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Darwin Harbour Region

Other Projects and Monitoring

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Articles were provided by staff and students at the Department of Natural Resources, Environment, The Arts and Sport, Museum and Art Gallery of the Northern Territory, Charles Darwin University, Australian Institute of Marine Science, Equatica Pty Ltd and Power and Water Corporation.

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Front cover photos
The Indo-Pacific humpback dolphin (*Sousa chinensis*) is commonly found in Darwin Harbour. Photo: Carol Palmer.

Beach stone-curlew (*Esacus neglectus*). A shy resident of reefs, beaches and coastal mudflats of northern and eastern Australia. Photo: Mat and Cathy Gilfedder.

An undescribed sponge species of the genus *Haliclona*. It is restricted to the intertidal area. Found only at East Point, Channel Island and Cullen Bay. Photo: Belinda Glasby.

Northern trout gudgeon (*Mogurnda mogurnda*) occurs in Rapid Creek. Photo: Dave Wilson.

Back cover photos
This species of the sponge genus *Petrosia*, is common in the area of Elizabeth River estuary. Photo: Belinda Glasby.

Sunset at Nightcliff, Darwin. Photo: Nolan Caldwell.

Rapid Creek is the largest freshwater stream in the Darwin area.

Acknowledgements

The project was supported by the Darwin Harbour Advisory Committee. We thank many people who contributed photographs. Information was kindly supplied by Belinda Glasby (sponges), Richard Willan (molluscs, cyanobacteria and algae), Carol Palmer (dolphins), Veronica French, Sue Codi and David Parry (micropollutants). We thank Larrakia Nation. Data and information in this report were obtained from projects funded by organisations including the Northern Territory Government and the Australian Government.

Symbols are courtesy of the Integration and Application Network (ian.umces.edu/symbols/), University of Maryland Center for Environmental Science, USA. Several conceptual diagrams were adapted from base diagrams from the Integration and Application Network.

Contents

The Indo-Pacific humpback dolphin (*Sousa chinensis*) is known as a coastal or near-shore dolphin and is typically found in small populations inhabiting shallow coastal and estuarine waters, usually within about 10 km of land, in water less than 15 m deep and within about 20 km from the nearest river mouth.

This dolphin is vulnerable to habitat degradation, boat strikes, pollution and increased shipping traffic. Estimates of population size in local areas along the Queensland coast indicate that populations are notably small making them particularly vulnerable to human-induced disturbances on coastal ecosystems.

The Coastal Dolphin Research Project is currently undertaking baseline research on this species in Darwin Harbour along with the two other species of coastal dolphins: the endemic Australian snubfin (*Orcaella heinsohni*) and the Indo-Pacific bottlenose (*Tursiops aduncus*). This photo of the Indo-Pacific humpback dolphin was taken in the Howard River area. Photo: Carol Palmer

Introduction

Aerial view of creek. Photo: Jeremy Freeman

Mindil Beach

Nymphaea violacea in Korebum Lagoon. *Nymphaea* is known as dambilinggwa to Larrakia people. Photo: Gisela Lamche

Introduction

Darwin Harbour Region Report Cards 2010

This report is a supplement to the Darwin Harbour Region Report Cards 2010.

Report contents

This report provides information on a selection of species that live in the Harbour's waters. This includes studies on sponges, molluscs and the ecology of coastal dolphins. Like many others, they depend on the Harbour's waters.

A summary of selected research and monitoring activities in the Darwin Harbour region is also presented in this report. These include cyanobacteria and algae commonly found at coastal beaches, detection of micropollutants and the composition of microbe communities associated with treated sewage discharge.

Other studies are the use of chlorophyll mapping in coastal waters, and the role of landscape features called 'dambos' in controlling sediment movement from the catchment to estuarine waters.

Activities to improve water quality from our urban areas are also described, including water sensitive urban designs. Improvements to sewage treatment plants and the sewerage network being undertaken by the Power and Water Corporation are also outlined.

Biodiversity in Darwin Harbour Region

A mixed flock of migratory waders crowd at the water's edge at high tide. Flock includes ruddy turnstone (one carrying a leg flag), Pacific golden plover, grey plover, grey-tailed tattler, terek sandpiper, greater sand plover and red-necked stint. These hemisphere migrants breed in high northern latitudes. Photo: Mat and Cathy Gilfedder

The lesser longbum (*Terebralia palustris*) is a major recycler because it consumes fallen mangrove leaves. Almost 100 species of molluscs live in mangrove forests in Darwin Harbour. Photo: Neil Wright

Other species, not pictured here, include Longbum (*Telescopium telescopium*) and several species of lesser longbum (*Terebralia palustris, Terebralia semistriata, Terebralia sulcata*).

Callyspongia sp. A common species of sponge in the intertidal zone of Elizabeth River estuary. Photo: Belinda Glasby

Introduction

This section presents information on a few of the species the region is home to. Like many others, they depend on the Harbour's waters. It's only a selection – we cannot describe everything here. Much of Darwin Harbour is a relatively pristine environment. Marine habitats include intertidal and subtidal mudflats, bare rocky outcrops in the high intertidal, fringing coral reefs and subtidal rocky reefs. The Harbour is fringed by extensive mangrove forests. These habitats are home to a diverse range of species. Estimates of marine invertebrate species richness exceed 3,000 species. The checklist of marine fish species includes 415 species. The Harbour is also home to four species of marine turtle, three species of coastal dolphin, a diverse fauna of marine snakes, and many species of shorebirds and mangrove-dependent bird species. The ways in which these animals use harbour habitats are frequently poorly understood. Many are small, sedentary and cryptic and spend their entire lives within harbour waters. Others such as some pelagic fish visit the harbour during seasonal wanderings around the northern coastline. Migratory waders visit the harbour shorelines as part of their migration journeys. All depend on high quality stewardship to ensure that they continue to be part of our tropical coastal environment.

Sponges

Belinda Glasby, Museum and Art Gallery of the Northern Territory

Darwin Harbour is a 'hot spot' of sponge biodiversity. Approximately 250 sponge species are found in different habitats throughout the Harbour, including soft muddy bottoms, rocky reefs, sea grass beds, artificial reefs, wrecks, wharf pylons and pontoons. Many of these species are new to science. Documentation of these new species is a major goal and is currently in progress. At least 60 of these species can be found in the intertidal areas. During the king low tides they are exposed for periods of 2–3 hours, resisting high temperatures and UV exposure which indicates the high degree of tolerance and adaptability to extreme conditions.

Sponges, as well other marine invertebrates are targets of bioprospecting research. They harbour a diversity of novel and bioactive compounds some of which have proven to be active against cancer and have been developed into anticancer drugs. The Coral Reef Research Foundation (Palau) provides the Museum and Art Gallery of the Northern Territory with funding for the collection and taxonomy of marine invertebrates including sponges, for screening of anti-cancer and anti-viral compounds at the US National Cancer Institute. The research and collection is under a Benefit Agreement between the Northern Territory Government and the US National Cancer Institute.

An undescribed sponge species of the genus *Haliclona*. It is restricted to the intertidal zone. Found only at East Point, Channel Island and Cullen Bay. Photo: Belinda Glasby.

Molluscs

Richard Willan, Museum and Art Gallery of the Northern Territory

The total number of marine and estuarine mollusc species recorded from Darwin Harbour is 1096 species. However, this diversity is low compared to similar areas on the same latitude elsewhere in the Pacific Ocean. The mollusc fauna of Darwin Harbour is similar to the Kimberley coast.

The largest families of molluscs in Darwin Harbour are bivalves – Veneridae (venus clams; 42 species) and Tellinidae (wafer clams; 40 species). The latter are all deposit feeders. Only four of these species are restricted to mangrove forests. Over 100 species of molluscs are obligate associates of mangrove forests. They belong almost exclusively to just a few families – Potamididae (longbums), Iravadiidae (irivadiid snails), Onchidiidae (mangrove slugs), Ellobiidae (ear snails) and Glauconomidae (glauconome clams).

The largest species of gastropod in the world, the false trumpet snail (*Syrinx aruanus*), lives in Darwin Harbour. The most iconic group of gastropods, the nudibranchs, is relatively poorly represented in Darwin Harbour with only 68 species.

Small molluscs are very abundant in the harbour and form major components of the food for fishes and migratory wading birds. About two-thirds of all the molluscs in Darwin Harbour are smaller than 10 mm when adult.

Nudibranchs such as this *Mexichromis multituberculata* are brightly coloured snails without shells. The colours warn fishes that nudibranchs are distasteful. Other organisms in the background include two types of compound sea squirts (ascidians). Photo: Neil Wright

Mangroves

Darwin Harbour contains large areas of intact mangrove forests. Mangroves are known as moerroerrlma to Larrakia people. These are significant for their extent and for the high diversity of mangrove species. They provide habitat for a large variety of vertebrate and invertebrate species, including several species which are harvested for food. The mangroves of Darwin Harbour provide habitat for a rich mangrove-dependent bird fauna. Flowering mangroves attract nectar feeding birds and bats, which in turn provide pollination for mangroves.

The chestnut rail (*Eulabeornis castaneoventris*) is a shy mangrove-dwelling species sought by bird watchers. Photo: Mat and Cathy Gilfedder

Coastal dolphins

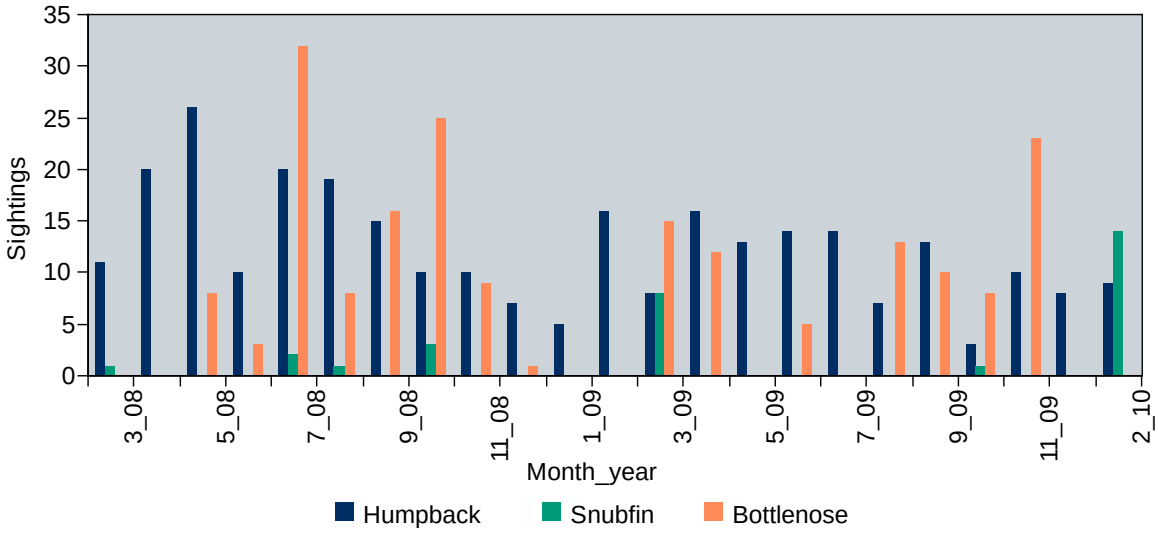
Carol Palmer, Department of Natural Resources, Environment, the Arts and Sport

Twenty six species of whales and dolphins have been recorded from tropical waters in northern Australia. Darwin Harbour is home to three species of dolphin – the Indo-Pacific bottlenose (*Tursiops aduncus*), Indo-Pacific humpback (*Sousa chinensis*) and the Australian snubfin (*Orcaella heinsohni*). The Indo-Pacific humpback is the most frequently sighted dolphin in the Harbour. Current research studies aim to describe how these species use the Harbour environment and how to mitigate possible disturbance from industrial development within the Harbour.

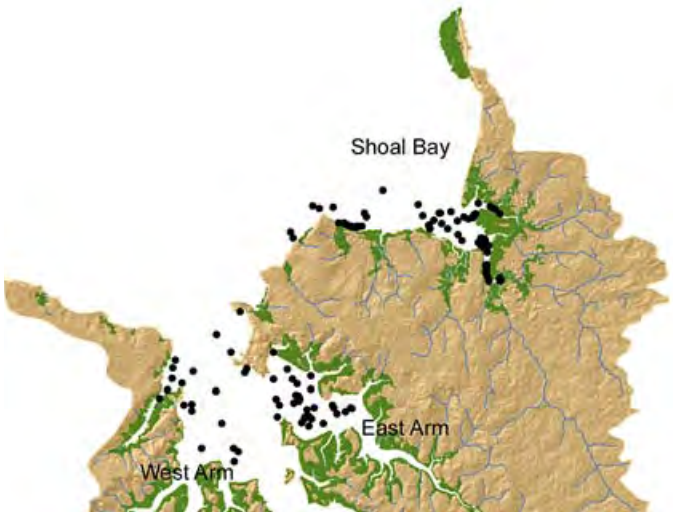
Coastal and river dolphins are among the world's most threatened mammals, primarily because they live in areas that overlap directly with human activities. They occur in discrete and localised populations, and are not known to undertake migrations or large scale movements.

Darwin Harbour is home to three species of coastal dolphins, described above. These three species are the only strictly coastal dolphins occurring in northern Australia.

Research on coastal dolphins in Darwin Harbour has been conducted since 2008. Surveys are designed to reveal spatial and temporal patterns in habitat use within the Harbour and adjacent areas. The Indo-Pacific humpback dolphin is the most commonly sighted dolphin in the harbour and is present all year round.



Number of sightings of three dolphin species in Darwin Harbour in surveys conducted from February 2008 to March 2010.



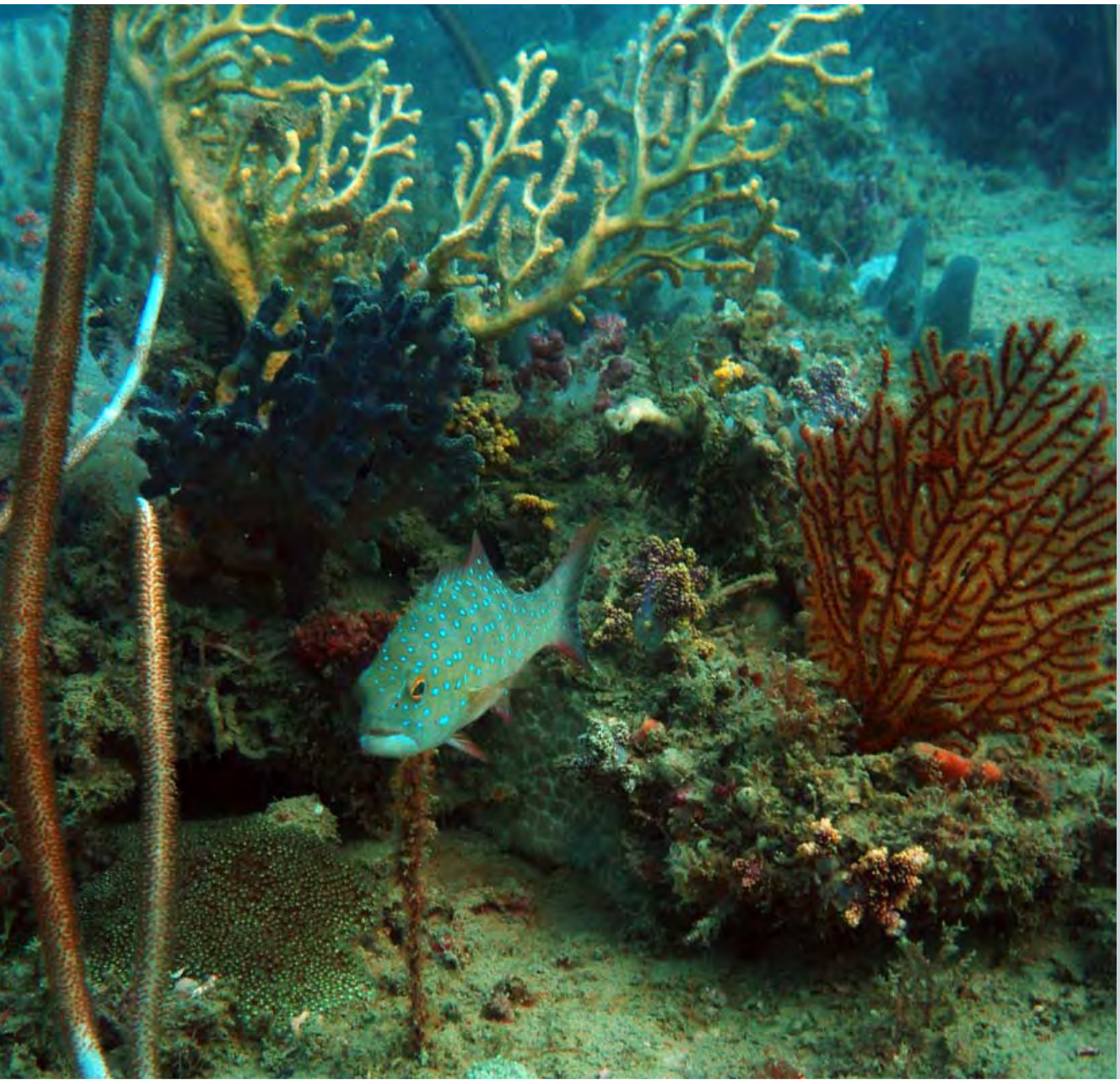
Locations of Indo-Pacific humpback dolphin sightings in Darwin Harbour from March 2008 to February 2010.

The Indo-Pacific humpback dolphin is most frequently recorded on survey transects in East Arm, lower Buffalo Creek (seaward of the boat ramp) and Shoal Bay. If we are to maintain viable populations of coastal dolphins in Darwin Harbour, we need to ensure that their ecological requirements are met and that threats to their persistence are identified and ameliorated.

Dolphins are susceptible to pollutants in coastal waters that are influenced by agriculture and urban development. Pollutants can include persistent organic pollutants (POPs). These are compounds like pesticides and industrial chemicals which can accumulate in predators at the top of the food chain. Exposure to POPs in marine mammals can affect reproduction and immune suppression. In Australian waters, there is currently little information on the effects of pollutants on coastal dolphin species. Tissue samples are being collected as part of a research program.

Indo-Pacific humpback (*Sousa chinensis*).
Photo: Carol Palmer

Other projects and monitoring



So called “sponge garden” habitats occurring in areas of high current movement in Darwin Harbour support over 600 species of molluscs. Comprehensive habitat mapping in many parts of Darwin Harbour remains a priority for research. Photo: Neil Wright

Maiden’s tresses (*Lyngbya majuscula*) resembles masses of long, dark, rather straggly hair. Photo: Neil Wright

Cyanobacteria blooms and algae found on Darwin's beaches

Introduction

Between June and September bacterial counts above guideline levels and presence of a cyanobacteria bloom led to beach closures at several of Darwin's beaches. A bloom of the cyanobacteria maiden's tresses (*Lyngbya majuscula*) occurred in Darwin Harbour in May–June 2010, as in other years. *Lyngbya majuscula* can cause skin irritation in humans and has been associated with pollution in other regions of Australia. Beaches affected included Mindil, Vesteys, Fannie Bay and Casuarina. Beaches were closed to assure public safety. Further investigation to determine linkages between the bloom and *E. coli* levels is continuing in addition to other monitoring to determine other sources of the high bacterial counts.

For further information on water quality at the beaches, see the Darwin Harbour Beaches Report Card. *Lyngbya majuscula* and other cyanobacteria and algae occurring in Darwin Harbour are described in the sections below. These cyanobacteria and algae may be observed as masses or slicks washed up on Darwin's beaches in the dry season.

Maiden's tresses (*Lyngbya majuscula*)

Information on maiden's tresses, sea sawdust and sargassum seaweed supplied by Richard Willan, Museum and Art Gallery of the Northern Territory

Lyngbya majuscula is a naturally occurring cyanobacteria (previously called 'blue-green algae') that has recently been observed in large masses on Darwin's beaches. This attached, colonial bacteria can grow to 150 mm long. Its cells, which have no nuclei, join into long filaments. It resembles a mass of long, dark, rather straggly hair. It can grow prolifically on both hard and soft substrates in shallow water during the wet season. Masses naturally wash ashore in June. It can fix its own nitrogen. Woolly sea hares (*Bursatella leachii*) are one of the few animals that eat maiden's tresses. Woolly sea hares occur in Darwin Harbour and their life cycle reflects the abundance of food. In mid 2007, woolly sea hares were observed to wash up on Casuarina Beach – a natural event.

Maiden's tresses (*Lyngbya majuscula*) was found on many of Darwin's beaches in mid 2010. It can cause a dermatitis reaction in some people. This photo was taken on Casuarina Beach in June 2010. Photo: Julia Fortune

Lyngbya majuscula can produce dermatitis in some people, hence the alternative name of fire weed. However, the true fire weed is a species of stinging hydroid. *Lyngbya majuscula* can contain several toxins that are known to cause dermatitis, eye, nose and throat irritation and respiratory symptoms in some people. Direct contact with *Lyngbya majuscula* should be avoided.

Lyngbya majuscula can reproduce rapidly under conditions such as high water temperatures and increased catchment loads of phosphorus, iron and dissolved organic carbon. These are often associated with land clearing, agriculture, poorly managed development, landscaping and wastewater discharges. However, natural blooms of *Lyngbya majuscula* have been reported in undeveloped areas of the NT coastline. Excessive *Lyngbya majuscula* growth associated with a bloom reduces available light through smothering. Fish-kills may be associated with depletion of oxygen in marine waters.

Sea sawdust (*Trichodesmium* cf. *erythraeum*)

Slicks of this cyanobacteria (previously called ‘blue-green algae’) appear on the sea’s surface. The blooms are also commonly known as “red tides”. These blooms typically occur every year between September and November. These blooms can occur in conditions with a combination of low wind speed, minimal cloud cover and warm water temperatures. Slicks are formed by aggregations of tiny brownish green flakes, each aggregation composed of hairy bundles of bacterial filaments bound together by a transparent membrane (‘tufts’ or ‘puffs’). Slicks caused by sea sawdust can have a strong, rank smell and form dark green scums when they wash ashore, but they are not iridescent like oil slicks. Blooms of some *Trichodesmium* can produce toxins. Large blooms may also have adverse effects on marine life by lowering oxygen concentrations in surface waters.

Slicks caused by sea sawdust (*Trichodesmium* cf. *erythraeum*) are natural occurrences in Darwin Harbour late in the dry season. This photo was taken 1 km west of East Point in Darwin Harbour on 8 November 2008.
Photo: Neil Wright

Sargassum seaweed (*Sargassum flavicans*)

This large seaweed (brown alga) grows to 1 m long. The smooth flexible stems are rounded and the leaves are small, narrow and smooth-edged. The edges of the leaves often have a furry ‘halo’ of microscopic epiphytes. The small round stalked bladders that occur between the leaves buoy up the alga in the water. These bladders cause the entire alga to rise to the surface when it severs from its base, a natural process that takes place in the middle of the dry season, and it washes up in masses on beaches to decay. Come the following wet season, new growth takes place rapidly from the base. Very few creatures eat sargassum seaweed because of unpleasant chemicals in the leaves.

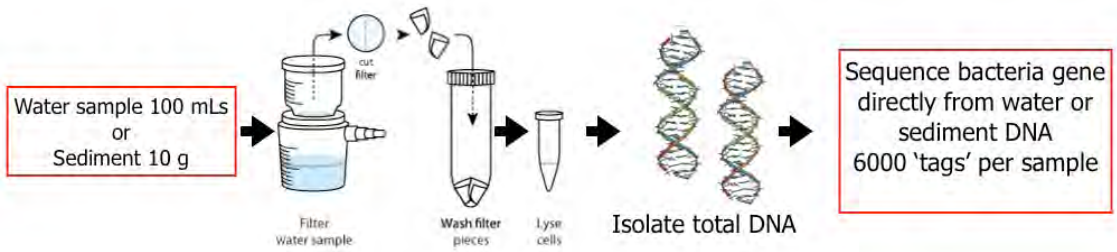
Sargassum seaweed (*Sargassum flavicans*) is naturally buoyed up by tiny air-filled bladders. Clumps wash onto beaches in the middle of the dry season as part of a natural cycle. Photo: Neil Wright

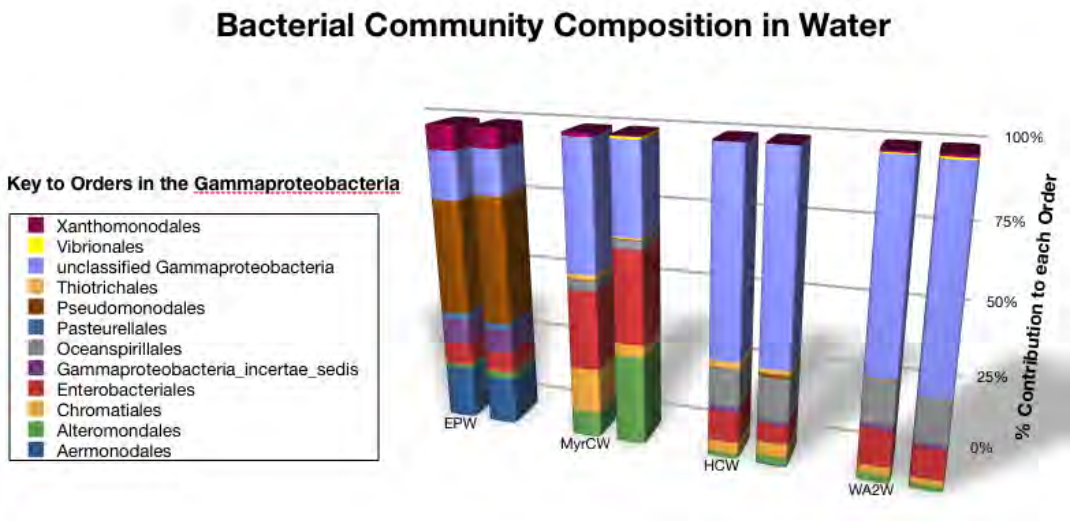
Microbes associated with treated sewage effluent in Darwin Harbour

Karen Gibb and Claire Streten-Joyce, Charles Darwin University

Coastal waters receive a variety of land-based pollutants, including sewage effluent, petroleum wastes, pesticides, heavy metals and sediment runoff. We know little about the natural microbiology of Darwin Harbour or the effects of treated sewage effluent discharges. Baseline information about the composition of the microbe community from clean sites and impacted sites would provide an industry-specific signature that has important implications for long-term monitoring and regulation. It would also highlight potential threats to human and animal health.

Researchers from Charles Darwin University have completed a pilot microbiology study of five sites that receive industrial waste and treated sewage effluent. They extracted DNA from water to identify microbes present. An example of the process is shown.





The graph is an example of the comprehensive microbe analysis that can be done for Darwin Harbour. It shows community composition of a group of bacteria known as the *Gammaproteobacteria.* We chose this group because it was different across study sites but other groups could be analysed in the same way. Each double set of bars is a set of duplicate samples from one site:

EPW = near the East Point treated sewage effluent discharge site;
MyrCW = Myrmidon Creek near the treated sewage effluent discharge site;
HCW = Hudson Creek, an industrial site; and
WA2W = reference site at West Arm.

The graph shows the bacterial community level differences and provides a snapshot of the kinds of microbes found. This approach can be used to provide a thorough inventory of the microbes present. The bacteria from Hudson Creek and West Arm are very similar to each other and many are naturally occurring bacteria.

The East Point and Myrmidon Creek samples were different. The bacteria at East Point are typical of those associated with treated sewage discharge sites world-wide. The group shown in brown was made up of *Azotobacter* which is a typical bacterium associated with sewage that utilises ammonium, so it may be a useful indicator species. At every site members of the *Enterobacteriales* were detected – this group includes *E. coli* and it is present naturally, although elevated at Myrmidon Creek. Other bacteria will be assessed to see whether they might be good sewage discharge indicators.

This work has revealed a lot about the bacteria in Darwin Harbour. This approach provides an opportunity to prepare a comprehensive database of microbes, pathogens and environmental factors. This information will provide information and tools for pollution detection, remediation and surveillance. Until we know what's out there normally, and keep monitoring, we won't know when things go wrong. This approach will lead to the development of simple monitoring tools.

Micropollutants and their potential impact in Darwin Harbour

Australian Institute of Marine Science, Charles Darwin University, Larrakia Nation and Aquatic Health Unit

The term micropollutants refers to low concentrations of organic compounds such as some of the by-products from pharmaceuticals, petroleum compounds and pesticides, which may be present in the aquatic environment.

Many micropollutants have been found to interfere with the normal functioning of the endocrine (hormonal) system in both terrestrial and aquatic organisms, and for this reason are termed 'endocrine disrupting chemicals' (EDCs). Along with the nervous system, the endocrine system regulates responses and functions of the body such as growth and development, stress response and reproduction. Therefore, knowledge of the presence and levels of these compounds in the Darwin Harbour environment is of importance in assessing the overall health of the Harbour as well as effects on aquatic organisms, many of which are valuable food sources in the region.

The detection and quantification of micropollutants may be a useful tool to track the health of the Harbour environment. Presently there is little information for Darwin Harbour on the presence, loads and levels of these compounds, nor of their effects on aquatic organisms. Studies elsewhere have shown that EDCs have adverse impacts on some aquatic organisms.

The Australian Institute of Marine Science (AIMS), together with the NRETAS Aquatic Health Unit and Charles Darwin University (CDU), is carrying out a collaborative project which is identifying and quantifying the presence of a number of EDCs being released into Darwin Harbour at sewage and urban outfall sites. In addition, the bioaccumulation of EDCs is being measured in two species of aquatic mollusc with contrasting feeding strategies. Associated effects on physiological and biochemical functioning will also be investigated as the project progresses.

The results of this study will provide an evaluation of water and sediment quality in relation to levels of micropollutants as well as an assessment of how aquatic biota are being affected by the presence of these micropollutants in Darwin Harbour. These results will add to the existing information on the overall health of the Darwin Harbour ecosystem, and will provide data vital to help make informed decisions regarding the future growth of the region.

Sampling sediment for assessing pollutant content near the Leanyer-Sanderson sewage treatment plant outfall.
Photo: Julia Fortune

Update on major sewerage projects

Power and Water Corporation

Power and Water Corporation holds waste discharge licences (WDLs) under the *Water Act 1992* for sewage treatment plants (STPs) that discharge to Darwin Harbour. These WDLs are issued by the Department of Natural Resources, Environment, The Arts and Sport (NRETAS) and require Power and Water to review compliance against the WDLs and report to NRETAS on an annual basis.

Over the last 12 months Power and Water has completed many activities related to delivery of essential sewerage services. Power and Water is acting on concerns about the health of the Harbour. These are outlined below.

Larrakeyah and Ludmilla

Works are continuing in Darwin city to support the closure of the Larrakeyah ocean outfall by October 2011. The closure of the outfall will stop the discharge of raw sewage to Darwin Harbour. Sewage from Larrakeyah and the central business district (CBD) will be diverted to the Ludmilla STP. The treated effluent will then be discharged via a longer and improved East Point outfall. This will improve dilution and dispersion of the treated effluent.

Diversion works from Larrakeyah to the Ludmilla STP are underway. Some construction in the CBD has occurred over recent months with completion expected in 2011. Construction for the Ludmilla STP upgrade is expected to start later in 2010 and finish in 2011. The Ludmilla STP will then treat the extra sewage from Larrakeyah and the CBD, as well as providing capacity to handle population growth to about 2030. An odour management project is included in the upgrade.

Power and Water is preparing a public environment report (PER) for the upgrade of the Ludmilla STP pipeline which will carry treated effluent from the Ludmilla STP as well as the extension to the outfall. The PER will identify potential environmental risks during construction and operation. It will outline how Power and Water will construct the works and undertake operations without having significant impacts on the environment.

Some of the other work undertaken for the East Point project includes:

- benthic marine life and bathymetric surveys to support the design of an extension to the outfall;
- development of a hydrodynamic model to identify mixing zones (to identify when water quality returns to ambient levels);
- finding the best route for the outfall extension to minimise impacts; and
- a tracer study to support the hydrodynamic model.

Power and Water has also been thinking about the “big picture” to provide sewerage services. To meet this challenge a Darwin Region Sewerage Strategy is being developed to document Power and Water’s vision for sewage treatment and disposal until 2030.

The Darwin Region Sewerage Strategy aims to:

- make sure that treatment plants can handle the increases in sewage and trade waste that come with a quickly growing population and industry base;
- improve performance of treatment and disposal facilities; and
- reduce potential impacts on the environment.

Leanyer Sanderson

Improvement works at Leanyer Sanderson STP that discharges to Buffalo Creek have commenced. In June, a world expert on waste stabilisation ponds visited and provided recommendations to improve pond treatment performance in the short to medium term. A pilot scale trial for an aerated rock filter is being designed to help assess if this technology will work.

A major maintenance project is being planned. Accumulated sludge will be removed from the waste stabilisation ponds. A sludge survey has been undertaken and logistics are being worked through. Some infrastructure within the ponds will also be upgraded. Sludge removal will commence this year and continue over the next few years.

A study to look at ways to upgrade the STP over the longer term has commenced. Options may include:

- effluent recycling in the suburbs to reduce the amount of treated sewage effluent discharged to Buffalo Creek;
- changes to treatment systems to improve the quality of the discharge; and
- investigations into construction of an ocean outfall off Lee Point, avoiding any significant environmental impacts.

Sustainability is a key outcome – a solution that provides value for money, protects human health, minimises environmental damage and considers greenhouse gas emissions and energy consumption is being considered.

Other activities

Power and Water has also been working on other activities. These include:

- a sewer re-lining program (a 20-year project). By re-lining sewers, the amount of stormwater entering sewerage systems in the wet season is reduced;
- in 2008 an external review was conducted on all licensed sewage pond facilities, and some recommendations have been implemented;
- environmental management plans were developed for the majority of the sewage pond facilities in 2008 and are due for review in 2011;
- an in-depth internal condition and performance review of eight STPs in 2009–10; and
- a sludge drying and storage facility has been established at East Arm to enable storage of sludge while reuse options are identified.

Monitoring and research

Power and Water has committed to being involved in the proposed Darwin Harbour integrated monitoring program, along with other stakeholders. Power and Water is also involved in current or proposed research projects including:

- differentiation of *E. coli* of environmental and host origins;
- cyano-survey, a national update on toxic cyanobacteria and their distribution;
- novel biomonitoring tools for water quality (marine sponges);
- microbial monitoring tools for water quality (e.g. see article by K. Gibb); and
- estimates of pathogen health risks with recycled water.

Design of strategies for monitoring specific tidal creeks is being undertaken. The objective will be to gather information on water quality over the cycle of tidal and seasonal conditions, further understanding of how quickly treated effluent discharges are mixed and dispersed. The information will be used to validate hydrodynamic models, and to better understand if there are risks to human health or the environment which require infrastructure improvements.

Dambos – natural sediment traps in Darwin Harbour catchment

Muhammad Nawaz, Charles Darwin University

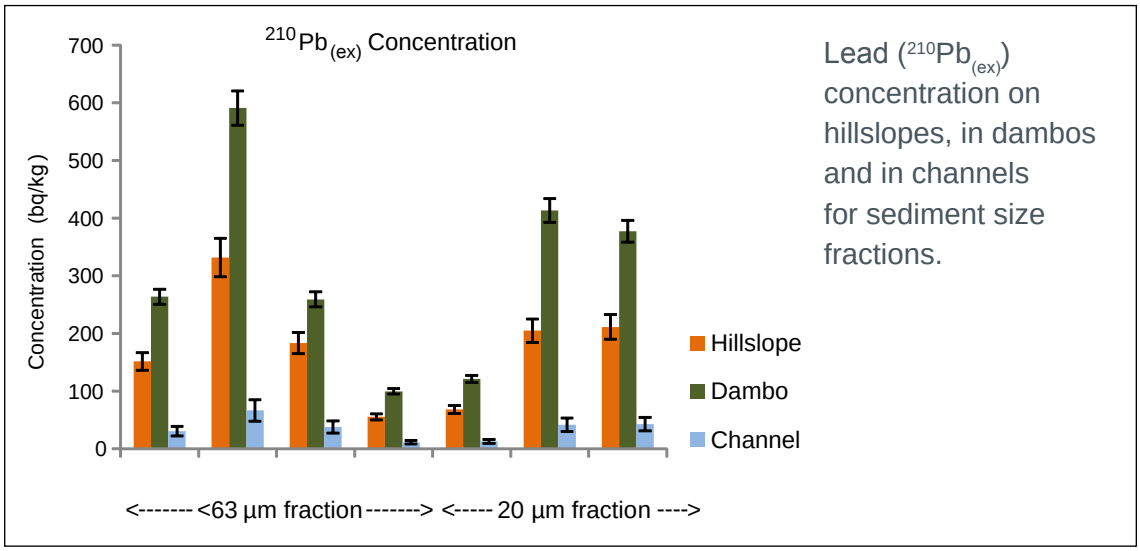
Dambos are shallow, seasonally waterlogged valleys without river channels that provide pathways for water to the sea. Dambos protect the Harbour by trapping organic material and sediment. Dambos are important landscape features.

Topsoil tracer analysis by Charles Darwin University shows that dambos trap up to 80% of fine sediment, organic material, metals and nutrients that may otherwise reach the Harbour. This research shows that sediment transported to the Harbour consists of approximately 80% from channel erosion and approximately 20% from sheet erosion of topsoil from hillslopes.

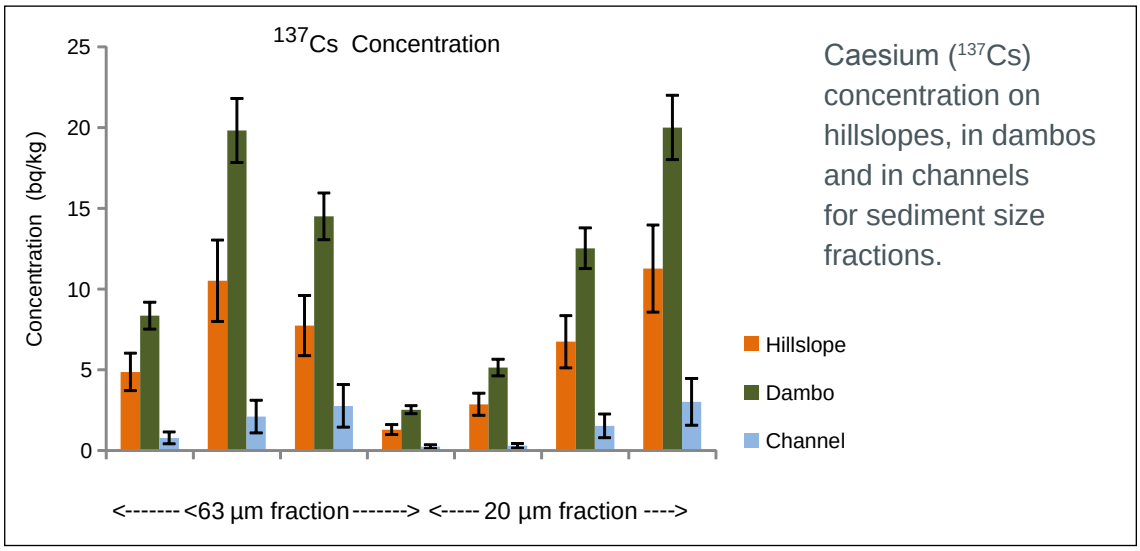
The diagrams show that the concentrations of tracers are on average 1.8 times higher in dambos compared with hillslopes. This shows that approximately 80% of the sediment coming from hillslopes is trapped in dambos and only 20% is passed on to channels. This is an important conclusion.

Dambo conservation should be taken into account when considering development proposals. This is the first time that the dambos have been identified as a geomorphic feature and recognised as natural sediment and pollutant traps in the Darwin Harbour catchment.

Muhammad Nawaz, a PhD student at Charles Darwin University, is researching selected dambos and their trapping efficiency. The mapping of the dambos in the Darwin Harbour catchment is still incomplete, and therefore a knowledge gap.



Lead ($^{210}Pb_{(ex)}$) concentration on hillslopes, in dambos and in channels for sediment size fractions.



Caesium (^{137}Cs) concentration on hillslopes, in dambos and in channels for sediment size fractions.

Chlorophyll *a* mapping

Chlorophyll *a* is a pigment contained in the cells of plants and algae that live in fresh and marine waters. Nutrients associated with catchment-wide and point sources in urban and other waterways can lead to increased algal growth. Chlorophyll *a* is one of the most important indicators of the effects of increased nutrients in water bodies.

Chlorophyll *a* can be measured with a fluorometer. The chlorophyll *a* distribution was determined by recording fluorometer readings and GPS positions while slowly driving a boat across the sample area. Chlorophyll *a* distribution was determined by spatial interpolation from measurements and backed up with samples analysed in a laboratory. The distribution of chlorophyll *a* has been mapped for several estuaries in the Darwin Harbour region during the dry season in 2009 and wet season in 2010. The estuaries were Reichardt Creek, Sadgroves Creek, Bleesers Creek, Buffalo Creek, Myrmidon Creek, Blackmore River and Elizabeth River. Chlorophyll *a* mapping is presented in the Shoal Bay and Buffalo Creek report card and showed the distribution of chlorophyll *a* in the Buffalo Creek estuary.

Water Sensitive Urban Design

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What is Water Sensitive Urban Design?

Water Sensitive Urban Design (WSUD) is a new approach to the planning and design of new development that minimises the impacts of urban cities on creeks, rivers and harbours. Examples of WSUD structures include constructed wetlands, swales and buffers, porous pavement and raingardens. By incorporating WSUD into our city we can:

- protect waterways from the impacts of pollution;
- reduce our water demands and conserve drinking water supplies;
- reduce the amount of wastewater discharged to the Harbour; and
- integrate water into our urban landscapes.

Water Sensitive Urban Design in Darwin

WSUD is a new approach to development in Darwin. The Harbour ultimately receives all stormwater and wastewater from Darwin and Palmerston urban areas. With significant growth forecast for Darwin there is potential for increasing impacts on the Harbour.

Water Sensitive Urban Design Strategy for Darwin Harbour

To address the impacts of development, WSUD will be progressively applied to several new developments in the Darwin Harbour catchment. A WSUD strategy for Darwin Harbour has been developed. The strategy links policy to locally relevant design guidelines as well as on-ground management. As part of this process the new suburb of Bellamack was selected as a showcase for the implementation of WSUD.

Bellamack

A site-specific WSUD strategy has been developed for Bellamack and includes:

- three constructed wetlands plus raingarden treatment systems to reduce stormwater pollutants;
- a recycled water supply system which will supply recycled water for outdoor uses, including irrigation of public and private landscapes;
- water conservation measures within public buildings and public open space; and
- promotion of wise water use within private dwellings and private open space.

These water sensitive urban design features (vegetated swales) are installed in the new suburb of Lyons to treat road runoff from the street. Water flows directly from the gutter (note the gaps in the gutter) to the vegetation and soil. Vegetated swales are suitable for removing sediment and some attached pollutants during small rainfall events. In intense rainfall, stormwater flows into the stormwater system. Photo: Equatica

Three constructed wetlands and raingarden treatment systems are components of WSUD in Bellamack.

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