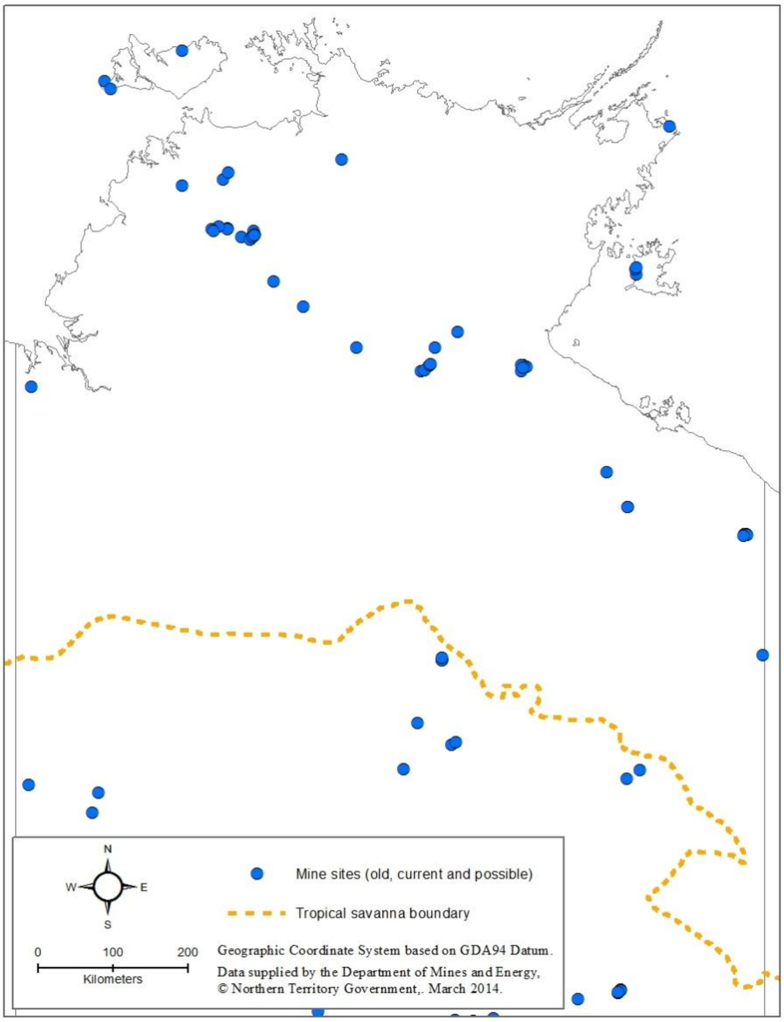
Provided: Yes

Metadata link:

Format: ESRI Shapefile or Mapinfo tab – point locations

Data version/date of creation: March 2014

Overview: Point locations of operating, ceased operating and feasible mine locations. This data was found to be sometime geographically incorrect and did not identify the locations of all mining activity.



Dataset Name: NT Mineral occurrence

Dataset Description: Locations of known minerals

Custodian: Department of Mines and Energy, Northern Territory Government

Web link: weblink

Associated information:

Accessibility: Public availability

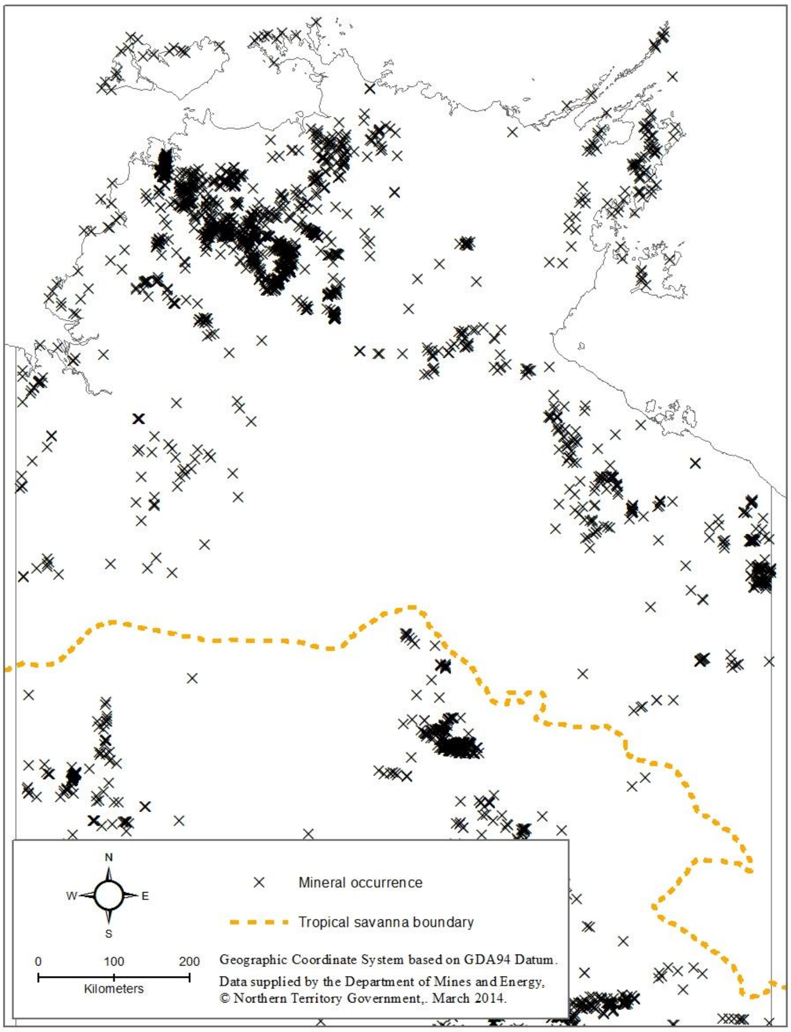
Provided: Yes

Metadata link:

Format: ESRI Shapefile or Mapinfo tab – point locations

Data version/date of creation: March 2014

Overview: The locations of mineral discoveries that have been recorded. General quantities have also been recorded for most sites



Dataset Name: Known Gas Potential of the Northern Territory

Dataset Description: The NT broken into categories of unconventional gas (shale) prospectively

Custodian: Department of Mines and Energy, Northern Territory Government

Web link:

Associated information: [weblink]

Accessibility: This data was not made digitally available. A map was digitise into a GIS dataset.

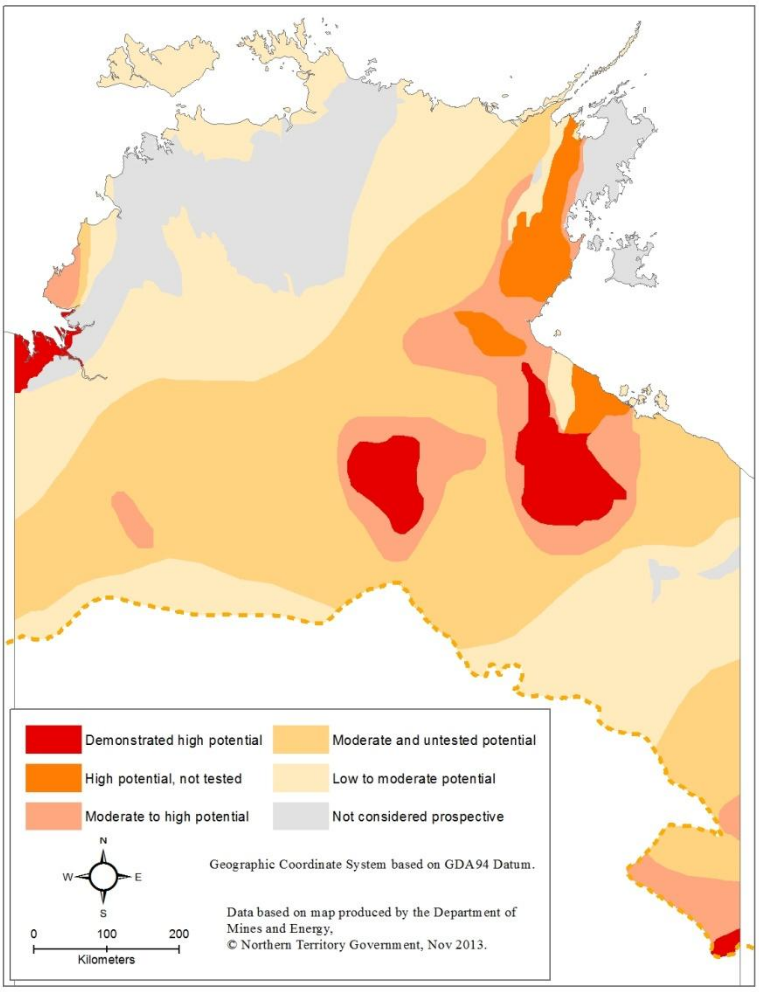
Provided: Yes

Metadata link:

Format: ESRI shapefile – polygons

Data version/date of creation: The map was produced in 2013

Overview: This dataset had to be digitised from an A4 map so is very coarse in accuracy and should be only be used as an approximate guide to gas potential in the NT.



Dataset Name: Geology of the Northern Territory

Dataset Description: Broad geology (1:250 000)

Custodian: Department of Mines and Energy, Northern Territory Government

Web link: weblink

Associated information:

Accessibility: Public availability

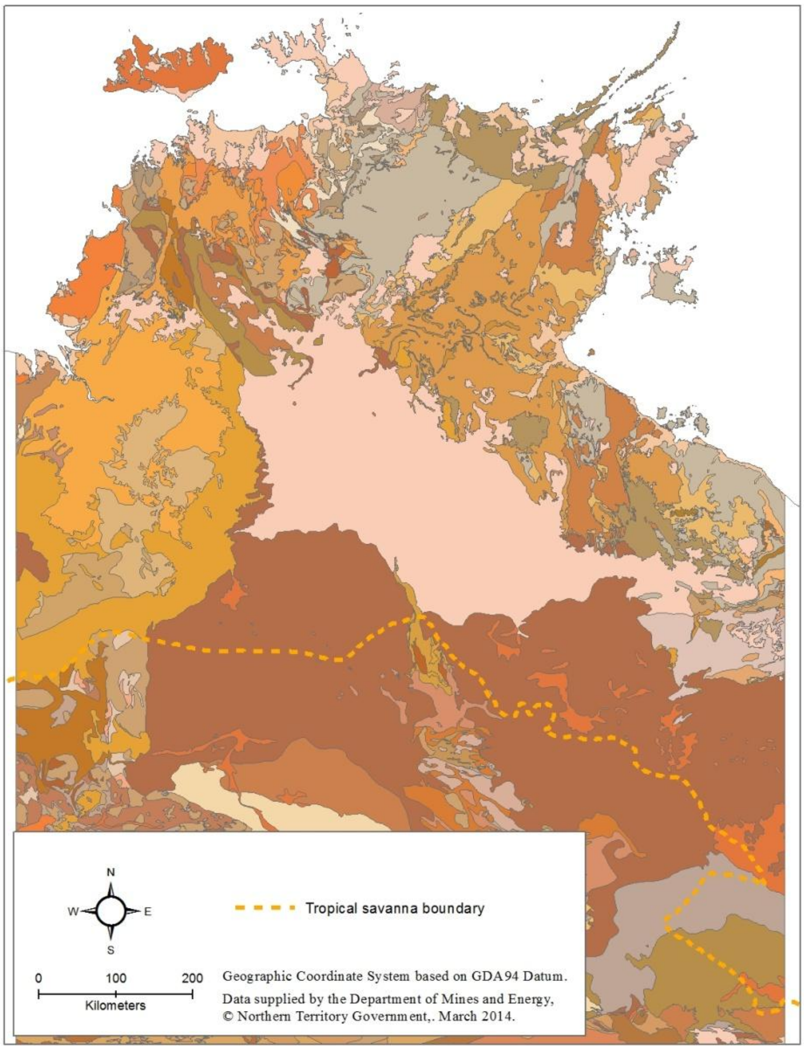
Provided: Yes

Metadata link: Included in data files

Format: ESRI Shapefile or Mapinfo tab – polygons

Data version/date of creation: 2006

Overview: This is a compilation of mapping done at the 1:100k and 1:250k scale.



Dataset Names: Geological regions of the NT, Fault Lines and Petroleum Wells

Dataset Description: Broad geological regions, known fault lines and locations of petroleum wells

Custodian: Department of Mines and Energy, Northern Territory Government

Web link: weblink

Associated information: weblink, weblink

Accessibility: Public availability

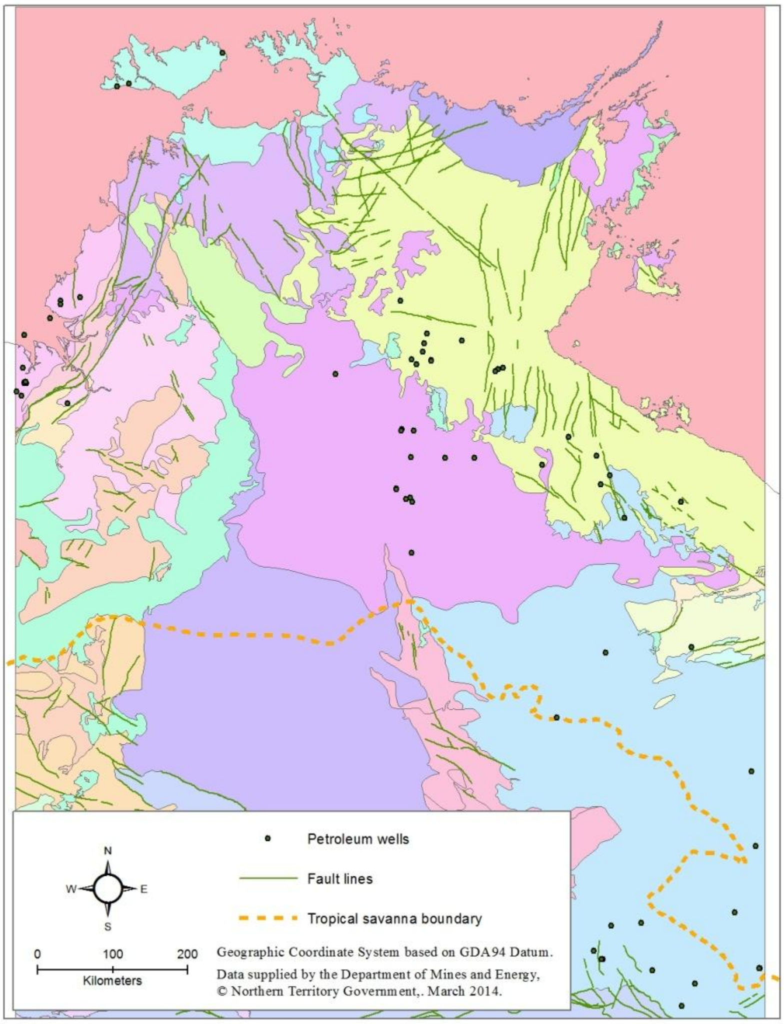
Provided: Yes

Metadata link: Included in data files

Format: ESRI Shapefile or Mapinfo tab – polygons, lines and points

Data version/date of creation: The data was obtained March 2014

Overview: Geological regions are the main basis for geological division in the NT. Many reports and information can be obtained via the web based on these divisions.



Dataset Name: NT Fauna Atlas

Dataset Description: Point locations of fauna species

Custodian: Department of Land Resource Management, Northern Territory Government

Web link: weblink

Associated information:

Accessibility: Available via data agreement with DLRM

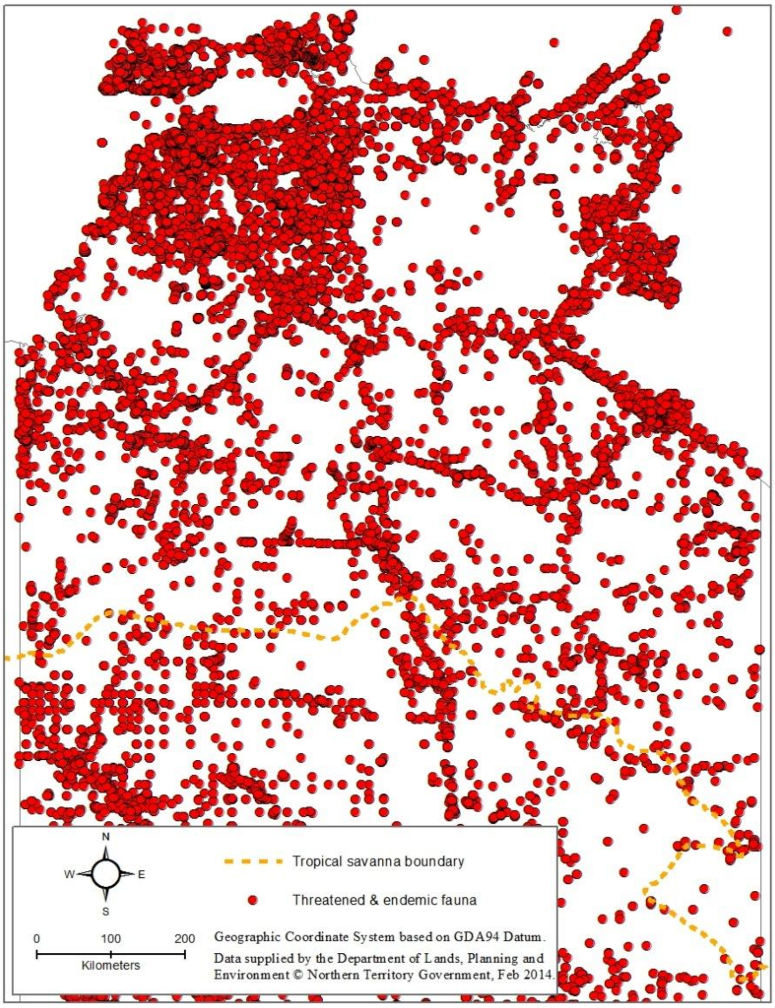
Provided: Yes

Metadata link: weblink

Format: ESRI geodatabase – point locations

Data version/date of creation: March 2014

Overview: This dataset in a compilation of all fauna records in the NT. It includes historic records, fauna surveys and other observations. There are several spatial errors and not all weed species are identified.



Dataset Name: NT Flora Atlas

Dataset Description: Point locations of flora species

Custodian: Department of Land Resource Management, Northern Territory Government

Web link: weblink

Associated information:

Accessibility: Available via data agreement with DLRM

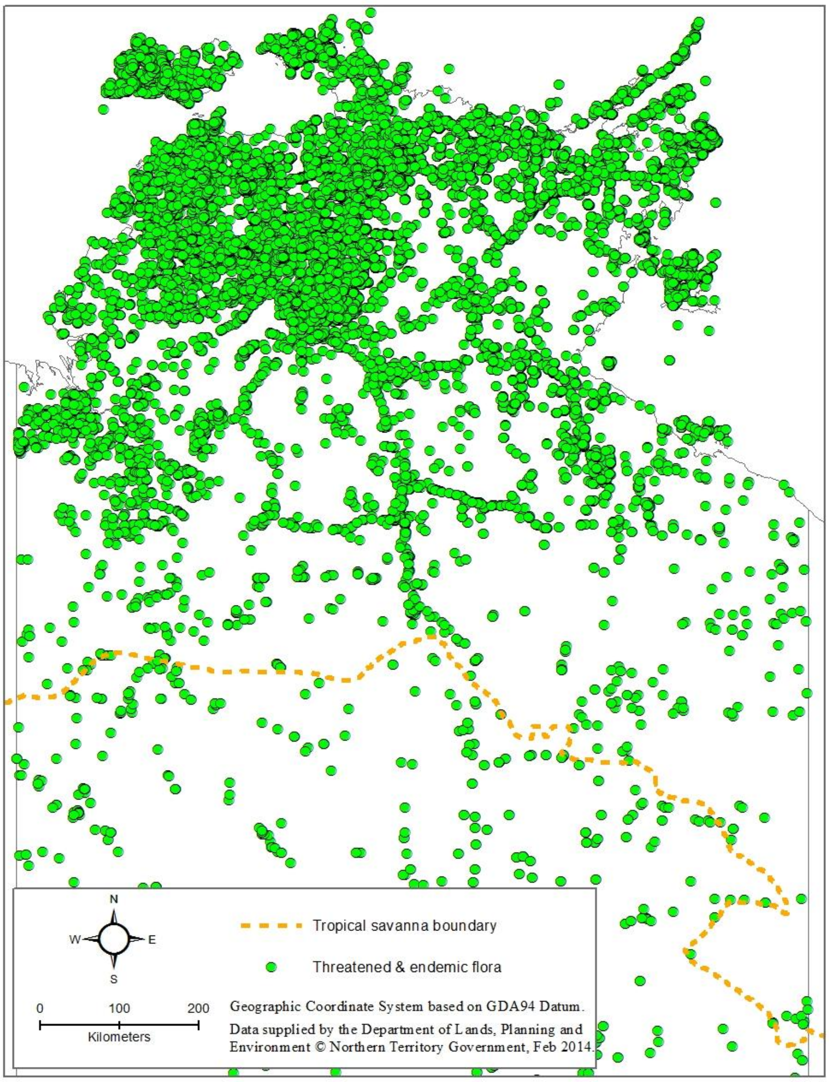
Provided: Yes

Metadata link: weblink

Format: ESRI geodatabase – point locations

Data version/date of creation: March 2014

Overview: Point locations of species and associated information. Includes historic and current observations.



Dataset Name: NT Weeds Public Atlas

Dataset Description: Point locations of introduced flora species

Custodian: Department of Land Resource Management, Northern Territory Government

Web link: weblink

Associated information:

Accessibility: Available via data agreement with DLRM

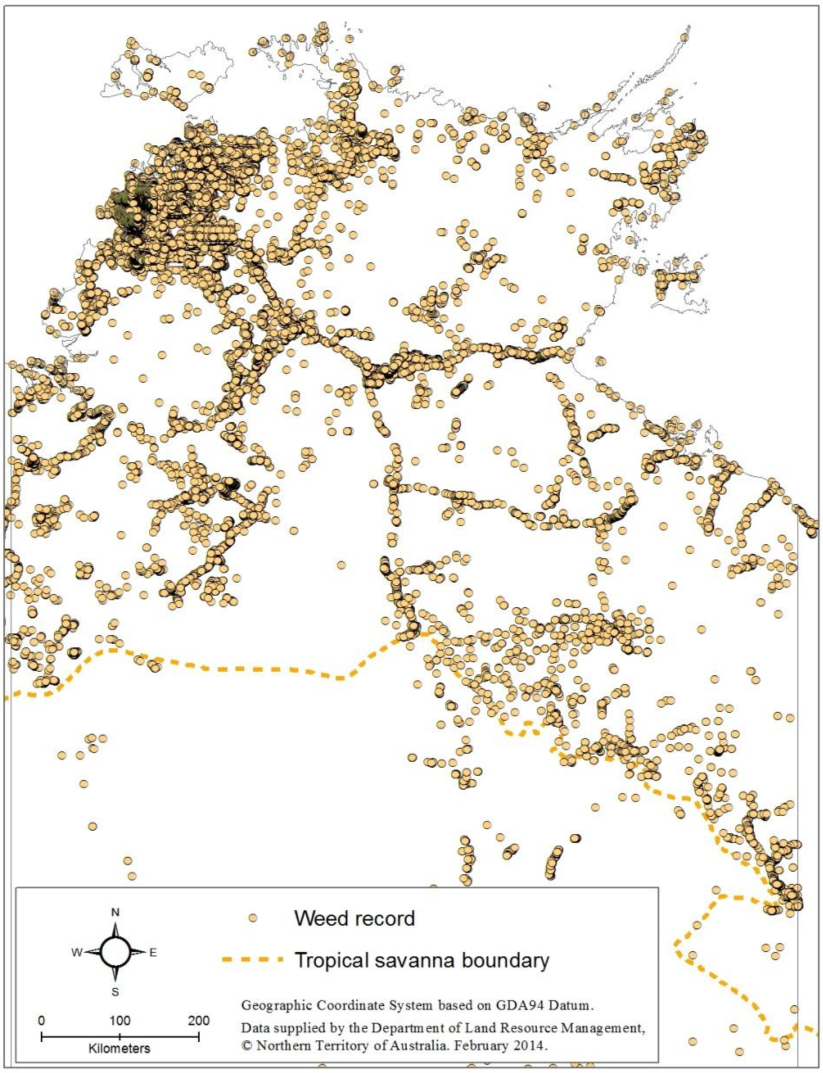
Provided: Yes

Metadata link: weblink

Format: ESRI geodatabase – point locations

Data version/date of creation: 2012

Overview: Point locations of species and associated information. Includes historic and current observations.



Dataset Name: Sites of Conservation Significance

Custodian: Department of Land Resource Management, Northern Territory Government

Web link: weblink

Associated information: weblink

Accessibility: Public availability

Provided: Yes

Metadata link: weblink

Format: ESRI shapefile – polygons and excel spreadsheet for additional information

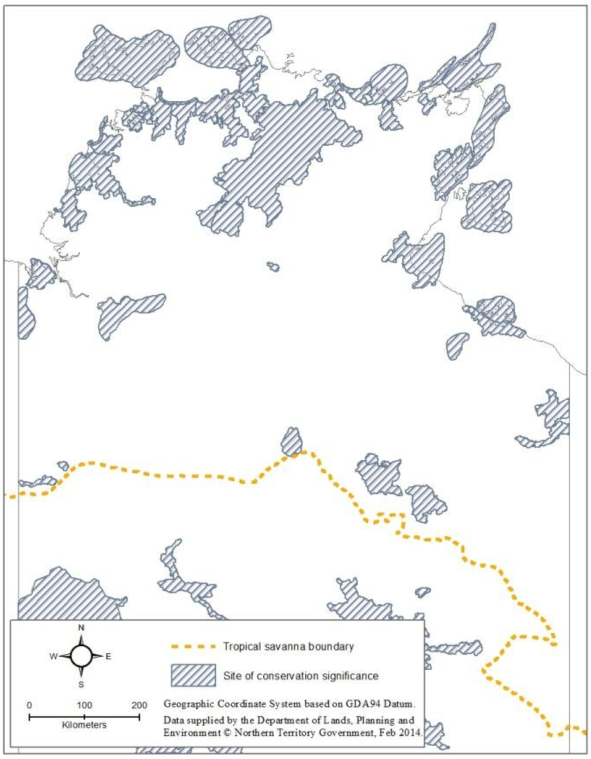
Data version/date of creation: 2009

Dataset Description: Scientists from the Department of Land Resource Management identified 67 of the most important sites for biodiversity conservation in the Northern Territory.

Overview: This dataset used a variety of influencing factors on biodiversity conservation including species, threats, land tenure and land use and degradation.

Ward, S. and Harrison, L. (2009). Recognising sites of conservation significance for biodiversity values in the Northern Territory. Department of Natural Resources, Environment, The Arts and Sport, Darwin, NT.
Download this report (pdf) from the Northern Territory library via http://hdl.handle.net/10070/240660

Harrison, L., McGuire, L., Ward, S. Fisher, A., Pavey, C., Fegan, M. and Lynch, B. (2009). An inventory of sites of international and national significance for biodiversity values in the Northern Territory. Department of Natural Resources, Environment, The Arts and Sport, Darwin, NT.
Download this report (pdf) from the Northern Territory library via http://hdl.handle.net/10070/240659



Dataset Name: Monsoon Vine-forest Survey

Dataset Description: Mapping of the five rainforest types and their distribution within the NT. Types are Allosyncarpia and spring fed forests, riparian, coastal and wet-dry vine thickets

Custodian: Department of Land Resource Management, Northern Territory Government

Web link:

Associated information:

Accessibility: Available via data agreement with DLRM

Provided: Yes

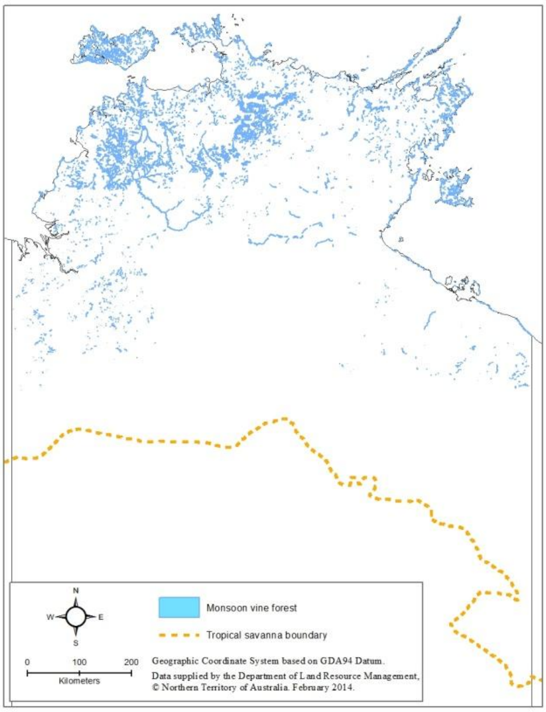
Metadata link: Weblink

Format: ESRI shapefile – polygons

Data version/date of creation: 1987

Overview: Good quality dataset, although the boundaries of the rainforest may have altered over time.

Russell-Smith, J., Dunlop,C.R 1987. The Status of Monsoon Vine Forests in the Northern Territory: A Perspective - In: The Rainforest Legacy: Australian National Rainforests Study. Vol. 1. Eds G. L. Werren, a. A. P. K., pp.227-288 (eds), Australian Government Publishing Service, Canberra. pp. pp.227-288.



Dataset Name: High Conservation Value Aquatic Ecosystems (HCVAEs) in Northern Australia

Dataset Description: Set of biodiversity attributes based on aquatic ecosystems

Custodian: Dr Mark Kennard [Contact]

Web link:

Associated information:

Accessibility: Contact custodian

Provided: No

Metadata link:

Format: ESRI Shapefile – polygon

Data version/date of creation: 2010

Overview: This data set comprises a spatially consistent and comparable set of biodiversity attributes used to identify High Conservation Value Aquatic Ecosystems (HCVAEs) in Northern Australia. Using predictive modelling and hydrosystem classifications, we generated spatially explicit biodiversity surrogate datasets for the entire study region. This information was attributed to 5,803 planning units (hydrologically-defined sub-catchments) and used to assess their relative conservation values using the mutli-criteria draft HCVAE Framework (developed by the Aquatic Ecosystem Task Group). This involved an exhaustive process (described in Chapter 8 of Kennard 2010)) of selecting appropriate attributes to characterise the six Framework criteria (which are: Diversity, Distinctiveness, Vital habitat, Evolutionary history, Naturalness and This data set comprises a spatially consistent and comparable set of biodiversity attributes used to identify High Conservation Value Aquatic Ecosystems (HCVAEs) in Northern Australia according to the draft HCVAE Framework (developed by the Aquatic Ecosystem Task Group). Using predictive modelling and hydrosystem classifications, seven sets of spatially explicit biodiversity surrogate data (for three aquatic systems and four species groups) were generated for the entire study region. A set of attributes were selected to characterise the six HCVAE Framework criteria (which are: Diversity, Distinctiveness, Vital habitat, Evolutionary history, Naturalness and Representativeness). A total of 65 raw attributes were calculated from the biodiversity surrogate data, integrated into 22 attribute types that shared similar properties and these were integrated to characterise the six Framework criteria for each of the 5,803 planning units (hydrologically-defined sub-catchments). The data were reported at each of three spatial scales: referential to the entire study region, each Drainage Division and each NASY region, respectively. This dataset is referential to the entire study region.

More information:

Kennard, M.J. (ed) (2010). Identifying high conservation value aquatic ecosystems in northern Australia. Interim Report for the Department of Environment, Water, Heritage and the Arts and the National Water Commission. Tropical Rivers and Coastal Knowledge (TRaCK) Commonwealth Environmental Research Facility, Charles Darwin University, Darwin. ISBN: 978-1-921576-23-2.
Available at: http://track.org.au/publications/registry/track843

Kennard, M.J. (ed) (2011). Priorities for identification and sustainable management of high conservation value aquatic ecosystems in northern Australia. Final Report for the Department of Sustainability, Environment, Water, Population and Communities and the National Water Commission. Tropical Rivers and Coastal Knowledge (TRaCK) Commonwealth Environmental Research Facility, Charles Darwin University, Darwin. ISBN: 978-1-921576-30-0. Available at: http://www.track.org.au/publications/registry/track907 or http://www.environment.gov.au/water/publications/policy-programs/nawfa-ecological-assets-report.html

Dataset Name: Arnhem plateau sandstone heath

Dataset Description: Mapped area of sandstone heath on the Arnhem Plateau region. The sandstone heath is listed as a 'Threatened Species and Ecological Communities' under the The *Environment Protection and Biodiversity Conservation Act 1999*

Custodian: Darwin centre for Bushfire Research

Web link:

Associated information: weblink

Accessibility: Via Darwin Centre for Bushfire Research

Provided: Yes

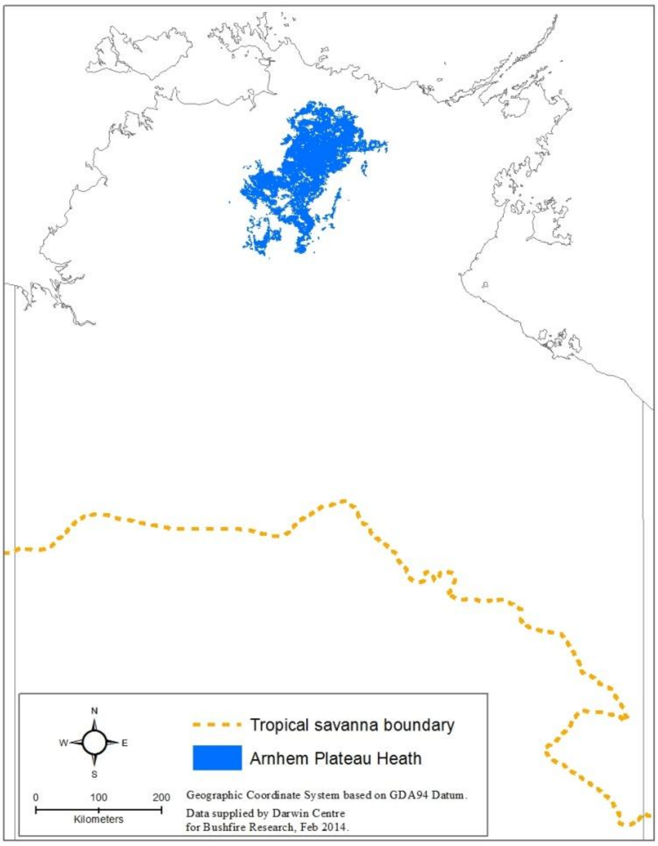
Metadata link:

Format: ESRI polygon shapefile

Data version/date of creation: 2004

Overview: Fine scale mapping of the heath community

Blake, G. (2004). Object Oriented Mapping of Sandstone Heath Vegetation on the Arnhem Plateau. Darwin, Charles Darwin University.



Dataset Name: Lancewood survey

Dataset Description: Survey of location of Lancewood (*Acacia shirleyi*)

Custodian: Department of Land Resource Management, Northern Territory Government

Web link: weblink

Associated information:

Accessibility: Available via data agreement with DLRM

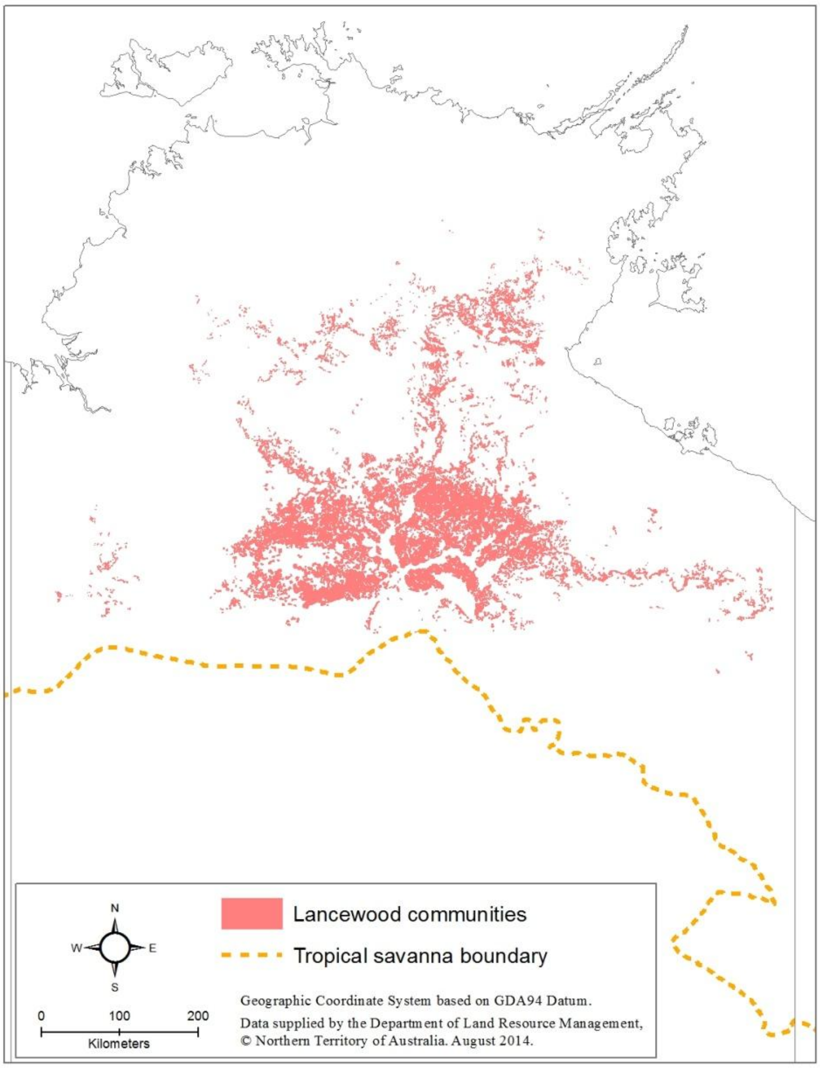
Provided: Yes

Metadata link:

Format: ESRI polygon shapefile

Data version/date of creation: 2009

Overview: Detailed survey of lancewood vegetation communities.



Dataset Name: Species and Communities of National Environmental Significance

Dataset Description: 18 different datasets with a count of recorded species/communities of significance in Australia

Custodian: Australian Government - Department of the Environment

Web link: weblink

Associated information:

Accessibility: Public availability

Provided: Yes

Metadata link: weblink

Format: ESRI shapefile – polygons

Data version/date of creation: 2010

Overview: Grids of 0.05 degrees with counts of known and likely distribution of species and communities of significance under EPBC Act.

Note: this data was not used in this project

- Species and Communities - Number occuring across Australia
  - Threatened Species All -kl
  - Threatened Species - Critically Endangered -kl
  - Threatened Species - Endangered - kl
  - Threatened Species - Vulnerable -kl
  - Threatened Birds - kl
  - Threatened Fishes - kl
  - Threatened Frogs-kl
  - Threatened Invertebrates -kl
  - Threatened Mammals -kl
  - Threatened Reptiles -kl
  - Threatened Plants -kl
  - Threatened Ecological Communities All -all
  - Threatened Ecological Communities - Critically Endangered -all
  - Threatened Ecological Communities - Endangered -all
  - Threatened Ecological Communities - Vulernable -all
  - Migratory Species -kl
  - Migratory and Terrestrial -kl
  - Migratory and Threatened Species -kl

Dataset Name: National Vegetation Information System (NVIS)

Dataset Description: Major and sub-major vegetation groups in Australia

Custodian: Australian Government - Department of the Environment

Web link: weblink

Associated information: weblink

Accessibility: Public availability

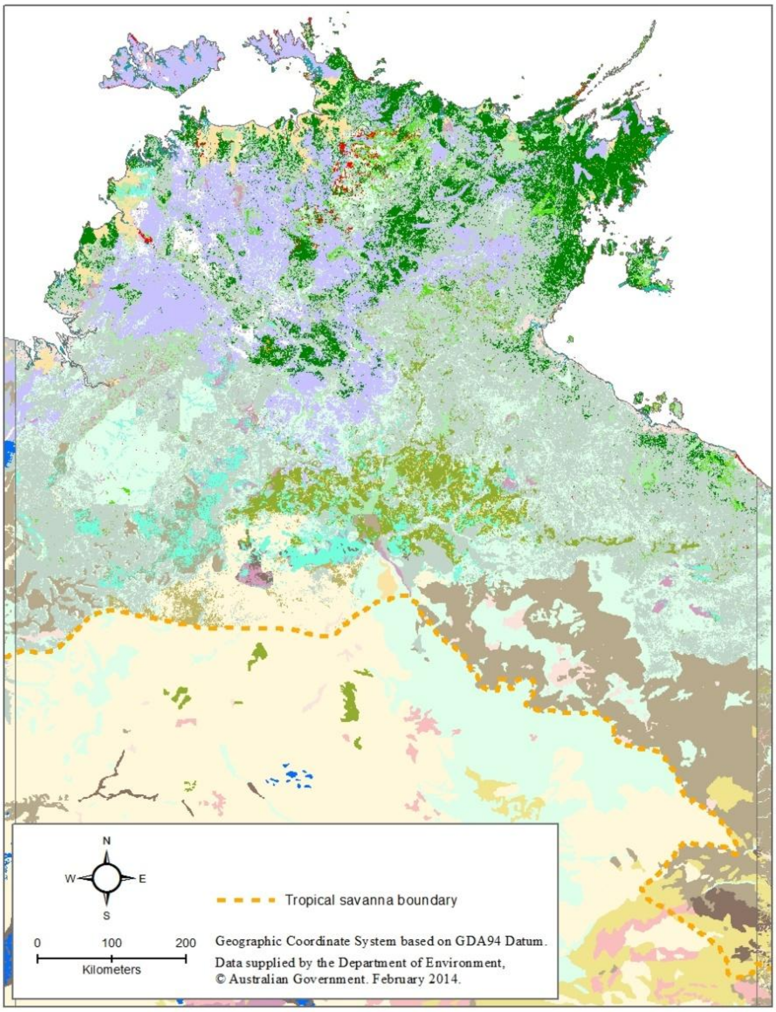
Provided: Yes

Metadata link: weblink

Format: ESRI ArcInfo Grid & ESRI File Geodatabase

Data version/date of creation: NVIS 4.1 - 2012

Overview: provides summary information on Australia's estimated Pre-1750 (pre-European or pre-clearing) native vegetation.



Dataset Name: Collaborative Australian Protected Areas Database 2010

Dataset Description: Locations of various types of protected areas

Custodian: Australian Government - Department of the Environment

Web link: weblink

Associated information: weblink

Accessibility: Public availability

Provided: Yes

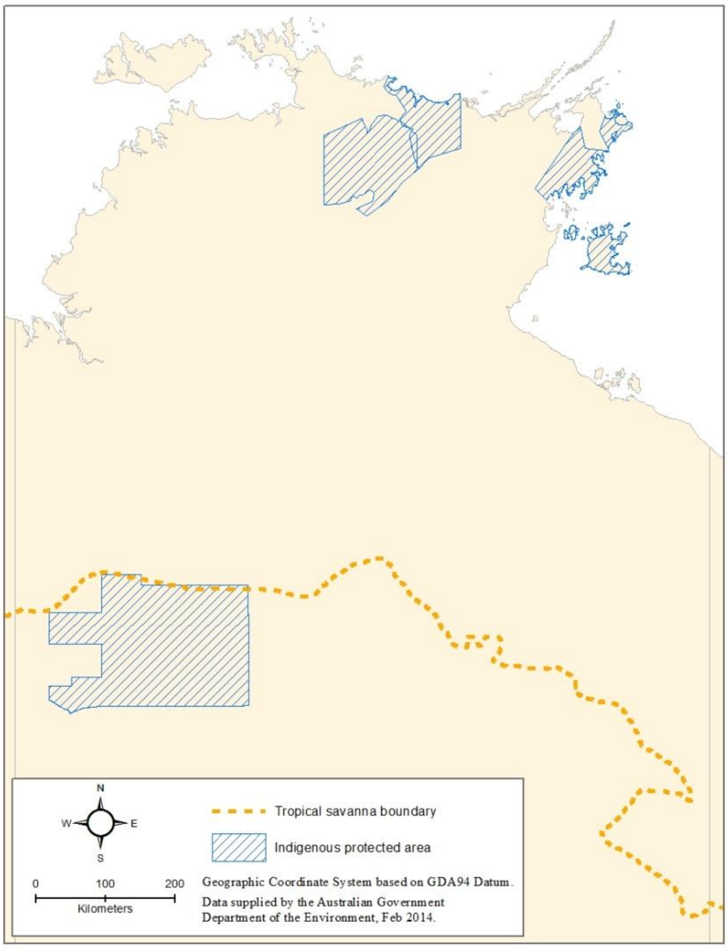
Metadata link: weblink

Format: ESRI shapefile – polygons

Data version/date of creation: 2010

Overview: This is a well maintained and comprehensive dataset. In this project we used Indigenous Protected Areas information only.

Note: A new version of this data has been released



Dataset Name: NT Parks and Reserves

Dataset Description: Locations of various types of protected areas

Custodian: Department of Land Resource Management, Northern Territory Government

Web link:

Associated information:

Accessibility: Available via data agreement with DLRM

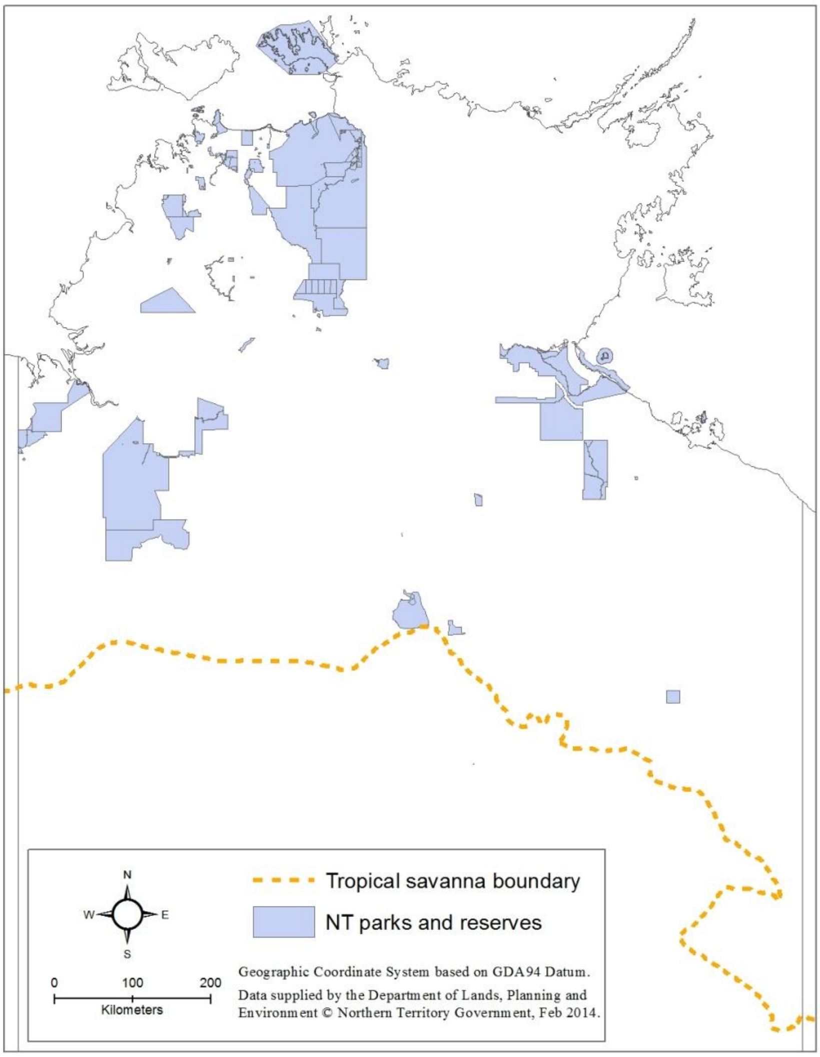
Provided: Yes

Metadata link: weblink

Format: ESRI shapefile – polygons

Data version/date of creation: August 2014

Overview: Basic dataset of parks and reserves operated by the Northern Territory Government and the Commonwealth Government.



Dataset Name: National scale land use data

Dataset Description: Land use data mapped at the national scale (1:2,500,000) using ABS agricultural commodity data and satellite imagery. Mapping based upon the Australian Land Use and Management (ALUM) Classification Version 6 (November 2005).

Custodian: Department of Agriculture, Australian Government

Web link: weblink

Associated information: weblink

Accessibility: Public availability

Provided: Yes

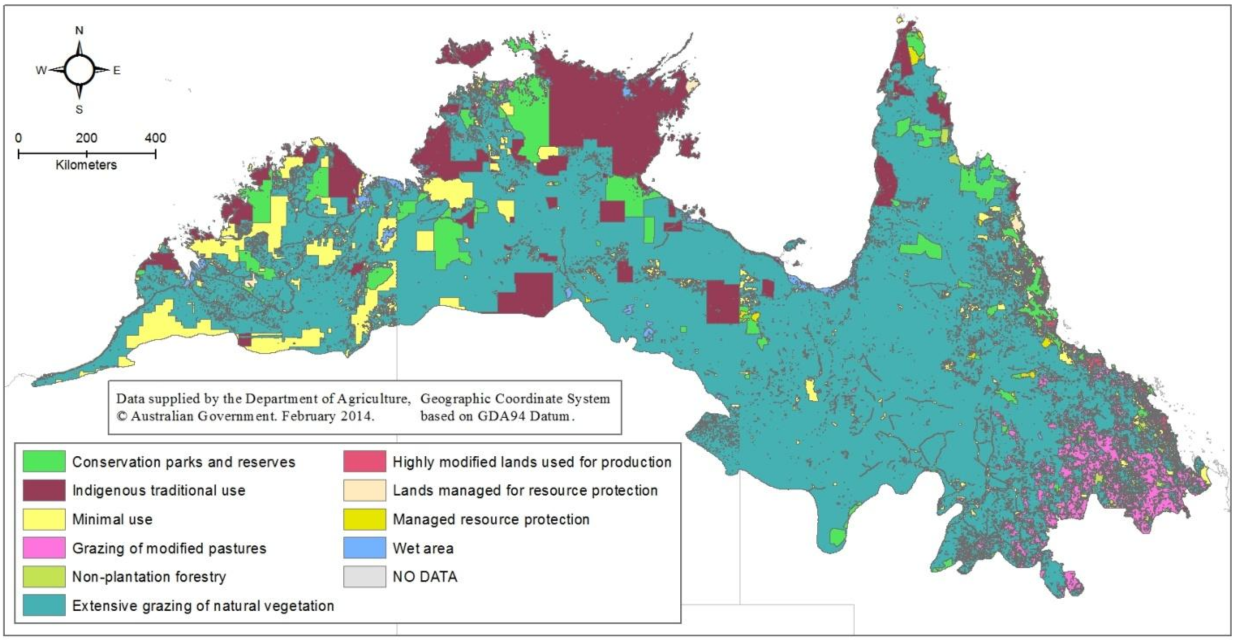
Metadata link: weblink

Format: ESRI raster grid

Data version/date of creation:

Overview: Broad scale land use mapping with many different categories which can be divided into smaller categories.

Note: Only tropical savannah area shown on map



Dataset Name: Land use mapping project for the NT 2008

Dataset Description: Land use mapped from local knowledge, aerial photographs, satellite imagery, ancillary datasets and fieldwork. Mapping based upon the Australian Land Use and Management (ALUM) Classification Version 6 (November 2005).

Custodian: Department of Agriculture, Australian Government

Web link: weblink

Associated information:

Accessibility: Public availability

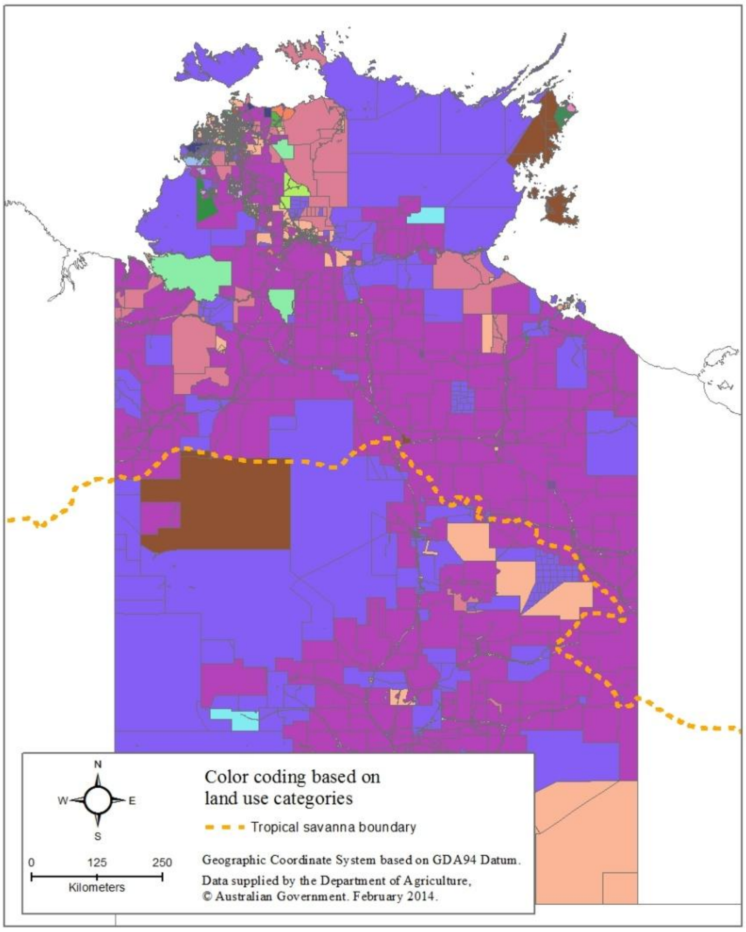
Provided: Yes

Metadata link: weblink

Format: ESRI polygon shapefile

Data version/date of creation:

Overview: This is a reasonably accurate mapping of land use. Some polygons have been classified different to their actual usage.



Dataset Name: Indigenous Sacred Sites

Dataset Description: Locations of Indigenous sites

Custodian: Aboriginal Areas Protection Authority

Web link: weblink

Associated information:

Accessibility: Limited via data agreement with Aboriginal Areas Protection Authority

Provided: No

Metadata link:

Data version/date of creation: No collection dates are included in this data. It was provided February 2014.

Format: GIS point and polygon file (format can be specified)

Overview: Data is collected under the Northern Territory Aboriginal Scared Sites Act. The collection of sacred site data is generally based on Indigenous land owners desire to record a site to assist in its protection or when an area need to be surveyed due to an application for land utilisation by a third party. This data has been collected for many years and over the majority of the Northern Territory.

A cultural site can be nominated by a custodian to become a registered site, where it is covered by the Northern Territory Aboriginal Scared Sites Act. This process ensures that the location and extent of the site are correctly mapped. Other sites may have an accurate location, and may not have a mapped extent.

However this data has not been collected in a systematic method and has varying degrees of accuracy and there are no prescribed attributes for the description of the site so often the type or nature of the site cannot be determined.

Dataset Name: Site of Archaeological Significance

Dataset Description: Point locations of aboriginal material culture and historic sites

Custodian: Department of Heritage, Northern Territory Government

Web link: weblink

Associated information: weblink

Accessibility: Not available to public

Provided: No

Metadata link:

Format: Mapinfo tab files (UTM Zone 52 and Zone 53)

Data version/date of creation: No collection dates are included in this data. It was provided February 2014.

Overview: Point locations of various different site types. Basic information about the type of site is provided; site type, materials and content.

Dataset Name: Native Title Applications and Determinations

Dataset Description: Locations of current and past applications and determination made under Native Title Act (1993)

Custodian: The National Native Title Tribunal

Web link: weblink

Associated information:

Accessibility: Public availability

Provided: Yes

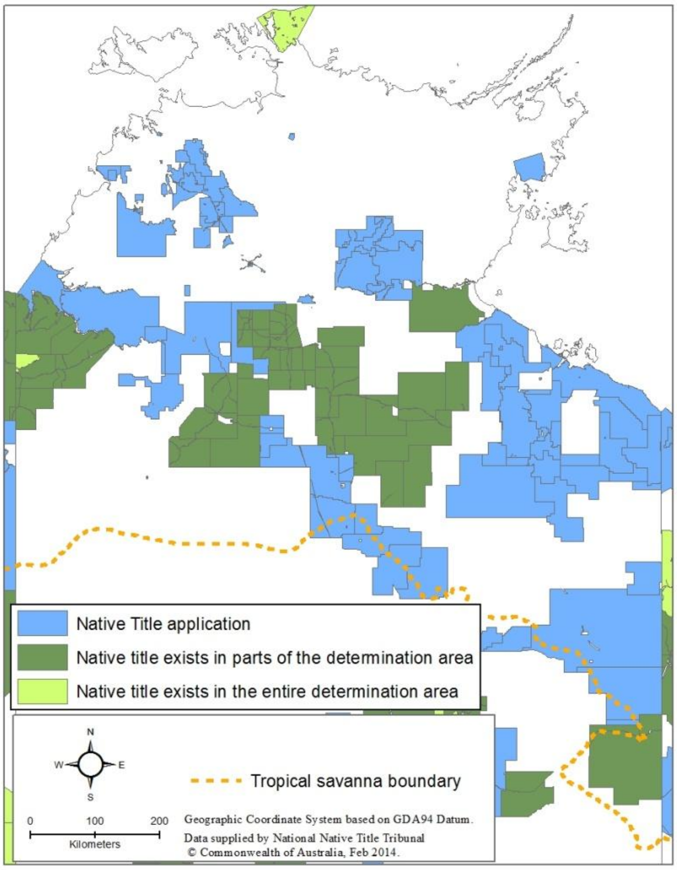
Metadata link: weblink

weblink

Format: Various GIS formats – polygons

Data version/date of creation: February 2014

Overview: This is a well maintained and comprehensive dataset. It is updated regularly.



Dataset Name: North Australian MODIS late fire frequency mapping 2000 to 2013

Dataset Description: Mapping of the late (after July 31) fire frequency in northern Australia for the period 2000 - 2013

Custodian: Charles Darwin University

Web link: weblink

Associated information:

Accessibility: Public availability

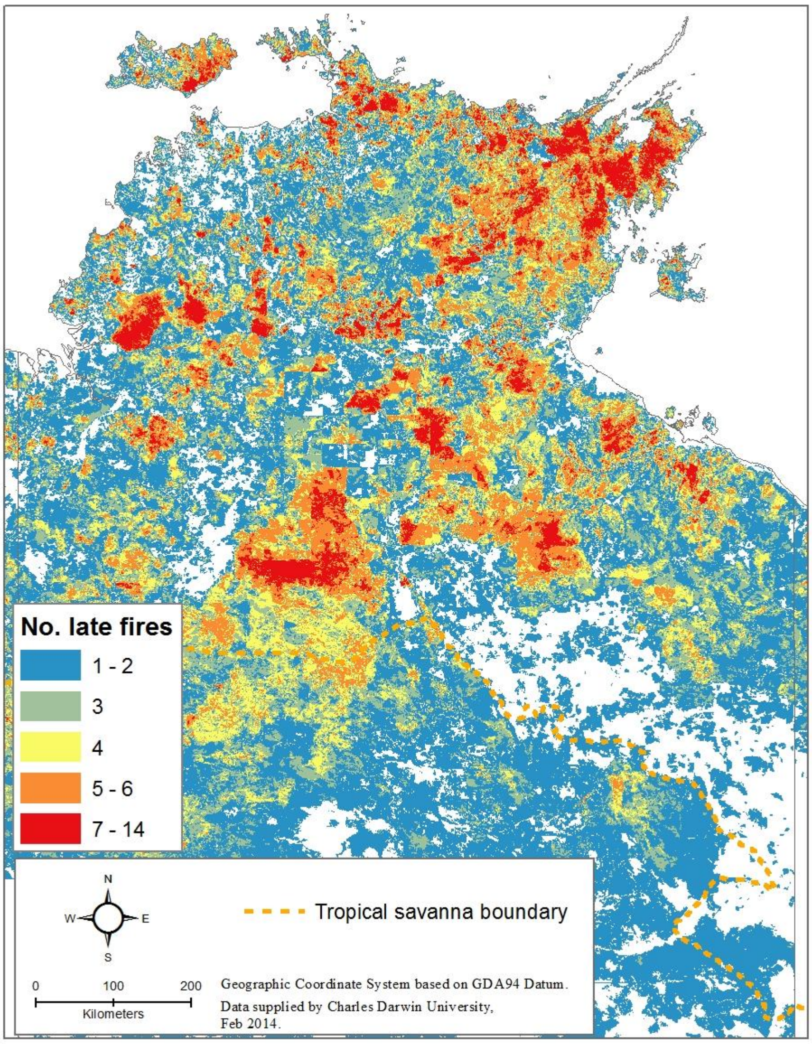
Provided: Yes

Metadata link: (contained as file in download)

Format: ESRI shapefile – polygons

Data version/date of creation: February 2014

Overview: This is a well maintained and comprehensive dataset. It is updated regularly.



Dataset Name: North Australian MODIS fire frequency mapping 00-13

Dataset Description: Mapping of the fire frequency in northern Australia for the period 2000 - 2013

Custodian: Charles Darwin University

Web link: weblink

Associated information:

Accessibility: Public availability

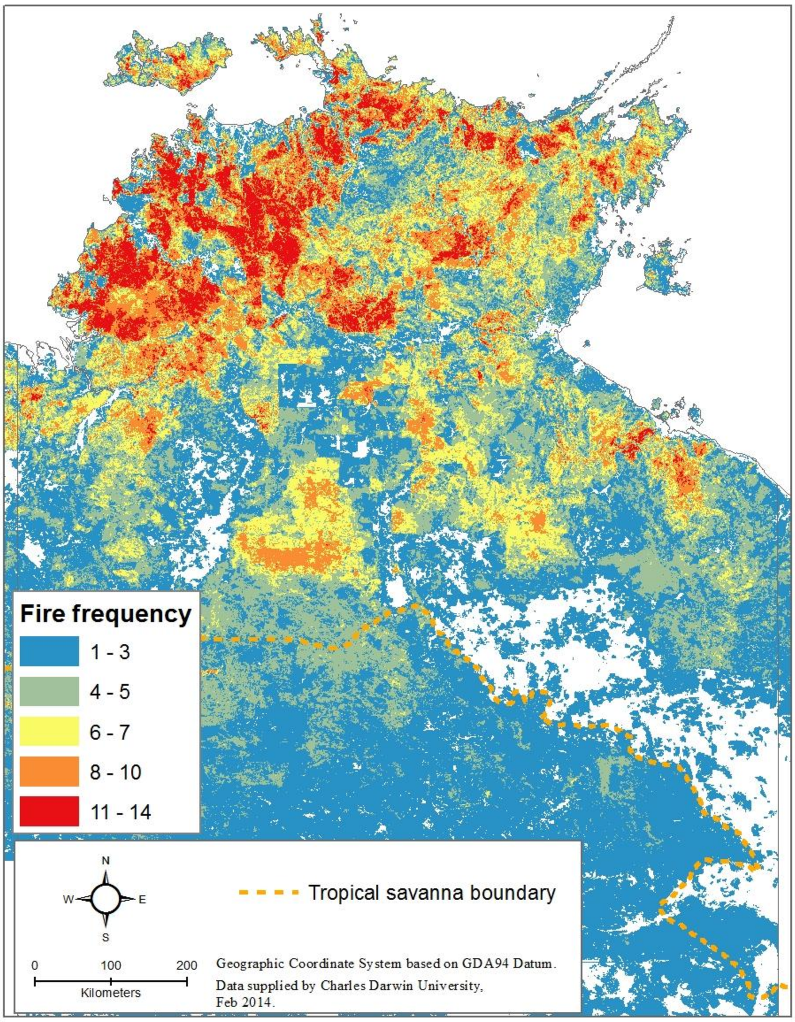
Provided: Yes

Metadata link: (contained as file in download)

Format: ESRI shapefile – polygons

Data version/date of creation: February 2014

Overview: This is a well maintained and comprehensive dataset. It is updated regularly.



Dataset Name: Fire sensitive flora species

Dataset Description: A list of Flora species which are known to be fire sensitive.

Custodian: Darwin centre for Bushfire Research

Web link: weblink

Associated information: weblink

Accessibility: Via Darwin Centre for Bushfire Research

Provided: Yes

Metadata link:

Format: Word document

Data version/date of creation: September 2012

Overview: This information includes a full list of species and details of the time to first seeding, seed longevity, and the particular response of the species to fire.

Dataset Name: Livestock density

Dataset Description: Density of cattle species in Northern Australia for year 1983 to 2011

Custodian: CSIRO and Qld Dept Science, Information Technology, Innovation & Arts

Web link: weblink

Associated information:

Accessibility: Via email to gary.bastin@csiro.au

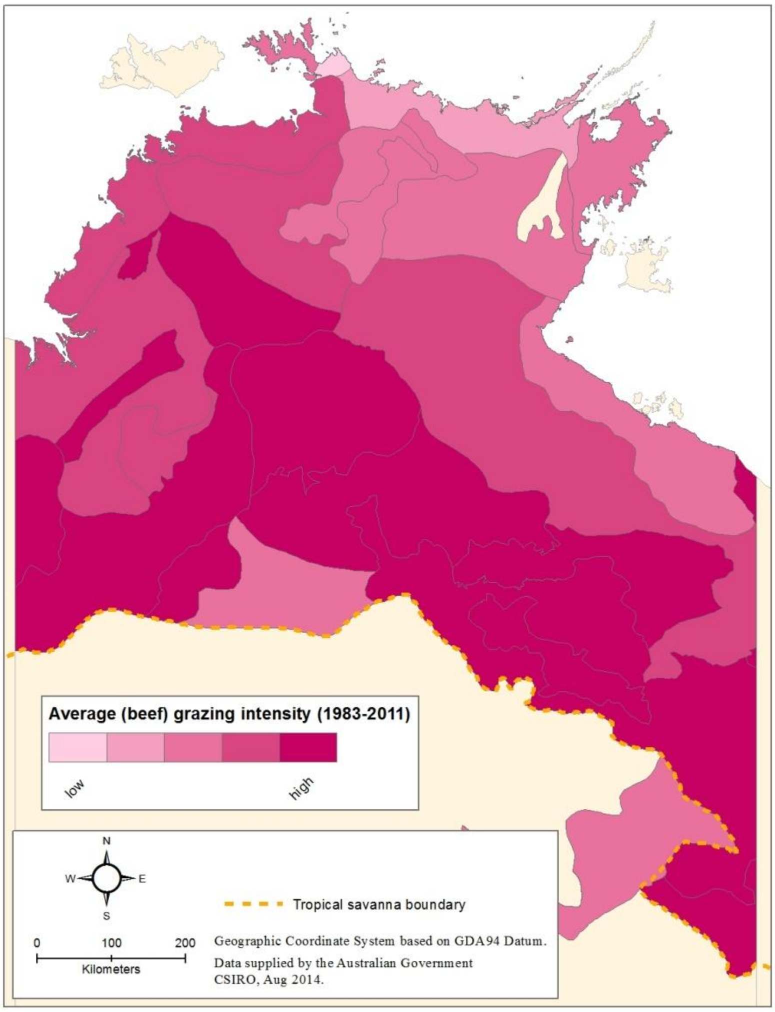
Provided: No

Metadata link:

Format: Excel file to be linked to bioregion data

Data version/date of creation: July 2013 (version 1)

Overview: Data based on sub-ibra bioregion of grazing density of various livestock. For this project only cattle values were obtained. Not all areas have been surveyed and the author indicated that some areas had dubious data quality. He indicated this for all of the Arnhem regions and one in the gulf plains area.



Dataset Name: NT Groundwater Aquifers, NT Springs, Gulf Water Study, Sturt Plateau Water Study, Arnhem Water Study and Katherine-Arnhem Water Study

Dataset Description: Information on water resources

Custodian: Department of Land Resource Management, Northern Territory Government

Web link:

Associated information:

Accessibility: Available via data agreement with DLRM

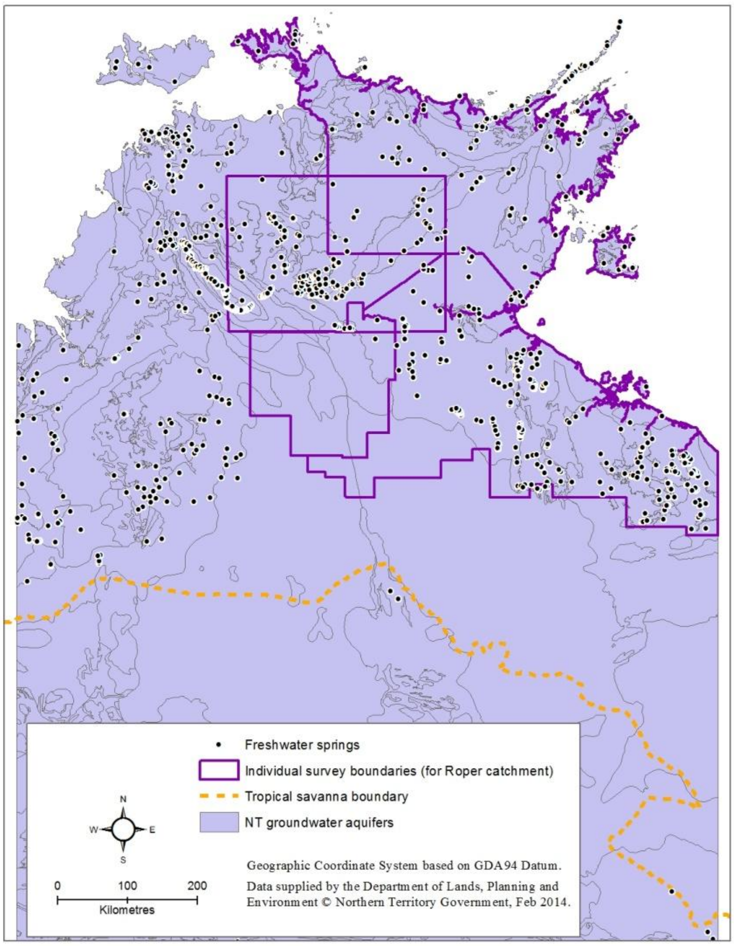
Provided: Yes

Metadata link: weblink

Format: ESRI geodatabase, shapefile – polygons and points (Springs)

Data version/date of creation: Various (see individual reports)

Overview: The attributes of the smaller scale (1:250 000) for the Sturt Plateau, Katherine-Arnhem, Arnhem and Gulf water studies are varied so it was not possible to merge the datasets together accurately. Many attributes are also incomplete and edges do not align.



Dataset Name: Land Systems of the Northern Part of the NT (1:250,000)

Dataset Description: Detailed information based on land systems.

Custodian: Department of Land Resource Management, Northern Territory Government

Web link:

Associated information:

Accessibility: Available via data agreement with DLRM

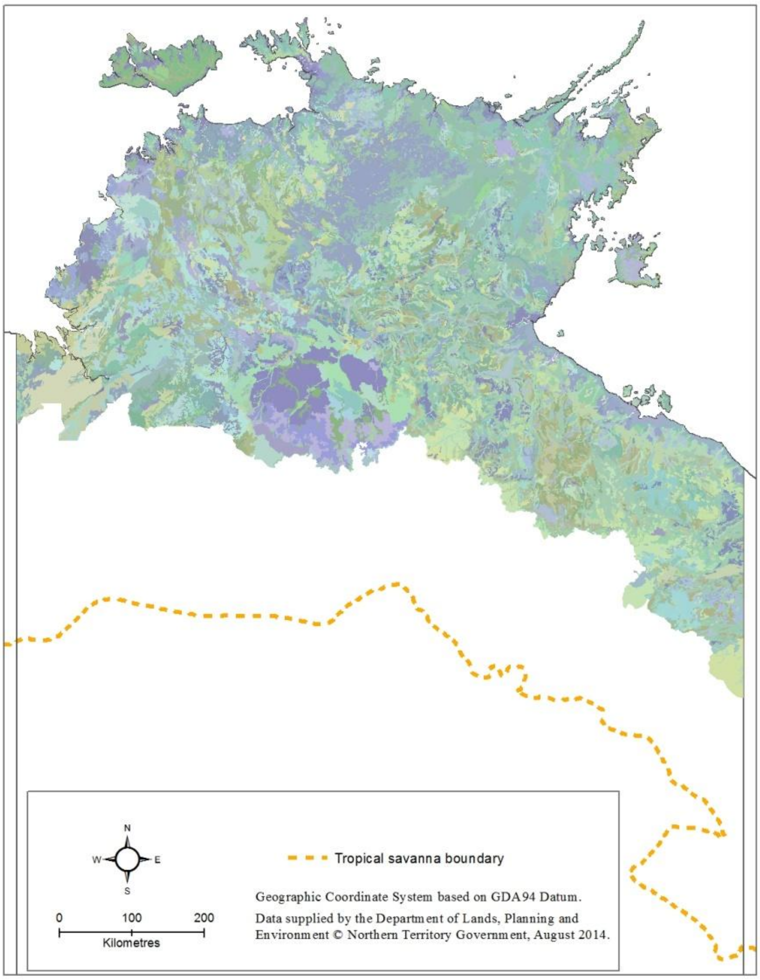
Provided: Yes (shapefile only)

Metadata link: weblink

Format: ESRI geodatabase or shapefile.

Data version/date of creation: Version 2, Nov 2012

Overview: This data has been compiled by the merging of many different individual surveys. The information is very detailed and there are many associated tables that can be linked (i.e. vegetation, soil).



Dataset Name: SRTM-derived 3 Second Digital Elevation Models Version 1.0

Dataset Description: Digital elevation

Custodian: Commonwealth of Australia (Geoscience Australia)

Web link:

Associated information:

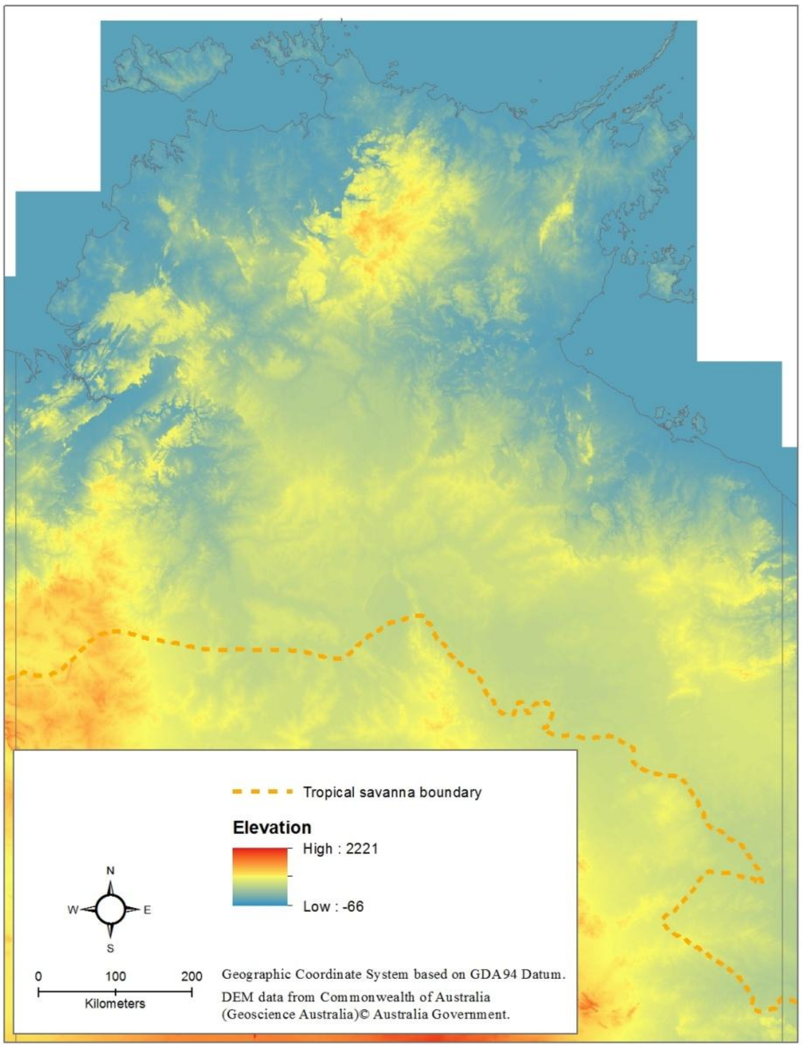
Accessibility: Available for purchase

Provided: No

Metadata link: weblink

Format: ESRI Grids

Data version/date of creation: 1.0



Dataset Name: Average Annual Rainfall

Dataset Description: Averaged rainfall data over 30 years broken into large areas by isohyets

Custodian: Commonwealth of Australia (Geoscience Australia)

Web link: weblink

Associated information:

Accessibility: Public availability

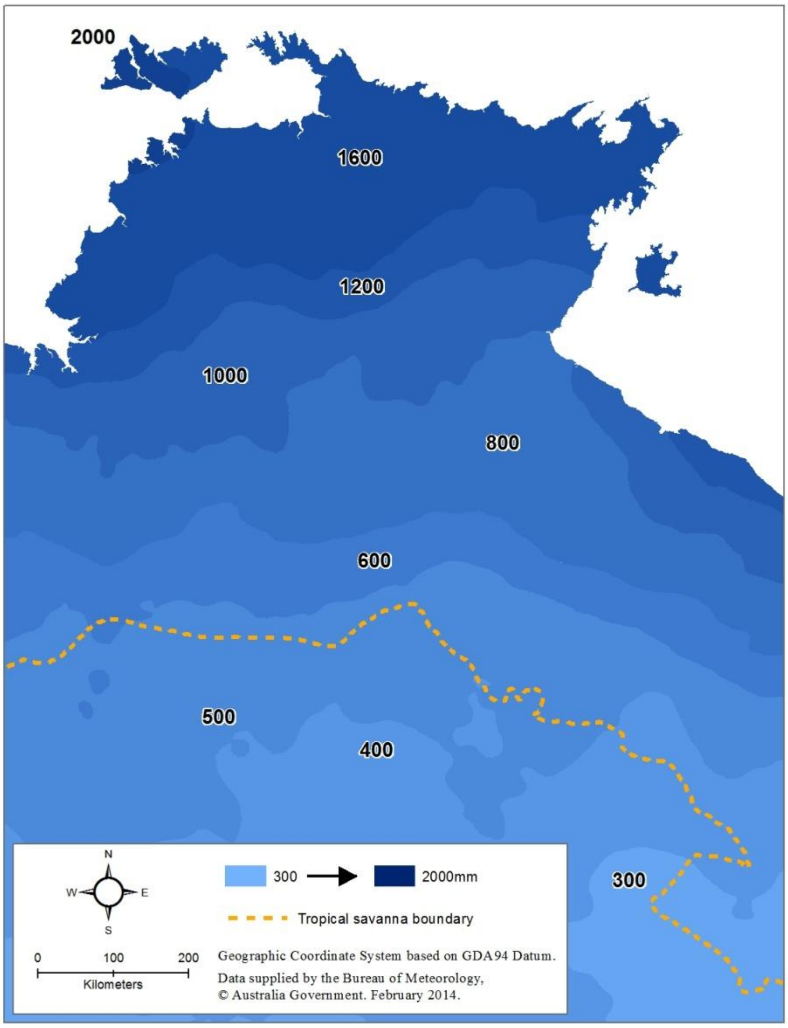
Provided: Yes

Metadata link: weblink

Format: ESRI Grid

Data version/date of creation: Based on data collected 1960 to 1990

Overview: This data is very coarse but is useful for general conditions. Finer scale data can be obtained from the BOM site for detailed analysis. However some of the data isn't in GIS format and requires work to convert it.



Details of companies active in developing new or expanding existing mineral and petroleum and gas projects (including unconventional gas) in the Northern Territory

Company	Partners / other interests (if any)	Project(s)	Current status	Significant issues
Advent Energy	2 backers MEC Resources Limited (ASX:MMR) and BPH Energy Limited (ASX:BPH).	Bonaparte Basin onshore conventional and unconventional gas	prospective recoverable resources est. at 15 tcf	
Armour Energy	none known apparently seeking partners	Batten Trough, McArthur Basin EP171, EP176, EP190, EPA193A	Conventional 314 PJ prospective resources in Batten Trough, McArthur Basin. Unconventional 18.7 Tcf prospective resources in several unconventional reservoirs a number of exploratory wells flaring gas exploration drilling at Caranbirini, Cat Fish Hole and Myrtle Sub Basin proposed	
Beach Energy	Territory Oil	Bonaparte Basin EP 126, 138, 136 NTC/P 10	drilling Keep Inlet sub-basin in July 2014	
Darwin LNG	Subsidiary of ConocoPhillips	Wickham Point processing site has approval to expand from 3.7 to 10 Mtpa	projected increases in volumes, including sources additional to Bayu-Undan fields	sources may include new NT fields (see under Santos)
Energy Resources Australia (ERA)	owned by Rio Tinto	Ranger 3 Deeps	exploration drilling	
Falcon Oil and Gas	Farm-out agreement and joint operating agreements with Origin Energy Resources Limited (subsidiary of Origin Energy Ltd) and Sasol Petroleum Australia	Beetaloo Basin	exploration and test wells done Farm-in arrangements will fund a nine well program over 5 years: 3 vertical exploration /stratigraphic wells and core studies; 1 hydraulic fracture stimulated vertical	anecdotal reports of substantial disturbance of Bulwaddy and Lancewood communities

	Limited		exploration well and core study; 1 hydraulic fracture stimulated horizontal exploration well, commercial study and resource assessment; 4 hydraulic fracture stimulated horizontal exploration/ appraisal wells, micro-seismic and 90 day production tests Drilling to begin in 2014 Origin to be the Operator	
Inpex	Total	Ichthys LNG	NT facilities under construction pipeline under construction export scheduled for	commited $91 m to offset projects. A number yet to be implemented.
McArthur River Mines	Glencore	McArthur river base metals	operating and expansion (Phase 3 approved) to more than double ore processed to 5.5 Mta	offsets offered in original EIS but never agreed
Pangaea Resources	none known	Beetaloo sub-basin EP167, 168, 169 & 198	little information available	has previously sold CSG tenements to Origin Energy
Santos	Darwin LNG	Bonaparte Basin (offshore)	3 well drilling campaign started Q2 2014	may link to Darwin LNG
		McArthur Basin EP161, 162, 189, EP(A)299, 288	3 permits and 2 pending applications presently drilling exploration well (Tanumbirini-1)	in part through arrangements with Falcon Oil and Gas (above)
TNG Ltd	Hyundai Steel (MoU) Woojin Industries (LoI)	Mt Peake Va, Tu, Fe, graphite ELs27069, 27070, 27787, 27941, 28941, 29578, 29627, 29867, MLA28341, 29855, 29856	PFS complete, DFS in progress, exploration program (drilling) continuing	

	none known	McArthur River, Zn, Cu, Pb ELs 27711, 28503, 30085	surface sampling of areas of geochemical anomaly drilling program in progress (Aug2014) NT DME co-funding drilling and analysis	
	none known	Manburrum Zn, Pb, Ag A24518, 26581 EL24395, 25646, 25470 MLA27357	partially assessed, described as non-core asset	
	Rio Tinto Exploration (JV agreement)	Melville Island, Al, ELA 28617	seeking licence for exploration	
		Croker Island, Fe, ELA29164		
Western Desert Resources	none known seeking partnerships to develop resource	Roper Bar Fe MLA28264	operating, exporting DSO at 3 mtpa proposing to develop lower grade deposits requiring on-site processing	
		Mountain Creek Fe EL27143 and EL2 5688	no present activity	
		Chambers Bay Fe EL28215 and 28216	exploration proposed	
Vista Gold	none known	Mt Todd Au	under EIA, proposing to expand pit and on-site processing	

(1) Apparent species number in sub-catchments: fauna with subcatchment area in model

```
Call:
lm(formula = log(Tot_Fa_sp) ~ log(Catch_ha) + MeanRain + divveg +
    Av_Tot_FF + domveg2, subset = (Tot_Fa_sp > 0))

Residuals:
    Min      1Q  Median      3Q     Max
-4.4338 -0.8407  0.2714  0.9499  2.8595

Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)    -1.2562906  0.4303532  -2.919  0.00359 **
log(area)       0.2905774  0.0333538   8.712  < 2e-16 ***
MeanRain        0.0013868  0.0002375   5.839 7.03e-09 ***
divveg          0.1283747  0.0257403   4.987 7.18e-07 ***
AvFF           -0.0574762  0.0231964  -2.478  0.01338 *
domvegNVIS_10  -0.3570625  0.4808782  -0.743  0.45794
domvegNVIS_11   0.2608660  0.2811661   0.928  0.35373
domvegNVIS_12   0.2738987  0.3027237   0.905  0.36579
domvegNVIS_13   0.1816058  0.7345629   0.247  0.80478
domvegNVIS_17   0.5522130  0.8292878   0.666  0.50563
domvegNVIS_19  -0.1273112  0.3406360  -0.374  0.70867
domvegNVIS_20  -0.1404303  0.5350036  -0.262  0.79300
domvegNVIS_21  -0.1607011  0.4565455  -0.352  0.72492
domvegNVIS_22  -0.7530448  0.4022487  -1.872  0.06148 .
domvegNVIS_23  -1.3998253  0.4254537  -3.290  0.00104 **
domvegNVIS_25   0.0720683  0.9755199   0.074  0.94112
domvegNVIS_3   -0.4416107  0.2784239  -1.586  0.11302
domvegNVIS_30  -0.1064765  0.4201586  -0.253  0.79999
domvegNVIS_31   0.3872669  0.9792640   0.395  0.69258
domvegNVIS_4    0.2254513  0.3740945   0.603  0.54687
domvegNVIS_5   -0.2543729  0.2776127  -0.916  0.35973
domvegNVIS_6    0.3615124  0.5134985   0.704  0.48158
domvegNVIS_8   -0.3407213  0.4530038  -0.752  0.45214
domvegNVIS_9   -0.8228209  0.4924946  -1.671  0.09508 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.324 on 1031 degrees of freedom
Multiple R-squared:  0.4181,    Adjusted R-squared:  0.4051
F-statistic:  32.2 on 23 and 1031 DF,  p-value: < 2.2e-16
```

```
(2)  Apparent species numbers in subcatchments - fauna with number
of fauna records in model

Call:
lm(formula = log(Tot_Fa_sp) ~ log(Tot_Fa_Rec) + MeanRain + divveg +
    domveg2 + Av_Tot_FF, subset = (Tot_Fa_sp > 0 & domuse2 !=
    "ModLand" & domuse2 != "GrzModP" & domuse2 != "WetArea"),
    family = poisson)

Residuals:
     Min       1Q   Median       3Q      Max
-2.36849 -0.23533  0.06213  0.31789  0.94255

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)      5.211e-01  1.212e-01   4.298 1.89e-05 ***
log(Tot_Fa_Rec)  7.628e-01  8.289e-03  92.023  < 2e-16 ***
MeanRain        -1.943e-04  6.647e-05  -2.924  0.00354 **
divveg          -2.822e-02  6.855e-03  -4.117 4.16e-05 ***
domvegNVIS_10    1.879e-01  1.690e-01   1.112  0.26652
domvegNVIS_11   -7.845e-03  9.536e-02  -0.082  0.93446
domvegNVIS_12   -2.610e-02  1.020e-01  -0.256  0.79799
domvegNVIS_13   -5.018e-01  2.488e-01  -2.017  0.04396 *
domvegNVIS_17   -1.976e-01  2.810e-01  -0.703  0.48212
domvegNVIS_19   -1.922e-01  1.122e-01  -1.713  0.08701 .
domvegNVIS_20    8.738e-02  1.800e-01   0.485  0.62748
domvegNVIS_21   -1.918e-01  1.825e-01  -1.051  0.29363
domvegNVIS_22    8.831e-02  1.358e-01   0.650  0.51580
domvegNVIS_23   -3.423e-01  1.504e-01  -2.276  0.02307 *
domvegNVIS_25   -5.023e-01  3.303e-01  -1.521  0.12862
domvegNVIS_3     7.464e-02  9.407e-02   0.793  0.42770
domvegNVIS_30   -3.734e-01  1.425e-01  -2.621  0.00890 **
domvegNVIS_31    1.691e-01  3.326e-01   0.508  0.61127
domvegNVIS_4    -4.224e-02  1.270e-01  -0.333  0.73945
domvegNVIS_5     1.020e-01  9.377e-02   1.088  0.27688
domvegNVIS_6     5.305e-02  1.745e-01   0.304  0.76118
domvegNVIS_8    -1.767e-01  1.586e-01  -1.114  0.26547
domvegNVIS_9     1.483e-02  1.737e-01   0.085  0.93197
AvFF        6.545e-03  7.106e-03   0.921  0.35722
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4495 on 1012 degrees of freedom
Multiple R-squared:  0.9326,    Adjusted R-squared:  0.9311
F-statistic: 608.8 on 23 and 1012 DF,  p-value: < 2.2e-16
```

Key to broad vegetation types used in statistical models. NVIS level 4.1

1	Rainforests and Vine Thickets
3	Eucalypt Open Forests
4	Eucalypt Low Open Forests
5	Eucalypt Woodlands
6	Acacia Forests and Woodlands
8	Casuarina Forests and Woodlands
9	Melaleuca Forests and Woodlands
10	Other Forests and Woodlands
11	Eucalypt Open Woodlands
12	Tropical Eucalypt Woodlands/Grasslands
13	Acacia Open Woodlands
14	Mallee Woodlands and Shrublands
16	Acacia Shrublands
17	Other Shrublands
19	Tussock Grasslands
20	Hummock Grasslands
21	Other Grasslands, Herblands, Sedgelands and Rushlands
22	Chenopod Shrublands, Samphire Shrublands and Forblands
23	Mangroves
25	Cleared, non-native vegetation, buildings
26	Unclassified native vegetation
27	Naturally bare - sand, rock, claypan, mudflat
30	Unclassified Forest
31	Other Open Woodlands
99	Unknown/no data