Northern Territory Government

Other Aquatic Health Unit projects

This section provides a snapshot of projects to protect water quality, investigate biological health of the region's ecosystems, and monitoring programs.

Rural residential and horticulture are two of many land uses that contribute to sediment, nutrient and pesticide loads to local waterways. Palmerston and Darwin Harbour in background, April 2008. The Northern Territory Government monitors water quality in rural areas of the region. Photo by George Maly

A water quality protection plan

The water quality of Darwin Harbour is regarded as being in a near-pristine or slightly modified condition. However there are concerns that continuing economic growth in the region will have a negative impact on the quality of waterways particularly around urban areas.

While the population residing in the Darwin Harbour catchment currently totals over 120,000 people, by 2026 it is expected to increase to 165,000 people. Population increase often leads to urban and rural growth which can lead to increased erosion and increased loads of pollutants entering waterways. High pollutant loads can compromise water quality particularly in areas where tidal flushing is limited, such as the upper estuaries, near the end of tidal influence.

A Water Quality Protection Plan for Darwin Harbour (WQPP) has been developed to ensure that the quality of the region's water resources is maintained and that the community's values and uses of waterways are protected from the adverse effects of urbanisation and other polluting activities.

Preparation of water quality objectives (water quality guidelines for local waterways) is a key component of the WQPP. Water quality objectives describe the water quality needed to protect values and uses of regional water resources. These water quality criteria act as guideline levels and/or reference levels to help guide planning and water management to achieve and protect each of the values over time.

The water quality objectives also are:

- aimed at protecting human health and the health of the aquatic ecosystems;
- for regions of relative homogeneity in water quality;
- not for heavily urbanised or disturbed areas;
- applied to perennial rivers and streams;
- not developed for intermittent streams, lakes, wetlands, estuaries or marine waters; and
- not to be used as a value to 'pollute up to' but instead be used to limit the amount and type of discharge flushed into Harbour waters or a particular body of water.

Water quality objectives for the Darwin Harbour catchment are intended for the community, local councils and government agencies to use in catchment management and land use planning activities. They are a tool for strategic planning and development assessment processes. Water quality objectives are agreed to by stakeholders.

Water quality objectives will be formally declared under the Northern Territory legislation (*Water Act* part 7). Formalisation of the water quality objectives will ensure that they are included in future policy and planning initiatives to protect Beneficial Uses identified by the community.

Environmental values (defined as Beneficial Uses under the *Northern Territory Water Act 1992*) are particular values or uses of water that are conducive to a healthy ecosystem and/or contribute to public benefit, welfare, safety and health. These environmental values require protection from the effects of pollution. The *Northern Territory Water Act 1992* defines these values or uses as Beneficial Uses. Examples include recreational and aesthetic values and maintaining aquatic ecosystem health. A public consultation process was undertaken in 2007 to evaluate existing Beneficial Uses originally declared in 1996. The community's preference was for existing uses to be retained and for the environment to be in the highest ranking category of Beneficial Uses.

Water quality objectives provide appropriate criteria to assess whether a designated Beneficial Use is being maintained – to protect our waterways. Nitrogen, phosphorus and total suspended sediment were identified as a broader management issues in the region and selected as key water quality indicators. Further information can be found at website http://www.nt.gov.au/nreta.

Darwin frog monitoring trial

Frogs are useful indicators of environmental quality. Their eggs and larvae are fully aquatic and therefore potentially exposed to water-borne contaminants. Elsewhere in the world there are concerns about declines in frog populations and loss of species. The causes are not always clear but involve change in habitat quality, habitat fragmentation and disease.

The frog fauna of northern Australia has not suffered the same patterns of decline that are evident elsewhere. There are 29 frog species present in the Top End of the Northern Territory. None are considered to be endangered. Twenty-one species have been recorded in the Darwin area. Species that have not been recorded, but which are present elsewhere in the Top End, are mostly rock habitat specialists.

In the wet season of 2008–09 the NRETAS Aquatic Health Unit, together with staff from the NRETAS Biodiversity Unit conducted surveys of frog species present at sites throughout the suburban and rural areas of the Darwin Harbour catchment. The aim of the surveys was to catalogue the number of species present at each site, and to provide data to design an ongoing monitoring program. Thirty sites were visited on 10 occasions each throughout the wet season. On each occasion frogs were identified by species-specific calls within a five-minute survey period.

Nineteen of the expected 21 species were identified during these surveys. One of the remaining species, Dahl's Aquatic Frog was seen at survey sites but does not call; the other was found at non-survey sites. For most sites, between seven and nine species were detected, and at one site, 12 species were detected. Common species include the Javelin Frog (*Litoria microbelos*) and the Northern Dwarf Tree Frog (*Litoria bicolor*).

Modelling revealed that detectability is influenced by factors such as recent rainfall and water temperature. This information will assist in the design of a monitoring program to detect long-term changes in the occurrence of frog species throughout the Darwin area. A rigorous monitoring program is required to document amphibian responses to intensification of land use, and the spread of exotic plants and animals such as the Cane Toad. The continuation of this work will be dependent on available funds and resources.

Northern Dwarf Tree Frog, (*Litoria bicolor*), is a very common species, usually associated with Pandanus. It was found at many sites during the recent survey. Photo by Leonie Richards

Common names and species of frogs recorded during surveys in the Darwin region, and the number of survey sites (of 30) and weeks (of 10) in which they were detected.

Common name	Species	Number of sites	Number of weeks detected
Species recorded in surveys			
Giant Frog	*Cyclorana australis*	7	4
Long-footed Frog	*Cyclorana longipes*	2	2
Green Tree Frog	*Litoria caerulea*	14	8
Northern Dwarf Tree Frog	*Litoria bicolor*	25	10
Javelin Frog	*Litoria microbelos*	26	10
Red Tree Frog	*Litoria rubella*	15	10
Red-eyed Tree Frog	*Litoria rothii*	14	10
Rocket Frog	*Litoria nasuta*	26	10
Peter’s Frog	*Litoria inermis*	2	2
Tornier’s Frog	*Litoria tornieri*	7	10
Wotjulum Frog	*Litoria wotjulumensis*	2	3
Ratchet Frog	*Crinia remota*	26	10
Marbled Frog	*Limnodynastes convexiusculus*	24	10
Ornate Burrowing Frog	*Limnodynastes ornatus*	1	1
Golfball Frog	*Notaden melanoscaphus*	1	2
Stonemason Toadlet	*Uperoleia lithomoda*	4	10
Floodplain Toadlet	*Uperoleia inundata*	17	10
Howard River Toadlet	*Uperoleia daviesae*	1	10
Cane Toad	*Bufo marinus*	12	9
Known to occur in region but not recorded at a survey site			
Pale Frog	*Litoria pallida*	-	-
Known to occur but does not call			
Dahl’s Aquatic Frog	*Litoria dahlii*	observed	-

Tornier’s Frog (*Litoria tornieri*) is infrequently encountered throughout the Darwin Harbour region. Photo by Peter Dostine

Water-bugs

Identifying water-bugs requires specialist taxonomic expertise to identify to genus level.

Invertebrate animals which live in streams are often collectively called ‘water-bugs’. They are more properly termed aquatic macro-invertebrates. They include a diverse set of animals, some of which are well known to many people such as freshwater mussels and large freshwater prawns, but most are relatively small, obscure animals which live unseen in our streams, rivers and lagoons. Most of the types of animals found in our waterways are insects: many of these have an immature aquatic phase, and a free-flying terrestrial adult phase in their life cycle. Common examples include dragonflies, caddis flies and mayflies.

Aquatic macro-invertebrates are important in both aquatic and terrestrial food-webs. Fish, waterbirds and aquatic reptiles all depend on aquatic macro-invertebrates for food. For example, the freshwater crab forms a large part of the diet of the Water Monitor.

Larvae of all damselflies (*Ceriagrion aeruginosum* shown in photo) and dragon flies are aquatic.

Many types of freshwater animals have fascinating life cycles. The immature stages of freshwater mussels snap shut on the fins of freshwater fish and are transported upstream as fish migrate to refuge habitats. The life cycle of some shrimps and prawns involves an estuarine phase where the larvae migrate to saline waters and then juveniles undertake a return migration upstream. These species rely on the ecological health of both the freshwater and marine parts of the system.

The most common types of animals in our waterways are larvae of the dipteran family Chironomidae. These animals are found in freshwater environments throughout the world and are commonly used to assess environmental quality. Different types of larval chironomids have different ways of obtaining food – some are predators on other aquatic animals, some consume microscopic algae, others trap small particles of food using a mucous net suspended at the mouth of protective tubes. The larval stage is followed by a pupal stage during which the animals metamorphose to adults. Adults emerge from the pupal skin at the water surface, leaving the shed pupal skin to float downstream. These shed skins (or exuviae) are useful in bio-assessment as they provide an easy way to tell what types of chironomids are present.

The composition of the water-bug fauna of our streams, rivers and lagoons is now reasonably well known. They are an important part of our monitoring work to track the condition of waterways in the Darwin area.

Sediment and nutrient loads in Darwin Harbour catchment streams

In areas with highly variable rainfall such as in the wet-dry tropical north, it is important to use storm event-based sampling for pollutant load estimation, as this is when most sediment and nutrients are transported. In the Darwin region, the climate is tropical with distinct wet and dry seasons. The monsoonal wet brings rainfall averaging 1,700 mm per year, with about 80 per cent falling between December and March inclusive (data from Bureau of Meteorology, 2009). The period from May to October is much drier.

Event-based water quality monitoring is being used to increase our understanding of catchment pollutant sources and help identify sources for management actions to protect the water quality in the region. The transfer of pollutants such as sediment and nutrients from land to water bodies originate from diffuse (non-point, such as a whole catchment) and point (e.g. sewage treatment plant) sources.

Event-load estimates to the Harbour have been made using wet season streamflow data from the Department of Natural Resources, Environment, The Arts and Sport (NRETAS) stream gauge sites (see photo) in urban, rural or undeveloped catchments. Water quality samples were collected by the NRETAS Aquatic Health Unit at Peel, Bennett, Berry, Howard, Elizabeth, Celia, Karama and Moil catchment gauge stations, and loads determined. Urban land use contributes greater diffuse source pollutant loads per hectare than non-urban land use. Some metal loads per hectare are greater for urban areas than non-urban areas due to metals associated with building materials. Other pollutants are from vehicle emissions, construction, manufacturing industry and roads.

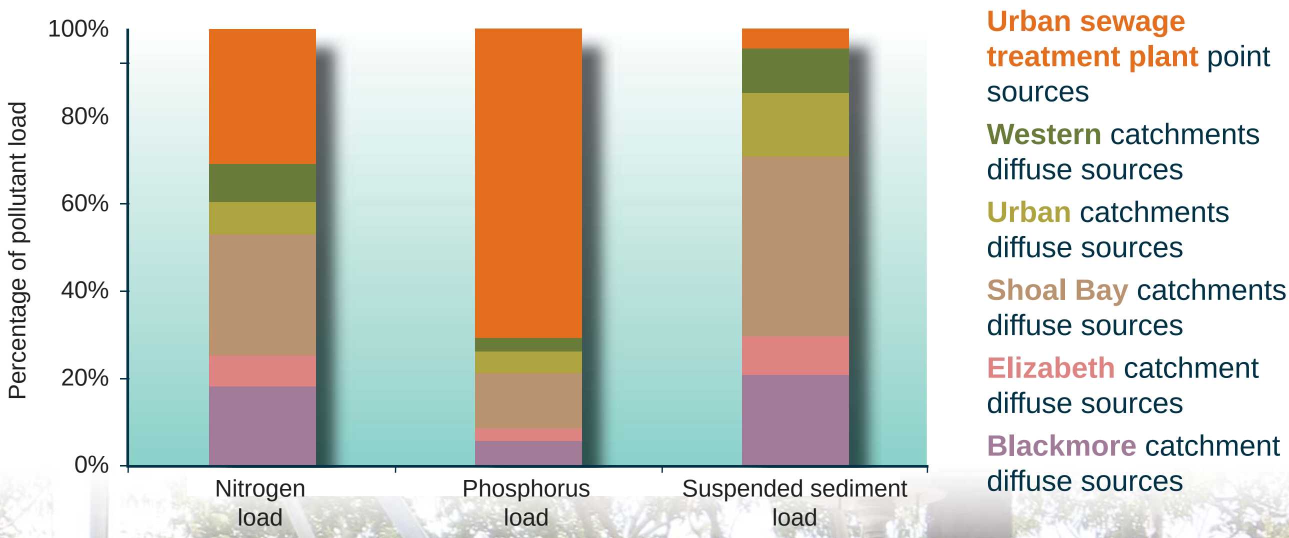
The table shows average wet season load per hectare for urban and non-urban land use in the Darwin Harbour catchment (adapted from Skinner et al. 2009)*.

Pollutant	Catchment classification	
	Non-urban	Urban
Total suspended sediment TSS (kg/ha)	110	730
Aluminium Al (kg/ha)	3.8	50
Total nitrogen TN (kg/ha)	3.2	9.9
Total phosphorus TP (kg/ha)	0.12	1
Zinc Zn (g/ha)	71	890
Copper Cu (g/ha)	13	200
Chromium Cr (g/ha)	8.5	44
Nickel Ni (g/ha)	4.3	13
Lead Pb (g/ha)	4.1	270
Arsenic As (g/ha)	2.2	11
Cadmium Cd (g/ha)	0.93	1.9

* Skinner, L., S. Townsend, and J. Fortune, (2009), The impact of urban land use on total pollutant loads entering Darwin Harbour, Department of Natural Resources, Environment, the Arts and Sport, Report 06/2008D, Darwin.

In an average wet season, about 36,000 tonnes of suspended sediment flow into Darwin Harbour from catchments – that is about 36,000 ute loads. Most of this is from soil erosion.

About 1,000 tonnes of nitrogen enter Darwin Harbour per year. Diffuse sources from catchments are an important source of nitrogen. The Blackmore River and Shoal Bay catchments are large in area and contribute about 18 per cent and 28 per cent of average annual loads, respectively. About 140 tonnes of phosphorus enter Darwin Harbour in an average year. The graph shows sewage treatment plants are currently an important source of phosphorus to the harbour from land-based activities. Much of the remaining phosphorus is from diffuse sources in the catchment.



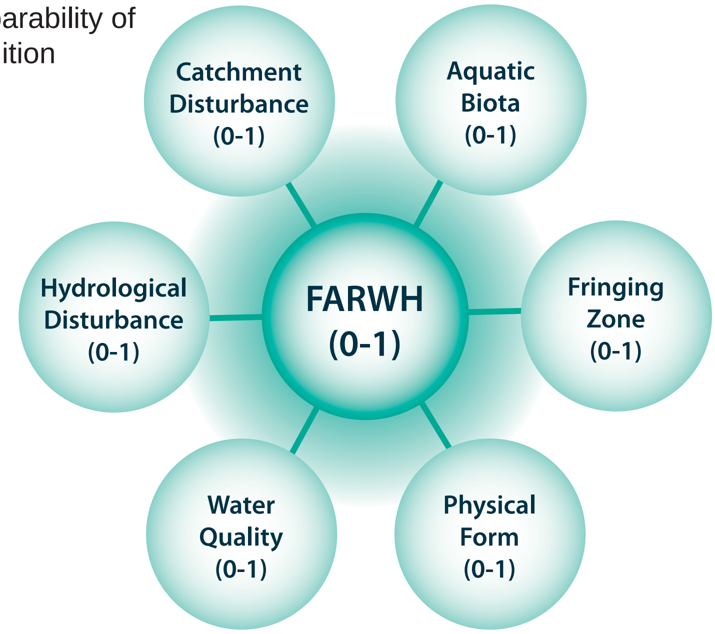
Contribution of catchment land-based diffuse and point source loads to Darwin Harbour in an average wet season.

Peel gauge station in the Department of Natural Resources, Environment, The Arts and Sport hydrographic network. Water quality samples and flow data are collected to determine pollutant loads.

A framework for river and wetland health – FARWH index

The Framework for River and Wetland Health has been developed as a monitoring system to guide the national assessment of river and wetland health to determine if there is long-term change in condition. The aim of the framework is to allow for national comparability of assessments of river and wetland condition based on the impacts of resource use.

The FARWH for river health has six components or sub-indices which are appropriate for the assessment of river and wetland health, as they evaluate ecological integrity. The components for river health are shown below.



FARWH indicator scores and banding system for wetlands

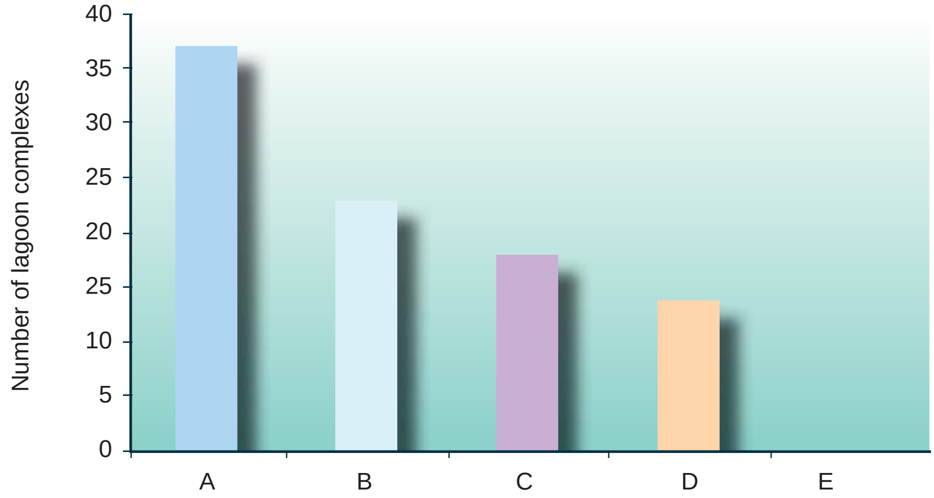
Band*	Indicator score	Description
A	0.8 – 1	Largely unmodified
B	0.6 – <0.8	Slightly modified
C	0.4 – <0.6	Moderately modified
D	0.2 – <0.4	Substantially modified
E	0 – <0.2	Severely modified

*This colour coding is used in the FARWH system for wetlands.

For wetland health, the FARWH includes similar components and water and soil quality. Each index component may comprise more than one sub-index. The catchment disturbance component for rivers, for example, may include land use and fire sub-indices. In the FARWH system, water quality assessment focuses on ecosystem health. The water quality component for rivers has several water quality parameters affecting ecosystem health. The water quality component for rivers is being trialled, including total and dissolved nutrients, dissolved oxygen, total suspended solids, electrical conductivity and pH.

The aquatic biota index may include macro-invertebrates, fish and aquatic weeds. The macro-invertebrate sub-index for streams is based on the AUSRIVAS system shown in some of the report cards. The indices, including the FARWH index, are scored between 0 and 1. A score of 1 refers to minimally disturbed reference condition. The scoring system is associated with condition bands A to E.

The FARWH index is currently being trialled on the streams of the Darwin Harbour region. Trials of the FARWH index on wetlands in the Darwin Harbour region has been completed. Results revealed more than a third of the 92 natural lagoon complexes to be in the 'largely unmodified' condition. A quarter were categorised as 'slightly modified', approximately a fifth classed as 'moderately modified' and the remainder as 'substantially modified'. No lagoons were classed as the worst condition 'severely modified'. The overall score of all natural lagoon complexes was 0.76, which is classed as slightly modified.



Condition of natural lagoons in the Darwin Harbour region, using the FARWH system

Further reading

For further reading, various reports on water quality and biological health from the AHU can be found at: http://www.nt.gov.au/nreta/water/aquatic/publications/index.html

For further information on water quality and biological indicators in the region, see the NRETAS website http://www.nt.gov.au/nreta/water/aquatic/ausrivas/index.html

For further information on water quality, see ANZECC guidelines and publications
http://www.environment.gov.au/about/councils/anzecc/index.html#reports
http://www.mincos.gov.au/publications/national_water_quality_management_strategy

Horticulture is an important industry in the region. Photo by George Maly

Glossary

Explanations of water quality and biological indicators (e.g. chlorophyll-a) are presented separately in the Interpretation section.

Terms	Definition
Ambient water quality	Background water quality levels in waterways. In freshwater streams this commonly refers to low flow (non event) conditions.
Diffuse source	Refers to transport (such as run-off) from non-point sources such as urban paved or non-paved areas, hillslopes, agricultural land and forest.
Event-mean concentration	A measure of total load in an event such as a storm divided by total flow.
Flushing	The capacity of tidal movement to dilute a body of water. In the Darwin Harbour region, upper estuaries and tidal creeks are generally poorly flushed.
Macroinvertebrate (or 'water-bug')	Aquatic macroinvertebrates are animals that have no backbone, are visible with the naked eye and spend all or part of their life in water. This diverse group includes insects, crustaceans, worms, and molluscs.
Mixing zone	An agreed area of receiving waters where water quality objectives may not be met. Mixing zones are at licensed wastewater discharge outfalls. The mixing zone should be determined through modelling to the satisfaction of the Controller (e.g. from NRETAS), and be verified with field monitoring.
Phytoplankton	Microscopic aquatic plants.
Point source	Discharge from a single point, such as an outlet pipe. Can refer to runoff or wastewater discharges.
Sewage treatment plant	A facility that processes wastewater and partially removes materials that damage water quality.
Water quality objective	Water quality objectives act as local waterbody guideline levels and/or reference levels to help guide planning and water management. Water quality objectives describe the water quality needed to protect Beneficial Uses identified by the community.

Western Rainbowfish (*Melanotaenia australis*) is found in Rapid Creek.
Photo by Dave Wilson