



17. Conclusions and Recommendations

17.1 Overall Value of Wetlands in Arid NT

The importance of most individual wetlands and of the combined suite of arid NT wetlands is poorly known, a situation only partly addressed by this broad inventory. Nevertheless, we have identified many wetlands as being of national and international importance for maintaining biodiversity. Wetlands in the arid NT sustain plant and animal species that are endemic to the region, as well as isolated and relictual populations of more widespread species. The wetlands also support important populations of nationally endemic species such as the Banded Stilt, which although vagrant is now confirmed as episodically breeding here in large numbers.

Although not quantified, the collective importance of a large number of small wetlands must not be overlooked. Many wetland species have naturally widespread and relatively sparse populations and rely on scattered small wetlands for their existence. Individual wetlands may therefore be important as components of aggregations across large distances, even where an individual is relatively small. Therefore, the wise use of individual wetlands may be very important to sustain regional biodiversity.

The main economic values of arid NT wetlands are for tourism and pastoralism. Many wetlands are of great significance in Aboriginal culture and spirituality.

Arid NT wetlands may provide an important resource for research into past climates and ecosystems, through pollen that is stored in sediments.

17.2 Condition of Wetlands in Arid NT

In the arid NT there has been relatively little wetland loss from land clearing or drainage and diversion works for agriculture. Those factors have caused massive reductions in wetland area and quality in some other parts of Australia.

However, there are few wetlands that have not been affected by feral grazing animals, domestic grazing stock or weeds. Of these three, weed invasion is considered to be the biggest threat to biodiversity values. The situation is not well quantified but there is clear evidence that few wetlands are weed free and that the most invasive species are rapidly spreading. Riverine environments are the worst affected at present, since the natural disturbance regime of episodic floods favours colonising species which includes most weeds. There is evidence that weeds are also encroaching swamps and claypans. Weed invasion is undoubtedly a threatening process for some wetland plants, which if left unabated may lead to extinctions.

17.3 Landholder Attitudes and Perceptions

Many landholders value the presence of wetland birds and possibly plants and other animals. In our survey we did not encounter any negative attitudes to wetlands. Perhaps due to the large size of properties, there is less concern about the effects of wetlands on access, agricultural production or mosquito breeding than in more densely populated parts of the country. The relatively positive attitudes may equate to receptiveness to conservation messages. However, we frequently encountered scepticism

about the use of the term 'wetland' for areas that are generally dry. Also, many pastoralists are defensive in regard to possible impacts from cattle. Several made statements to the effect that plants and animals that have survived many decades of grazing, or even over a century in some places, have shown that they are compatible with current land use.

17.4 Data Limitations

The large size of the study area compared to the time and resources available for this inventory, mean that there are various gaps in the spread of ground and aerial survey sites. Relatively little field work was done in the MacDonnell Ranges Bioregion because it was the best known area prior to the survey, both in the authors' general experience and in pre-existing documentation and research. The north western portion of the Tanami Bioregion was also under sampled. Previous survey work supplemented by strategic sites surveyed in this project was considered to provide an adequate basis for documenting the wetland values of that region. The Murchison Ranges and the area of the Tanami Desert to their west were not sampled. Most of the survey gaps are on Aboriginal Land and considerable time should be allowed for consultations in any plans for future survey. The central Simpson Desert in the region of the borders with South Australia and Queensland was not sampled due to its remoteness. The portion of the Great Sandy Desert to the south and south-east of Lake Mackay was not visited. Also, the far south west corner of the NT, to the south of the Petermann Ranges was not surveyed and is poorly known. Existing mapping and recent satellite imagery indicate that there are few large or longer lasting wetlands there.

17.5 Recommendations for Community Education

Educational and promotional material should be developed to increase understanding of arid NT wetlands and their importance. A one-page information sheet could be created for each wetland type, similar to those created for south-west Queensland by Jaensch (1999). An additional sheet or sheets could cover the general abundance, distribution and values of arid NT wetlands. The same information could also be presented on the internet. Other material should be produced for traditional Aboriginal landholders for whom English is often a second or third language.

An information campaign is recommended regarding the degree of threat posed to wetland values from the most invasive weed species, and should include ways to avoid spreading weeds.

An information campaign is also recommended about the risks associated with translocating or introducing fish and crustacean. People living in and near the catchments of high aquatic biodiversity should be targeted, such as: the Finke River, Frew River, Whistleduck Creek, the long-term waters of the George Gill Range (Kings Canyon/Watarrka area) and the Dulcie Ranges. This type of education applies equally to those undertaking deliberate introductions, to developers of commercial aquaculture and to owners of pet fish and invertebrates in aquaria.

There is scope for increased education of tourism providers of the need to limit or avoid sunscreens and insect repellants when bathing in waterholes.

Community education regarding wetland conservation should be guided by the general principles set out in the national action plan: the *Wetland Communication, Education and Public Awareness (CEPA) National Action Plan* (internet site of EA: cepa0105.html). Community education will be most effective when undertaken cooperatively. Accordingly, various interest groups should work together including Waterwatch, the NT fisheries authority, Parks and Wildlife and other components of the Department of Infrastructure Planning and Environment, and the Education Department.

17.6 Recommendations for Management

Law Enforcement

Legislated responsibility for protecting aquatic life and controlling its utilisation are mainly with the Fisheries Branch of the NT Government, however, all the Fisheries officers are based in the Top End. Consequently it is difficult for them to perform education and law enforcement duties in the arid NT,

some 1000 to 1700km from Darwin. It is recommended that some way be found to increase education and protection measures regarding aquatic life in the arid NT. The Parks and Wildlife Commission has some powers to protect aquatic life in conservation reserves by designating no-fishing areas.

Conservation Management

Further work is required to assess the level of any long-term impacts that human wetland use may be having, including cattle production. As this work will be a long-term activity, a precautionary approach should be applied such that representative wetlands or parts of wetlands should be managed for the conservation of biodiversity. This need not necessarily preclude all other land uses. However, fencing to control or exclude stock access to some wetlands, or parts of wetlands, will often give the best protection to natural values. The costs involved include fencing materials and construction and may also include the provision of artificial watering points for stock. Conservation works such as fencing may require the provision of funds or other assistance to landholders.

Priority should be given to formulating management plans for all important wetlands including plans for monitoring, further biological assessment, weed control, and management of grazing regimes. Some wetlands are already covered within park plans of management.

There is no doubt that some wetland areas are 'essential habitat' for some species. It is recommended that some such wetlands should be declared as essential habitats under the Territory Parks and Wildlife Act. Primarily this should be done for habitats that occupy a relatively small total area and where there are threats to their ability to support the dependent plants and animals.

Both cooperative and legislated approaches for off-park conservation of wetlands should be pursued. The protection of some important wetlands in new national parks should also be considered.

Management of weeds should involve the following:

- listing important environmental weeds as noxious, most critically *Cynodon dactylon* and *Cenchrus ciliaris*;
- a ban on the sale and sowing of *Cynodon dactylon*;
- raising awareness of the impacts of environmental weeds;
- creating better identification guides;
- more education on ways to avoid spreading weeds;
- increased resources to the government weeds branch;
- increased assistance and incentives to private landholders for weed control;
- monitoring encroachment in key areas, such as Stirling Swamp;
- a pilot study on the possibilities of reversing *Cynodon dactylon* (Couch Grass) encroachment on swamps;
- investigation of control options for introduced grasses in rivers, particularly *Cynodon dactylon* and *Cenchrus ciliaris*;
- continuation of the Athel Pine control program.

The waterholes surveyed in several catchments of the Dulcie Ranges, were free of Couch Grass (*Cynodon dactylon*) and Noogoora Burr (*Xanthium strumarium* s. lat.) and had a relatively low abundance of Buffel Grass (*Cenchrus ciliaris*). All three weed species are abundant lower in the Bunday-Sandover drainage system, while Couch and Buffel are abundant in the Plenty-Hay drainage system (the other major system for which the Dulcies provide catchment). It is recommended that management actions be taken to control access into the ranges by feral and domestic herbivores (mainly cattle and horses) which will otherwise eventually convey these weed species into the Dulcie Ranges. This will require further survey to establish 'clean' areas, fencing, and increased feral animal control. The majority of the land area is pastoral lease so a formal agreement to conduct such management would need to be negotiated and considerable funding made available.

Consideration should be given to the protection of good examples of each main wetland types. These would serve as important 'reference standards' for assessing impacts and changes in other wetlands. A number of wetlands in national parks serve in this way and some stock exclosures already exist on cattle

stations. To be most effective, reference areas would need to have major weed species controlled, be ungrazed by exotic species and have undisturbed hydrological function. However, most riverine systems are heavily infested with *Cenchrus ciliaris* and *Cynodon dactylon*, including those on national parks, and current weed control methods are only viable for very small areas for these species. Also, these species are generally regarded favourably by pastoralists as stock feed.

17.7 Recommendations for Further Inventory and Research

Overview

This reconnaissance inventory has laid a solid foundation for future, more detailed inventory of wetlands in the arid NT. Future inventory is required as a basis for conserving the biodiversity of the region's wetlands, and should include the following general tasks:

- further consultation with landholders regarding their knowledge of wetlands (particularly water regimes);
- ground testing of the revised wetland maps produced by the current project, including attributing mapped wetlands with a wetland type;
- further investigation of mapping and references to wetlands in unpublished reports;
- investigation of the correlation between wetland type and abundance and land systems, such that land systems mapping might be used to estimate the extent of some types and be used in attributing wetlands that have been identified from satellite imagery;
- further biological survey of identified priority wetlands, including aerial bird survey;
- adequate resourcing of survey on Aboriginal Land, which typically involves longer planning times and funds to conduct meetings and engage traditional owners as consultants;
- establishing a list of plant species with high fidelity to wetlands in general or particular wetland types and the use of Herbarium specimen records to map or attribute wetlands;
- more detailed mapping of some wetlands using aerial photographs and satellite imagery;
- further study of inundation regimes using archival satellite imagery;
- actively maintaining a database of inventory level information about individual wetlands, building on the one created by this study.

Mapping and General Inventory

Additional wetland mapping data could be obtained from land resource assessment maps, and 1:50,000 scale orthophoto maps for some areas. Some of the important wetlands could be much better delineated with additional aerial photograph and satellite image interpretation. Finer scale mapping using these sources could be part of future wetland inventories of smaller areas, such as individual bioregions.

Collation is required of the coordinates, names and descriptions (including longevity) of individual waterholes and springs in aggregate sites that have been identified for potential inclusion in *A Directory of Important Wetlands in Australia*. These sites are the permanent waterholes of the Finke River, the Davenport Ranges waterholes and floodouts, the George Gill Range springs and waterholes, and the Dulcie Ranges springs and waterholes. There are some other wetlands that warrant further general inventory. This would include mapping individual water bodies and swamps in other wetland complexes, including the Elkedra floodout, and the Frew River floodout.

Additional information on the existence and attributes of specific wetlands undoubtedly exists in unpublished reports and local knowledge. Researchers undertaking future more detailed inventories of regions within the arid NT should not assume that these sources are all cited in this report. Resource appraisals of pastoral stations undertaken in the 1980s to assess applications for perpetual leases, are one of the sources not yet thoroughly searched. Others possible sources of additional information are reports on land resources, biological surveys and studies of water resources.

Detailed mapping of key wetlands using aerial photographs, satellite imagery and further consultation with local people, should be done. This will assist with improving knowledge of the general ecological function, hydrological regimes and inundation patterns of the wetlands.

Further investigation into the relationship between certain species of wetland plants and wetland types could result in a new tool for wetland inventory, based on Herbarium specimen records.

Priority areas for further general wetlands inventory are as follows:

- the upper Palmer River catchments - waterholes in the ranges and alluvial swamps;
- the far east of the MacDonnell Ranges bioregion;
- the floodouts of Skinner, Gastralobium and Yaddanilla creeks;
- the north western portion of the Tanami Bioregion;
- the Murchison Ranges;
- the area of the Tanami Desert west of the Murchison Ranges (including Porcupine Swamp);
- the Hanson River floodout;
- Lake Caroline;
- the Hay River floodout;
- the central Simpson Desert in the region of the borders with South Australia and Queensland;
- the Great Sandy Desert bioregion to the south and south-east of Lake Mackay;
- the far south west corner of the NT, to the south of the Petermann Ranges;
- various salt lakes in the far west of the NT: Lake Neale; Lake White; Lake MacDonald and Lake Albert.

Hydrological Regimes

Analysis of patterns of flow in arid NT rivers should be further researched. The existing stream gauging data provide a basis for this and might be supplemented with local knowledge of certain waterholes such as has been collated in this inventory.

Further investigation of the frequency of inundation of particular wetlands could be undertaken as part of a more detailed study of their ecology. This would involve further gathering of local knowledge, plus temporal analysis of satellite imagery of moderate to fine resolution. Landsat MSS data is available for up to three decades in some areas.

Further research is required to document the depth and duration of inundation in floodplains and floodouts, particularly those associated with the Sandover and Finke Rivers.

Priority should be given to documenting and mapping the permanency of waterholes and springs; particularly in the Davenport, Dulcie and MacDonnell Ranges. This would create a foundation for survey of other wetland values in those areas.

Bird Survey

There are still a great many gaps in our information on the importance of specific wetland types and specific wetlands for wetland birds. There have been quantitative total counts for a few wetlands from this and previous surveys, but the vast majority of bird records do not include abundance or are from counts of sections of wetlands only. As a result of this survey it has been possible to identify priority areas for future wetland bird survey. Using a combination of rainfall data and satellite images it would be possible to identify opportune times to visit particular areas. A substantial budget would be required for both helicopter and fixed wing aircraft. Helicopters would be essential to combine ground based calibration counts and species identifications with total wetland counts from the air. Sites should be targeted either opportunistically or as part of a follow up wetland bird survey program.

Total water body counts should be obtained for the various Newhaven Lakes to supplement the non-count records of birds. This might be achieved opportunistically with the combination of relatively good access to the lakes and claypans, and anticipated visitation by competent observers as a consequence of the purchase of Newhaven Station by Birds Australia.

Lake Lewis could be counted by boat or with aircraft. Total counts from this survey were made when the extent of water in the lake was significantly reduced. The lake was navigable by boat for 4 – 6 months in 2000 and for many months in 1974/5. Due to the limited vehicle access to the lake shore a helicopter could be used to assist with shore based counts if water depth does not permit use of an outboard motor.

Lake Amadeus is listed in a *Directory of Important Wetlands in Australia* but has not been aerially surveyed for birds. This should be a priority. Although the lake is generally shallower than the salt lakes with confirmed importance for wetland birds, its large size and numerous islands indicate potential importance. The same reasons indicate that the other large and poorly known salt lakes should be aerially surveyed for birds, including: Lake Neale; Lake White; Lake MacDonald and Lake Albert.

A number of the larger bluebush swamps should be targeted to assess the importance of this wetland type for birds. The abundance of cover and nesting sites in this wetland type indicate possible importance for the breeding of some species, although Northern Bluebush is less important for nesting than Lignum (R.Jaensch pers. comm.). Priority wetlands could include: Indinda and Casuarina swamps on Andado Station, Duffield swamp on New Crown Station, the two large swamps on the Burt Plain, just north of the West MacDonnell Ranges (Narwietooma and Milton Park Stations), the large swamp at Tarlton Downs, some of the many on Tobermorey Station and some of the large swamps on the Mitchell Grass Downs.

Total counts should be obtained for some of the Eucalypt wooded swamps. There are reports from property holders of large flocks of waterbirds in examples of this wetland type. Some of those surveyed in 2001 were subjectively assessed as having abundant and diverse waterbirds but few were systematically counted. Priority wetlands are Mud Hut Swamp on Stirling Station, the Elkedra and Frew River floodouts and Indemina swamp on Andado Station. Lake Surprise which includes areas of wooded swamp should be recounted at some stage, as part of ongoing biological assessment and monitoring in the region.

The Snake Creek Interdune Lakes should be recounted next time they are filled. They are among the longer lasting of the temporary NT wetlands due to their great depth and were virtually undocumented before this study.

Fish

The fish fauna of the Dulcie Ranges have not yet been systematically studied and may include isolated populations of *Neosilurus hyrtlui* and *Mogurnda sp.*, which are both relatively cryptic and could have eluded the relatively opportunistic survey conducted so far. Other possible species, not yet recorded from the Dulcies but recorded from the Sandover system on this survey are *Porochilus argenteus* and *Nematalosa erebi*. A systematic survey should be conducted with a variety of methods, including night fishing and preferably electro-fishing. Fish poison (e.g. rotenone) should not be used due to the low number of waterholes in each catchment and their generally disconnected state. The larger waterholes of the Ooratippa Creek system (part of the Sandover River system) should be given highest priority, including the one referred to as 'Rangey Bull Waterhole' by Latz and Langford (1983). The headwaters of Lucy Creek and the Plenty-Hay river system should be checked for the existence of any species in addition to *Leiopotherapon unicolor*.

The fish fauna of the Davenport and Murchison Ranges are better known than those of the Dulcies Ranges, but never-the-less warrant further study. The extremely brief and opportunistic sampling during this inventory added a species to those known from one of the creeks (*Neosilurus hyrtlui* in Kurundi Creek). The taxonomic status of the Davenport Ranges *Mogurnda* needs resolving. If it is found to be genetically distinct from *Mogurnda mogurnda* and *Mogurnda larapintae* it will have a high conservation significance. Fish survey work should be conducted in Skinner Creek. Numerous waterholes are marked on the 1:250,000 scale topographic map, but there is no information on permanency. Some are within a few kilometres of the Whistleduck Creek system and so it is possible that some are spring fed and permanent. Further survey is suggested for this creek as it may harbour additional species for the Western Drainage Division.

Fish Survey work should be conducted in Illara Waterhole which is one of the most permanent waterholes of the Finke River system. It is in a tributary of the Palmer River and is isolated from the other documented permanent and long lasting waters which are all on the mid to upper Finke River. There has been no systematic sampling of fishes occurring at Illara Waterhole. There may be other long lasting smaller rockholes in smaller tributaries of the Palmer River such as Petermann and Walker creeks and Bowson Waterhole further up Areyonga Creek from Illara Rockhole. All these areas warrant further survey work to establish fish distributions.

The occurrence and distribution of fishes in the Finke River is reasonably well known, but not the ecology. Particular emphasis is required on the Finke Goby (*Chlamydogobius japaipa*) which is listed as Vulnerable, to determine whether there is any threatening process at work.

Invertebrates

The invertebrate biodiversity of arid NT wetlands is very much under studied. Studies of waterholes in the West MacDonnell Ranges and the George Gill Ranges (Watarrka-Kings Canyon) have revealed each to have a distinctive fauna.

Work to improve knowledge of aquatic invertebrates will preferably involve repeated sampling through time, especially for temporary wetlands, since the aquatic invertebrate species assemblages can change through time in an inundation event. Further work is also required on the terrestrial invertebrate fauna that specialise in the substrate of playas when dry.

The highest priorities are the spring fed pools of the Dulcie Ranges, springs of the Treuer Range (Vaughan Springs, Eva Springs and others), permanent and semi-permanent waterholes of the Davenport and Murchison ranges and isolated rockholes, particularly those of the Great Sandy Desert bioregion. Other, more isolated, long-term permanent springs should be surveyed, including those on the south side of the Georgina Range in the East MacDonnell Ranges. Fresh water wetlands of lowlands (broadly: riverine waterholes, swamps and claypans) are the most heavily impacted by both weeds and introduced herbivores. Accordingly, study of their invertebrate life should be given a high priority and ideally will extend beyond documenting species occurrence to the study of broader ecology and the impacts of weeds and introduced herbivores.

Study of the aquatic fauna of salt lakes should be conducted, with comparison to the relatively well known salt lakes of arid South Australia, chiefly Lake Eyre.

The interactions and respective ranges of Inland Crab (*Holthusiana transversa*), Yabby (*Cherax destructor*) and Redclaw (*Cherax quadricarinatus*) warrant further investigation.

Improving Access to Species Distribution Records

Various databases of species distribution records exist at the state/territory and national levels, yet information is fragmented between many databases and can be difficult to access. It is important that existing initiatives to integrate databases are widely supported and in some cases extended, to assist with management and research of natural environments, including wetlands. However, in providing improved access to such information, it is important that information about the precise locations of environmentally sensitive organisms and sites be appropriately generalised. This includes sites where species may be poached, sites where quarantine from weeds and diseases is important and sites with cultural sensitivities. This may require the institutions involved to create parallel database fields for location coordinates and descriptions, with the more detailed information being only accessible by authorised researchers.

For plants, the situation is relatively well advanced with a project to create the Australian Virtual Herbarium. This involves databasing those state herbaria collections which are not databased and creating 'real-time' links to databases maintained by the various institutions, which will become accessible through a single internet site. Within the NT there is a need to establish an ongoing database of non-specimen species distribution records (including weeds), and this should be integrated into the Australian Virtual Herbarium as supplementary, non-vouchered data.

The situation is less advanced for fauna. Museums are the primary custodians of most preserved scientific animal specimens, and their collections are variously databased. A program called Australian Museums On Line maintains a collaborative internet access point to the major Australian Museums and will eventually incorporate specimen collection databases (http://amol.org.au/about_amol/about_amol.asp). Within the NT, the Parks and Wildlife Commission maintains a database of observational records of vertebrate fauna but does not include fishes. For invertebrates, the situation is far more complicated due to the generally poor level of taxonomic knowledge and the vast array of species.

Botanical Survey

There are several wetland areas which should be given a high priority for further botanical survey and documentation.

Warrabri Swamp at the floodout of the Skinner and Murray Creeks holds water for more than six months, but has never been surveyed botanically. Similarly, two other floodouts from the Davenport Range warrant further investigation, for which there is no information about longevity of inundation: Yaddanilla Creek and Gastralobium Creek.

Long lasting waterholes in the upper catchment of the Palmer River are very poorly known.

The various springs and waterholes in the catchments of the Hale River and Illogwa Creek, in the remote eastern areas of the East MacDonnell Ranges are poorly known. Any significant biota are likely to be plants but the possibility of significant invertebrates cannot be excluded.

All the known permanent and semi-permanent springs should be surveyed for plants including those on the south side of the Georgina Range in the East MacDonnells and those of the Treuer Range (Vaughan Springs, Eva Springs and others).

The waterholes and springs of the West MacDonnells, the James Range (Palm Valley Area), the George Gill Range (Watarrka National Park), the Dulcie Ranges, the Davenport Ranges and the Murchison Ranges are relatively well known in terms of species occurrence in each general area, but adequate species lists are not available for individual waterholes/springs in each area. Obtaining comprehensive species lists for individual waterholes and springs is justified given their general botanical distinctiveness. A database of this information is in preparation for the Watarrka sites (D. Schunke pers. comm.) and preliminary lists for some sites are available in White *et al.* (2000b).

Impacts of Various Wetland Uses by Humans

There is a need for further research on the impacts of human uses of wetlands, including use for grazing and watering domestic cattle. To get robust information that quantifies impacts is not easy and will require sustained long-term research. A collaborative approach between wetland users and various government departments and research institutions will be required to address the issues.

Research is required on the hypothesised adverse effects of personal chemicals polluting waterholes from swimmers; particularly sunscreen and insect repellent. A review of relevant monitoring and toxicological studies is necessary, as is design of a monitoring or research study of key waterholes such as the Garden of Eden on Kings Creek, Ellery Creek Big Hole, Glen Helen Waterhole, Redbank Waterhole and Ormiston Waterhole.

17.8 Recommendations for Listing Important Wetlands

The process of consultation with landholders about the possible listing of wetlands of national importance in the Directory, should be continued. This should not only result in most sites being listed, but also be a positive step in facilitating more active off-park conservation of wetlands.

Further survey and documentation of individual wetlands, within important wetland aggregates, may result in some of the individual wetlands being separately list in the Directory. For example, individual waterholes in the Finke River Headwaters site.

A process should be developed within the NT Government for nominating appropriate wetlands as Ramsar sites.