



# Darwin Harbour

# HEALTH CHECK

Threats to the health of the Harbour and actions needed to safeguard it





Sunset, Nightcliff Jetty. Paul Arnold

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Printing: Printed on 100% recycled paper by IMAGE OFFSET, Darwin.

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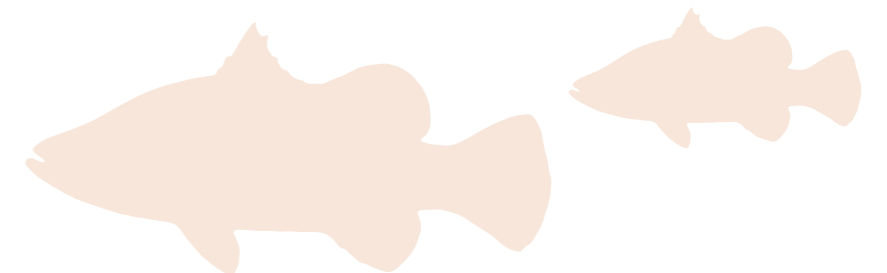
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Darwin Harbour Cruises

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## EXECUTIVE SUMMARY

This report finds that as one of Australia's largest working Harbours adjacent to a major city, sustaining the health of Darwin Harbour is vital to the Territory's future and identity. Despite this, the Harbour has been under increasing pressure from a range of industrial and urban developments for some time. Community concerns about these impacts have spawned many government attempts to safeguard the health of the Harbour but they have lacked strategic oversight, adequate implementation and funding. As a result, successive governments have failed to halt the declining health of the Harbour and protect its environmental, cultural, social and economic values.



The Top End and its capital city Darwin have a unique coastal lifestyle worth protecting. Darwin is surrounded by the waters of the Harbour, providing a beautiful backdrop to the daily lives of locals, a source of recreation and leisure, and providing healthy food in the fish and crabs caught by many fishers and their families. It's a centrepiece for the tourist experience and facilitates the passage of many marine-based industries. The Larrakia people are the Traditional Owners of the Darwin region and for these saltwater people, all aspects of social, cultural, and economic life are intimately connected to their coastal lands and seas.

The Northern Territory's coastal environment, the beauty and the bounty it provides, are at the heart of the Top End way of life, central to economic success and to our shared futures.

The Top End fishing experience - a magnet for tourism - sits at the core of our local livelihoods as one of the Territory's most important economic and cultural pursuits. A recent report<sup>1</sup> found the Territory's coastal waters support more than 6000 jobs and contribute \$2billion annually to the economy. This report finds these jobs are absolutely reliant on the Territory's coasts remaining healthy.

Darwin Harbour is home to a number of nationally threatened species including dugongs, coastal dolphins, sawfish, saltwater crocodiles and three of the world's seven species of marine turtles. This report finds that some of these species are in decline in the Harbour. Despite this and the Harbour's many other ecological and cultural values, only a small number of places in the Harbour have formal protection.

Damaging industrial and urban development within the Harbour's catchment and coastal zone have been of concern to Territorians for many years. Growing pressures on Darwin Harbour include:

- Industrial and urban developments threaten to remove substantial areas of mangroves which moderate water quality and provide essential nursery habitat for juvenile fish species;
- Stormwater, sewage, and industrial outfall continues to contaminate local tributaries, with high loads of sediment and heavy metals;
- Increased shipping activity has raised the Harbour's vulnerability to oil spills, invasive marine pests, and is likely to have contributed to declining populations of marine mammals.



Territorians have observed that things on the water are not as good as they used to be. The toxic oil spill in Darwin Harbour and the Gulf of Carpentaria's massive mangrove die-off sent shockwaves through the community. Many have noticed that fishing - a core part of the Territorian identity - is not as good as it used to be.

This report finds that the history of pollution, degradation and ad-hoc management actions in Darwin Harbour also provides important lessons for how we can better manage and protect Territory coasts in general.

Despite having arguably Australia's most iconic coastline - central to which is Darwin Harbour - and one of the world's last remaining intact tropical marine environments, until recently the Territory lagged behind other jurisdictions for the lack of a sound marine management and conservation strategy.

The Northern Territory Government's draft *Darwin Harbour Strategy 2019* and its new *NT Coastal and Marine Management Strategy* more broadly, provide a clear blueprint for turning these threats around and securing the future of the Harbour. However, action must commence without further delay to manage and protect the cultural, environmental, social and economic values of our Harbour and coasts. The need for action is now a high priority given the major developments that are on the horizon for the Harbour and their potential to significantly impact its health.

The Territory community expects their coastal backyard to be well managed and protected. We must heed the lessons of the past, and urgently put in place the necessary safeguards to ensure our enviable Top End lifestyle is protected for our children and grandchildren.

This report summarises the values of Darwin Harbour, identifies the major threats to these values and sets out recommendations for improved management.

### Recommendations:

1. Implement the *Darwin Harbour Strategy*, taking into account the issues raised in the *Keep Top End Coast Healthy* submission<sup>†</sup>
2. Conduct a Strategic Environmental Assessment of Darwin Harbour, including Middle Arm;
3. Develop an integrated and Harbour-wide Dredge Management Plan, and
4. Implement the *NT Coastal and Marine Management Strategy*, the Territory's first ever plan to safeguard Top End coasts.

## UNIQUE AND SPECIAL Darwin Harbour

### Reefs and beaches

Rocky reefs are more commonly found on the western side of Darwin Harbour, while sandy beaches backed by cliffs and dunes are found to the east. The large tidal range in Darwin Harbour creates turbid waters and sedimentation that usually prevent the growth of corals. However, those in Darwin Harbour have adapted to such conditions, helped by strong currents but also sheltered areas that maintain light availability. At least 123 species of hard corals<sup>2</sup> and 20-25 species of soft corals have been recorded<sup>3</sup> at Channel Island, Wickham Point, Weed Reef, South Shell Island and also Mandorah, East Point Reef, Plater Rock, Stevens Rock and Gunn Point. Darwin Harbour's reefs and intertidal areas also support approximately 250 sponge species<sup>4</sup>.

With such extensive tidal flats and mangrove forests, it is easy to forget that Darwin Harbour also has many sandy beaches at Cullen Bay, Vestey's, Mindil, Little Mindil, Rapid Creek, East Point Reserve, Nightcliff, Lamaroo, Casuarina and Lee Point on the eastern side, and Wagait and Mandorah to the west. These are very popular with Darwin residents and visitors, with Mindil Beach having more than one million visitors each year.

Darwin Harbour's reefs and beaches are used by three threatened species of marine turtles. Monitoring indicates that there could be between 500 and 1000 flatback, hawksbill and green turtles in Darwin Harbour, with their highest densities at East, Lee and Gunn points<sup>5</sup>. Coral and rocky reefs and seagrass meadows are their favoured foraging areas. Adult green turtles eat seagrasses and seaweed, while hawksbill turtles eat sponges, snails, seagrass and seaweed. Flatback turtles feed on soft corals, jellyfish and sea cucumbers and nest at Bare Sand Island and Quail Island, two of the Territory's most important nesting areas<sup>6</sup>, and Casuarina Beach.

### Estuarine waters

Three species of coastal dolphin feed and breed in Darwin Harbour: Australian snubfin, Indo-Pacific bottlenose and Indo-Pacific humpback dolphins. The Harbour also supports a rich fauna of marine reptiles, including turtles, sea snakes and estuarine snakes. Saltwater crocodiles are also found in the Harbour but are actively removed. In 2016-2017, there were 303 crocodiles removed in the Northern Territory<sup>7</sup>, with 81% from Darwin Harbour<sup>8</sup>.

More than 430 fish species have been recorded in Darwin Harbour. A survey by Gomelyuk et al. (2011) found that the most abundant species were northwest threadfin, whipfin ponyfish, fringe fin trevally, stripey snapper and scribbled angelfish<sup>9</sup>. The threatened dwarf sawfish has been found in Buffalo and Rapid creeks, the threatened green sawfish in Buffalo Creek, the only record in the Northern Territory<sup>10</sup>. Barramundi, golden snapper and black jewfish are popular targets of recreational fishers.



Dugong feeding on seagrass. Getty Images



### Tidal flats and mangrove forests

The Harbour's macrotidal range reaches almost eight metres. Between the low and high tide, the volume of water in the Harbour triples<sup>11</sup> and its water surface expands from 660km<sup>2</sup> to 1220km<sup>2</sup><sup>12</sup> flooding extensive tidal flats along 750 kms of shoreline. This macrotidal range exposes extensive tidal flats at low tide where up to 25 migratory shorebirds species<sup>13</sup> can be seen searching for crabs, molluscs and other prey in the mud and sands.

Soft sediments cover 80% of Darwin Harbour's seabed<sup>14</sup> and host more than 3000 marine invertebrate species<sup>15</sup>. Polychaete worms, crustaceans, mussels and snails are the more visible benthic animals found in and on the Harbour seabed, where they play an important role cycling nutrients.

There are around 600 polychaete (marine worm) species<sup>16</sup> living in the Harbour, with 70 of them found in the mangrove forests<sup>17</sup>. They are the prey of migratory shorebirds, fish and tiger prawns, and also aerate and cleanse seabed sediments and consume sand fly midges. The Harbour is home to up to 1096 species of mollusc<sup>18</sup>, including the largest marine snail in the world, the false trumpet snail<sup>19</sup>. Harvesting in the early 1900s severely depleted the pearl oyster beds<sup>20</sup> but baby oyster spats are now hatched at the Darwin Aquaculture Centre on Channel Island.

With one of Australia's richest mangrove systems, the Harbour has been designated a wetland of national significance<sup>21</sup>. There are 27,000 ha of mangrove forests growing around its fringe and they contain three-quarters of Australia's known mangrove species<sup>22</sup>. They provide storm protection, sediment traps and fish nurseries. They include 41<sup>23</sup> of Australia's 50 mangrove species, 40-60 crab species<sup>24</sup>, at least 112 species of birds, mammals and bats<sup>25</sup>, more than 300 invertebrates<sup>26</sup>, 100 molluscs<sup>27</sup> and the juveniles of common recreational fishing targets<sup>28</sup>.

### Seagrass meadows

Seagrass meadows are mostly found in the Shoal Bay area and the entrance to Darwin Harbour near Casuarina Beach, Talc Head, Vestey's Beach and Gunn Point, and further inside the Harbour near East Point. Dugongs feed on seagrass, sea squirts and seaweed at Channel Island in Middle Arm, Casuarina Coastal Reserve, Vestey Beach, Mindil Beach, Fannie Bay, Weed Reef and West Arm. There are somewhere between 180 to 200 dugongs in the Darwin region<sup>29</sup> but their highest densities have been observed in seagrasses off Casuarina Beach and Lee Point<sup>30</sup>.

### Culture

Darwin Harbour is home to the Larrakia people, whose traditional lands and seas stretch from the Cox Peninsula to Gunn Point, up the Adelaide River and down south to Manton Dam. The Larrakia people have lived in the region for at least 60,000 years and there are 120 registered Larrakia sacred sites in the Harbour and its catchment.

Shell middens, artefact scatters, campsites, stone fish traps and gathering places throughout the mangroves show that the Larrakia people have a long connection with the Harbour. Trevally, barramundi, mud crabs, mud whelks, mangrove worms and coastal bush fruits are gathered for food, while crocodiles, turtles, dugong, whales and dolphins have totemic significance. After waiting 37 years for their land claim to be settled, the Larrakia people were granted title to much of the Cox Peninsula in 2016.

Larrakia Rangers are involved in a number of monitoring programs in Darwin Harbour, including those recording the status of coral reefs and migratory shorebirds. The rangers are tracking the movements of one of the world's largest migratory shorebirds, the far eastern curlew, which has suffered a rapid decline in numbers due to loss of habitat along the East Asian-Australian Flyway. It is thought that 75% of the global population spends the summer in Australia, feeding on crabs and shellfish in salt pans and mangroves at low tide and roosting in trees on higher ground during the flood tide. In addition to building their understanding of this critically important species, monitoring on the water allows the rangers 'to be present on country and maintain a connection with Larrakia culture'<sup>31</sup>.

## Recreation and leisure

Most Territorians love the outdoors, have a special connection to their coasts and live on the Harbour's edge in the suburbs of Bayview, Stuart Park, Darwin CBD, Larrakeyah, Fannie Bay, Coconut Grown, Nightcliff, Rapid Creek, Brinkin and Tiwi. In fact 60% of the Territory's population live on the doorstep of the Harbour's 2010 km<sup>2</sup> catchment.

Darwin Harbour is a big recreation hub, with residents visiting the Harbour at least once a week to relax, walk, fish, boat, picnic, birdwatch, swim, scuba dive, canoe and cycle along its beaches, foreshore parks, jetties, wharves, trails, rivers, creeks, mangroves and reefs<sup>32</sup>. The Harbour is the backdrop to the lives of Darwinites; it is well loved and well used.

Recreational fishing is a central element of the Territory lifestyle. During the wet season, fishers commonly target barramundi, while in the dry season golden snapper and black jewfish (reef species), and mackerel and tuna (pelagic species) are popular target species<sup>34</sup>. Territory fishers spend 27% of their annual fishing effort in Darwin Harbour, and another 28% in nearby waters<sup>35</sup>. Fishing is also a major reason to visit for the one million tourists coming to the Greater Darwin region each year<sup>36</sup>.

Scuba diving is another popular recreational activity in Darwin Harbour. Important dive sites include Dudley Bommies for corals and clown fish, and The Ridge, a rock wall covered in soft corals and sponges. Channel Rock is in 12-16 metres of water and known for its hard and soft corals and sponges, stingrays, turtles, barracuda, trevally, baitfish, gropers and sea snakes<sup>37</sup>. The wrecks from WWII, Cyclone Tracy and the Vietnam War are also popular, as well as artificial reefs at Stokes Hill Wharf, Lee Point, Fenton Patches and many other sites.

## Tourism

Darwin Harbour is a beautiful backdrop to the city and a big drawcard for tourists visiting the Northern Territory. Some of Darwin's most popular tourist locations are along the Harbour shoreline and include Stokes Hill Wharf, the Waterfront, the Esplanade and sunsets at Mindil Beach Markets. Hundreds of visitors every day take Harbour cruises throughout the dry season and there is great interest in the sunken wreckage from WWII bombing and Cyclone Tracy.

A number of guided fishing charters are based in Darwin and offer fishing tourism trips in Darwin Harbour and surrounding regions. In 2012, the annual economic contribution of fishing tourism to the Northern Territory was estimated at \$26 million, with 80% of that provided by interstate and overseas visitors<sup>38</sup>.



## Fisheries

Ensuring Darwin Harbour's good health is vital for commercial fishing, recreational fishing, guided fishing and the aquaculture industry.

Two of the Northern Territory's 15 wild catch commercial fisheries, the Coastal Line Fishery and the Aquarium Fish/Display Fishery, operate in Darwin Harbour, although catches are small.

Aquaculture is also a major contributor to the Northern Territory economy. Research and hatchery operations of the Darwin Aquaculture Centre on Channel Island are helping to grow the aquaculture industry and supply important businesses such as Paspaley and Humpty Doo Barramundi. The centre is supporting the barramundi, algal and pearl oyster farming, the culture of sea cucumbers with Traditional Owners on Goulburn Island, and research into giant clam and tropical oyster production techniques for remote Indigenous communities<sup>39</sup>. The centre uses water from Darwin Harbour.

## A working Harbour

Darwin Harbour is an important port and industrial area which acts as a hub for rail, road and air transport. In 2018-2019 the weight of trade through Darwin Port was 2,439,798 tonnes, and it serviced more than 2000 vessel visits<sup>40</sup>. Its importance and use is likely to grow significantly in future for both economic and national interest reasons, with flagged developments including more petrochemical, industrial and port development.

## Conservation

Darwin Harbour provides the habitats for nationally threatened species such as dugongs, coastal dolphins, sawfish, saltwater crocodiles and three species of marine turtles. Despite this and the Harbour's many other ecological and cultural values, only a small number of places have formal protection.

Charles Darwin National Park has undisturbed mangroves and extensive mudflats, shell middens and WWII bunkers. Channel Island is listed on the Register of the National Estate, being the site of a leprosarium (1931-1955) and also mangroves, extensive rocky reefs and corals. Casuarina Coastal Reserve between Rapid Creek and Buffalo Creek protects sandy beaches and dramatic cliffs. Mangroves, coastal vine thicket and a tidal creek with a swampy floodplain are found in Tree Point Conservation Area near Gunn Point in Shoal Bay, while the Shoal Bay Coastal Reserve contains extensive tidal flats, swamps, monsoon vine thicket and many Larrakia shell middens. Most of the mangroves fringing the Harbour are zoned Conservation in the Northern Territory Planning Scheme but this is weaker than legislative protection in conservation reserves.

There are two tiny aquatic life reserves established under fisheries legislation at Doctors Gully and East Point. The 365-hectare reserve at East Point was established in 1993 to protect coral reefs and sponges from collectors and prohibits commercial fishing. All fishing is banned at the 14-hectare reserve at Doctors Gully, which was established in 1992 to support the fish feeding at the Aquascene tourist attraction. Together with the waters in the Channel Island reserve, only 0.004% of Darwin Harbour's waters have been provided some level of protection.

## OUR Harbour's HEALTH AT RISK

Keeping Darwin Harbour healthy is essential if its environmental, cultural, social and economic values are to be maintained for the enjoyment of future generations. However, industrial development within the Harbour's catchment and coastal zone have been of concern to Territorians.

Industry, and successive governments at the federal and territory level, have pushed for port and industrial development. Port expansion on the East Arm, the construction of the Inpex and Darwin LNG (originally owned by Conoco/Phillips and now by Santos) gas plants at Middle Arm, which could be joined by plants to process minerals and methanol (which would dwarf the current scale of industry at Middle Arm), and proposals for the development of West Arm, Glyde Point and Cox Peninsula, are all part of that push.

The outcomes from Darwin's industrialisation have included pollution of Darwin Harbour by oil spills, sewage, sediments, nutrients and toxins; changes in freshwater inflows; invasive marine species; habitat destruction and degradation, and the disturbance of marine animals.

According to the Australian Institute of Marine Sciences, key causes for concern for Darwin Harbour are:

- Point-source discharges of contaminants, nutrients and sediments;
- Treated sewage;
- Land use and management;
- Diffuse contamination of waters by stormwater;
- Native vegetation clearing and reclamation of coastal, catchment and riparian vegetation for development;
- Dredging of Harbour and dumping of dredged spoil, and
- Oil and chemical spill contingency planning and response<sup>41</sup>.

Community concerns about the increasing environmental, cultural, social and economic impacts of urban and industrial development upon such a vitally significant area have spawned many government plans and strategies – water quality strategies, stormwater plans and land development plans – and a relatively large body of research when compared with other parts of the Territory coast where attention is very low or completely absent. These various plans have failed to halt the decline of the Harbour's health and protect its environmental, cultural, social and economic values. A lot now hangs on the successful implementation of the Northern Territory Government's new draft Darwin Harbour Strategy 2019.

This section reviews the threats facing Darwin Harbour and the impacts they will have on the natural, cultural, social and economic benefits it provides the Territory and Territorians.

### Expansion of the East Arm Wharf

Darwin Port is one of the largest in northern Australia, big enough to handle ships up to 80,000 tonnes. In 2018-2019 more than 2200 vessel visits and 2,439,798 tonnes of trade passed through the port. The port encompasses most of Darwin Harbour and is a natural deep-water port – the shipping channel in the middle of the Harbour averages 20-30 metres in depth. It is well placed for access to Asian markets by exporters and importers. Bulk ores and liquids, cattle, containers and cars are loaded and unloaded at East Arm Wharf, more than 70 cruise ships each year dock at Fort Hill Wharf, and the Marine Supply Base supports service vessels travelling to and from offshore oil and gas platforms.

The East Arm Wharf expansion project includes the Marine Supply Base, a rail loop, and the dredging of almost one million cubic metres of estuarine sediments and their disposal within the wharf precinct. During the expansion, land cleared for reclamation bunds suffered from sediment run off, and reclamation decant water flowed into the Harbour<sup>42</sup>.

Future construction of the rail loop could involve the clearing of at least 74 hectares of mangroves, while dredging plans risk the sponge gardens of South Shell Island. The rail loop and dredging plans were criticised by the Northern Territory's Department of Environment and Natural Resources (DENR) when submitting to the project's draft Environmental Impact Statement: 'It may be true in a broad regional scale that 74 hectares is not a great deal but in a local context, these mangroves may be critical in assisting in achieving local water quality objectives for this part of the Harbour'<sup>43</sup>.

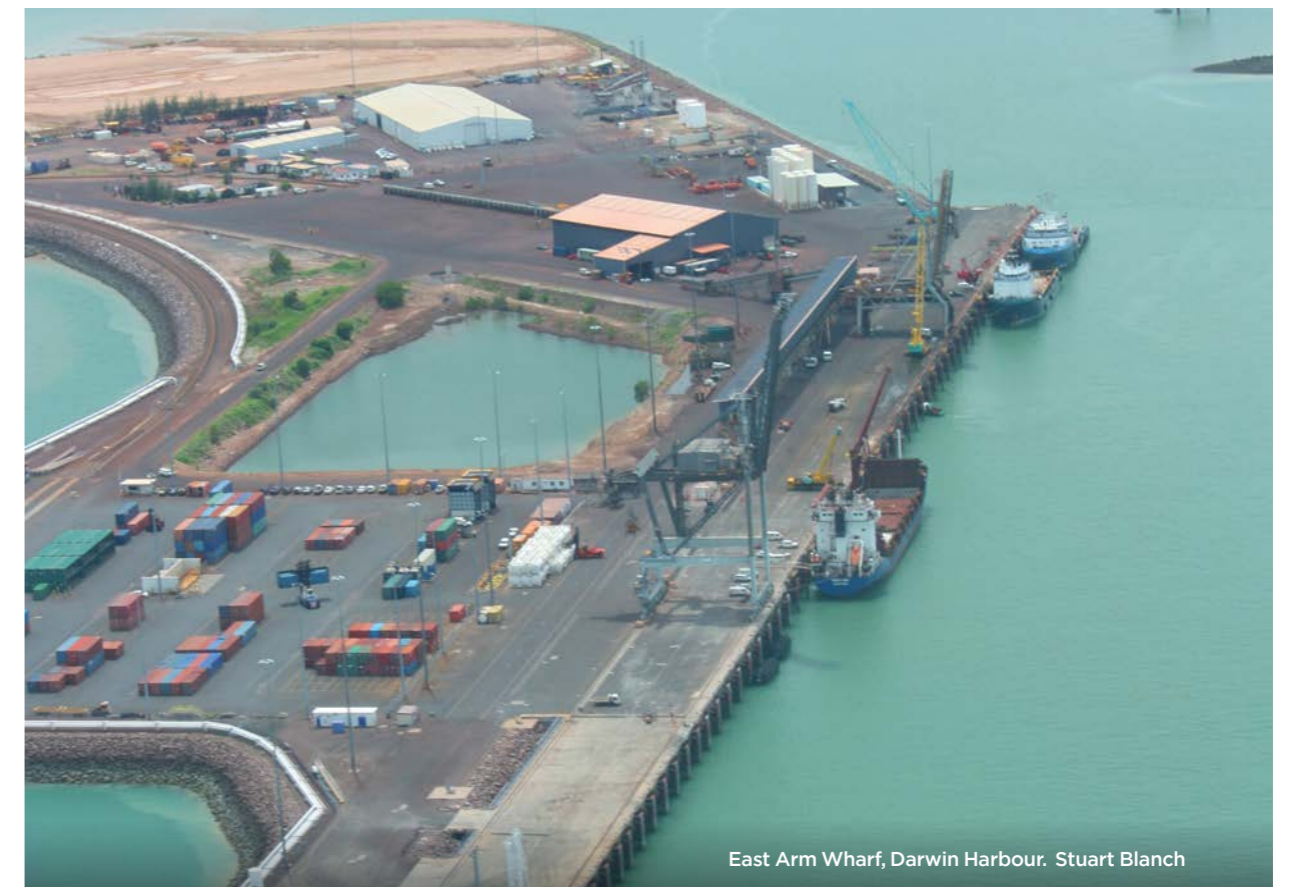
South Shell Island near East Arm Wharf has 'the highest diversity of sponges and soft corals in Darwin Harbour and almost the entire diversity of sponges in the Harbour'<sup>44</sup>. DENR was concerned that the dredging program would severely impact this biodiversity hotspot and feeding ground for dugong: 'Dugongs are known to feed on the sponge gardens beside South Shell Island'<sup>45</sup> and 'dredging and constructing through the sponge beds and coral communities will cause a clear, direct loss of sensitive, highly biodiverse and important habitat, and should be avoided at all reasonable costs'<sup>46</sup>.

The final dredging plan realigned the channel away from South Shell Island. However, the response from the Department of Lands and Planning (the expansion project's proponent on behalf of the Darwin Port Corporation and the Chief Minister's Department) to the DENR comment about dugong feeding revealed that the proponent was unwilling to accept advice it dismissed as 'anecdotal', despite the expertise of the reviewer: 'The Proponent remains unaware of recorded dugong feeding on the South Shell Island coral and sponge community in the published literature. It is considered likely that the reviewer's statement is based upon anecdotal evidence'<sup>47</sup>.

### Dredging in the Harbour

Dredging is a key feature of industrial development in Darwin Harbour. Almost 16 million cubic metres were dredged for Inpex's Ichthys gas plant between 2012 and 2014 to allow large tankers to access Blaydin Point. The dredged sediments were dumped 12 kms off Lee Point. The East Arm Wharf expansion project dredged almost one million cubic metres, maintenance dredging of up to 1.5m cubic metres over five years from 2018 has been approved, and ongoing Harbour dredging operations remove 50,000 cubic metres each year<sup>48</sup>.

Dredging can lead to changes in the composition of benthic animals and plants, changed behaviours in fish, loss of habitat and water pollution. Modelling by Fernando Andutta and colleagues from the University of New South Wales and the Australian Institute of Marine Sciences in 2014 showed that dredging disturbs sand and mud habitats and places sediments in suspension. This can change the shape of the seabed, smother mangroves and seagrass, and dumping pollutants. According to Andutta et al (2014) 'In the future, DH [Darwin Harbour] is likely to accumulate polluted sediment' and lead to 'similar conditions to many European estuaries, where pollutant sediment has been found to be buried since the industrial revolution'<sup>49</sup>.



East Arm Wharf, Darwin Harbour. Stuart Blanch

They concluded that the 'trapping of polluted sediment within mangrove areas combined with increased suspended sediment concentration in the estuarine waters would negatively impact marine species. Additionally, if sediment pollution affects the mud crabs and many other local marine species that are responsible for local bioturbation, trapping of polluted sediment would increase further'<sup>50</sup>.

### Middle Arm industrial development

For many years Darwin's industrial and urban development was concentrated on the north-eastern side of the Harbour in Darwin city, Palmerston and Winnellie, satellite industrial estates servicing the East Arm Port at Hudson Creek, and in Berrimah and Pinelands. According to the draft Darwin Harbour Strategy 2019, the Harbour and its catchment are considered to be in an early development phase with approximately 30% of its land currently developed<sup>51</sup>. Industrial development has been spreading south along Darwin Harbour's shoreline. The clearing of 88 hectares of native vegetation at Wickham Point for the Darwin LNG plant, and the development of the Inpex Ichthys gas plant at Blaydin Point, began the process. This expansion is part of the Northern Territory Government's 600 hectare Middle Arm Industrial Precinct (i.e. equivalent to 350 times the playing surface of the Melbourne Cricket Ground<sup>52</sup>) for oil, gas, and chemical and mineral processing plants.

The Darwin and Ichthys LNG plants could soon be joined by a TNG plant that will process magnetite railed in from the company's Mount Peake mine, 1400 kilometres south of Darwin, and a Coogee plant that will convert gas to methanol. *The Darwin Region Land Use Plan 2015* has also earmarked West Arm for strategic industry that could include a sea port, ferry terminal and rail connection, as well as the Cox Peninsula.

The TNG magnetite processing plant proposes to use an outfall to discharge 12 gigalitres per year of treated process water into the Elizabeth River. The company claims that the tidal processes in East Arm will adequately dilute the waste discharged from its outfall<sup>53</sup>. But according to Williams et al (2006), 'Darwin Harbour is poorly flushed, especially in the dry season when the residence time in the upper reaches is of the order of 20 days'<sup>54</sup>. This is because of the 'complex bathymetry of headlands and embayments generate complex currents comprising jets, eddies, and stagnation zones that can trap pollutants inshore'<sup>55</sup>. In conclusion, the scientists warn that the 'environment in Darwin Harbour has the potential to degrade and the water circulation in the Harbour must be considered when planning developments'<sup>56</sup>.

There are concerns that the discharges could cause metal contamination of recreational fishing areas and traditional gathering sites, and pollute the clean waters required for the Darwin Aquaculture Centre on Channel Island, and its associated producers Paspaley Pearls and Humpty Doo Barramundi. Construction of the plant would also involve the clearing eucalypt and melaleuca woodlands deemed in 'very good' and 'excellent' condition by the TNG Environmental Impact Statement, as well as some riparian vegetation, large habitat trees, threatened plants and mangroves<sup>57</sup>. In the TNG statement, emphasis is placed on the disturbed and degraded nature of vegetation and its presence elsewhere in Darwin Harbour region to justify the clearance. This form of argument is also seen in other development proposals for Darwin Harbour and its catchment. But as DENR commented with regard to the potential loss of 74 hectares of mangroves at East Arm Wharf, local vegetation communities are important for ecology and biodiversity at the local scale.

### Air pollution around Darwin Harbour

Land-based industrial operations around Darwin Harbour can also lead to local air pollution. In September 2018, Inpex's Ichthys plant released into the air PFAS (per-fluoroalkyl and poly-fluoroalkyl substance), which is used in fire-fighting exercises<sup>58</sup>. A federal environment department investigation concluded that the release risked harm to dugongs, dolphins and turtles<sup>59</sup> and the company was fined the following year. It is one incident of many that have plagued the Ichthys plant's operation including: three dredge spoil spills/leaks additional to the two they infringed on; two oil spills; and vessels twice entering restricted heritage zones. The company also exceeded its effluent limits on four occasions in 2018-2019. None of these incidents were followed up by the federal environment department.

PFAS contamination led the Northern Territory Government to advise that people should limit their consumption of shellfish to just three times per week<sup>60</sup>.

### Urban development in the Darwin region

Land reclamation in Darwin Harbour has often been given the official go-ahead but it can also occur illegally. Between 2016 and 2018, thousands of cubic metres of construction waste were dumped illegally on freehold and Crown land next to the now-closed Navy fuel tank depot near Stokes Hill Wharf, an area where groundwater is already contaminated by PFAS<sup>61</sup> and a theme park and hotel are proposed. The NT EPA when laying charges against the company allegedly responsible said the 'disposal and burial of these wastes raised the levels of the land, covered foreshore habitat, and filled a large area of Darwin Harbour with wastes and contaminants'<sup>62</sup>.

The Larrakia Development Corporation chief executive Nigel Browne said the entire site was important to the Larrakia. 'It's one of the last remaining [sacred] sites on this side of the Harbour ... Larrakia people, Larrakia land has been the most affected [compared to other traditional custodian groups] by urban encroachment over the last century and a bit.'<sup>63</sup>

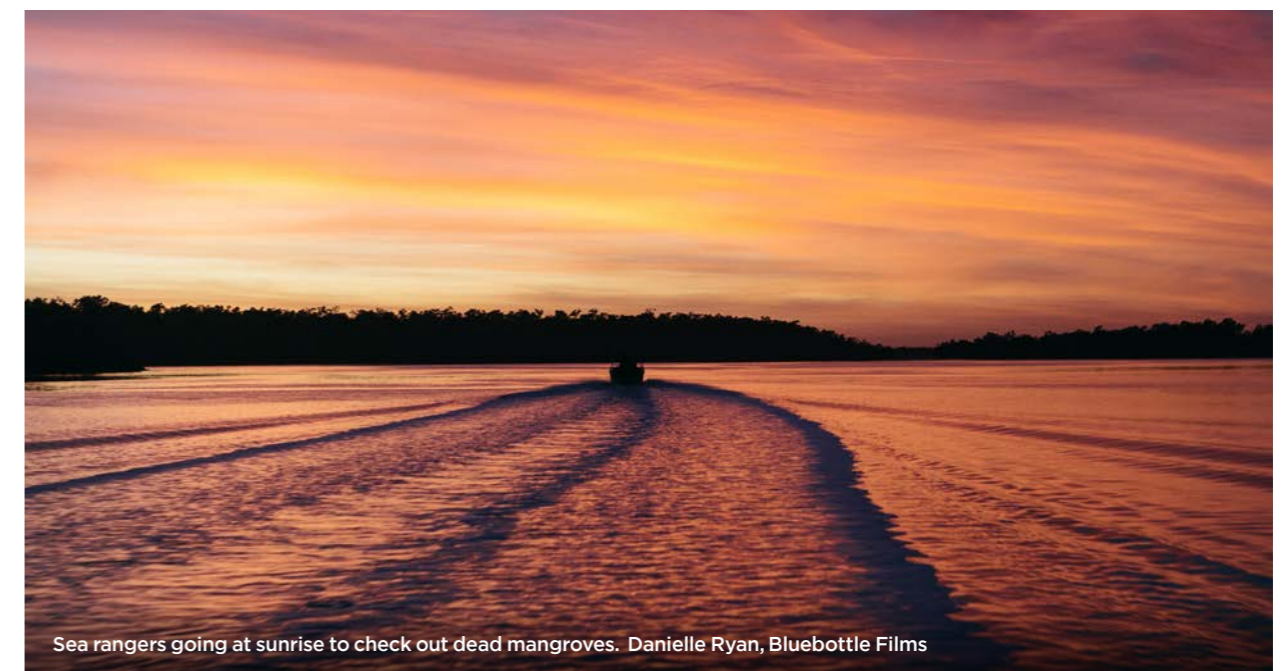
### Clearing the Harbour's mangrove forests

Mangrove forest line Darwin Harbour's edge and provide storm protection, sediment traps, nurseries for fish and habitat for mud crabs. About 400 hectares of the Harbour's mangroves have been cleared or buried for residential, industrial, marina and port development, and tidal flats drained. The Bayview marina and housing project developed in the 1990s at Sadgroves Creek cleared 103ha of mangroves<sup>64</sup>, with waterlogging and smothering killing more mangroves along the development's edge.

A study of mangroves in Darwin Harbour reported that the disturbance of mangroves at the East Arm Wharf 'ranged from complete habitat destruction in reclaimed areas to major changes in hinterland drainage, and alterations to tidal flows from the construction of bund walls and the wharf'<sup>65</sup>.

Increased sediment flows after catchment land clearance can also reduce water quality and oxygen levels in mangroves, and alter the Harbour's water movements and sediment transport. Scientist Jennifer Atchison from the University of Wollongong observed in 2019 that 'Darwin's mangroves are characterised as highly biodiverse and near pristine but are undergoing rapid change as they face numerous impacts including legalised clearing for heavy industry and residential housing development, illegal clearing, alteration to hydrological function, pollution, and dredging'<sup>66</sup>.

As the catchment is developed, an increase in runoff will bring more sediments, nutrients and metals down into the Harbour to accumulate in the mangrove forests. Increased freshwater flows could change the composition of mangrove forests and alter their ability to provide the many valuable ecosystem services they provide. It is also unknown 'how long the metals remain adsorbed to the mangrove sediments, whether they are available for uptake by flora and fauna, whether the metals accumulate, or whether contaminated sediments are transported to other parts of the Harbour'<sup>67</sup>.



Sea rangers going at sunrise to check out dead mangroves. Danielle Ryan, Bluebottle Films

According to scientist Neils Munksgaard and his co-authors from Charles Darwin University, DENR and EcoScience NT: 'The future health of Darwin Harbour depends substantially on the protection of the mangrove estate against further pressures from coastal land clearing, catchment derived pollutants and accelerated sedimentation from runoff and dredging<sup>68</sup>.

The Harbour's mangroves, already suffering from clearing, pollution and sedimentation, now face continuous encroachment from the sea. Sea levels in Darwin Harbour are rising at an average of 8 mm per year<sup>69</sup>, much faster than other parts of Australia. This accelerated rise is exceeding the rate that sediments can accumulate on the seaward edge, preventing mangroves from expanding seaward. Yet, as Charles Darwin University researcher, Madeline Goddard notes, they cannot move inland, as the land behind the mangroves becomes urbanised and industrialised. It has become 'a race, and if the rate in sea level rise increases faster than the mangroves can keep pace, then they could drown<sup>70</sup>, as could turtle nesting sites at places like Casuarina Beach.

In 2003 the NT Planning Scheme established a conservation zone in Darwin Harbour that included 26,200 hectares of mangroves and areas of tidal flats. Any changes to the zone require ministerial approval after consultation but this is not as strong as legislative protection in a reserved area.



### Darwin Harbour water pollution

According to the Northern Territory Environment Protection Authority's 2014 stormwater strategy for the Darwin Harbour region, 'Darwin Harbour is not pristine. Our history of early European exploitation, periods of large anthropogenic disturbance and more recent modifications have caused long-term impacts, with the potential for permanent change. Those changes include the beginnings of deterioration in the Harbour's water quality. Zones of long term nutrient elevation and temporary blooms of algae and bacteria are evident, particularly in the less well flushed upper reaches of the Harbour. Stormwater runoff is a major contributor of sediment, nutrients and toxicants to pollution of the Harbour. Sediment flow to the Harbour are estimated to have more than doubled since European colonisation<sup>71</sup>.

Any reduction in vegetation cover due to increased urban and industrial development in the catchment increases the area of hard surfaces and increases the volume and speed of runoff and stormwater, collecting contaminants along the way. Land clearance in Darwin Harbour catchment has already removed 19% or 46,000 hectares of prior vegetation cover and continues to do so at the rate of an average 460 hectares per year<sup>72</sup>. Of this, approximately 6846 hectares of severely waterlogged riparian and other areas have been cleared for urban, industrial and rural development<sup>73</sup>, reducing habitats available for aquatic wildlife.

Not only has the expansion of Darwin's urban and industrial areas removed habitats, but it's also generated stormwater, sewage and other wastes that find their way into Darwin Harbour through numerous outlets, outfalls and wastewater treatment plants that discharge into tidal creeks. Water pollution has also been caused by contamination from live-export activities, mineral exports, and brine and saltwater discharge from LNG facilities, as well as WWII shipwrecks, past lead exports from Fort Hill Wharf, and TBT from vessel cleaning at the former slip-way and the old power station site<sup>74</sup>.

The *Water Sensitive Urban Design Strategy in 2009* reported that: 'Wastewater discharges are resulting in localised degradation within the estuarine tributaries of the Harbour and during the wet season, stormwater runoff from urban areas is resulting in high loads of sediments, nutrients and heavy metals entering local waterways<sup>75</sup>.

A study by French et al. (2015) identified sewage waste as the main source of microcontaminants in Darwin Harbour. Microcontaminants include pharmaceuticals and personal care products, hormones, pesticides, herbicides and metals, and DEET in insect repellents, which are appearing in a higher measured concentration range than have been reported previously<sup>76</sup>.

Ludmilla Creek receives sewage overflows (from the Ludmilla Wastewater Treatment Plant when its capacity is exceeded), stormwater and runoff from residential and industrial areas. The closure of the Larrakeyah waste treatment plant in 2012 saw its wastes diverted to an upgraded Ludmilla plant, which discharges treated waste into Darwin Harbour at the East Point outfall. This same outfall in 2019 was the source of a 'black and pretty evil-looking<sup>77</sup> plume that spread across the East Point Aquatic Life Reserve where people fish for barramundi and collect shellfish<sup>78</sup>.

Sewage leaks are common in the Darwin sewerage system operated by the Power and Water Corporation. From 1 January to 15 July 2019 there were 19 incidents involving sewage discharges from the corporation's network in the Darwin area<sup>79</sup>. Some of these resulted in discharges to local creeks or into the stormwater system. For example, after a monsoonal storm on 4 February 2019, sewage discharges flowed into Rapid and Ludmilla creeks.

Skinner et al. (2009) modelled the pollutant loads for Darwin Harbour in 2009, assuming the full development of Middle Arm between the estuaries of the Elizabeth and Blackmore estuaries. They found that nitrogen and phosphorus measurements were, respectively, 3 and 12 fold higher from urban areas than for rural or undisturbed areas. Sediment coefficients were 8 fold higher, while urban metal loads were more than 10 fold higher for lead, zinc and copper, and 3-7 fold higher for the other metals when compared to non-urban values<sup>80</sup>.

Their modelling also showed that: 'The cumulative effect of all proposed future developments, based on an average rainfall year, could result in total nitrogen and phosphorus loads increasing by 37% and 67% respectively, and total and volatile suspended solid loads increasing by 60% and 52% respectively. The projected annual metal loads could result in increases which range from 31% for cadmium and 36% for nickel through to 107% for lead<sup>80</sup>.

The scientists concluded that 'water sensitive urban design, the implementation of stormwater codes of practice for various industry sectors, water reuse, recycling and other management actions can combine to reduce this otherwise predicted load to Darwin Harbour<sup>81</sup>. Since then a number of water sensitive urban design projects have been developed for Johnston (Palmerston), Weddell<sup>82</sup> and Bellamack<sup>83</sup>. The Bellamack project included three constructed wetlands to reduce stormwater pollutants, a recycled water supply system, water conservation measures and the promotion of wise water use<sup>84</sup>.

Rainfall in the Winnellie Industrial Area runs off into Reichhardt Creek, and was found by Welch et al. (2008) to contain 'significantly higher levels of heavy metals, markedly copper, zinc and lead, than water from less disturbed catchments<sup>85</sup>. The study for DENR's Aquatic Health Unit also found that 'heavy metals are accumulating in mangrove muds exposed to urban and industrial run-off. The mangrove sediments seem to be acting as a sink for metals from urban runoff<sup>86</sup>.

Bacteria spikes in the 2011 wet season forced the closure of the Casuarina, Lee Point and Rapid Creek beaches<sup>87</sup>. The main cause of the spikes was the discharges from the Larrakeyah (closed in 2012) and Ludmilla waste treatment plants, the Botanic Gardens drain and Rapid, Vestey's and Little Mindil tidal creeks. Vestey's Beach, for example, has many stormwater outlets fed by roads in nearby housing, recreational and commercial/industrial areas<sup>88</sup>.

The Darwin region's projected population growth will see pollutant output increase at a similar rate of 2% per year and, according to the Territory's EPA, a 'significant increase in pollutant load to the Harbour will occur unless steps are taken to eliminate, reduce, reuse and recycle the wastes that our homes and industry produce<sup>89</sup>.

Shipping operations can also pollute Darwin Harbour. In 2016 there was a 30 kilometre oil spill in the Harbour that was later found to have come from the cargo ship *Antung* as it left the East Arm Wharf. The oil spread to Blaydin Point, Hudson Creek, Emery Point and Larrakeyah, impacting mangroves, intertidal mud flats and coastal areas, the habitat for marine turtles, spawning fish, mud crabs and the critically endangered far eastern curlew<sup>90</sup>.

Polluting hydrocarbons can also find their way into sediments from stormwater, fuel storage areas and refuelling stations. In one study, Kitchener Bay, Fort Hill Wharf and Iron Ore Wharf were found to have the highest concentrations of petroleum hydrocarbons, while TBT (tributyltin, a toxic chemical in anti-fouling paints used on boats) levels were detectable across the Harbour but highest at Fort Hill Wharf due to the large number of ships that have docked there<sup>91</sup>.



### Introduced marine pests

Darwin Port has a heightened vulnerability to invasive marine species due to its proximity to Asia, its status as the first port of call for many small craft arriving in Australia, and an increasing number of shipping movements. In 1999, during a survey of invasive marine species in Darwin Harbour, divers found more than 23,000 South American black-striped mussels on 'floating pontoons, concrete piles, retaining walls, ship's hulls and mooring ropes inside Cullen Bay Marina'<sup>92</sup> and smaller infestations in Tipperary Waters and Frances Bay marinas. The pest likely arrived on the hull of a recreational boat visiting from overseas.

Dense mats of this invasive species on the seabed can reduce the diversity of native fauna and pose a threat to shipping, recreational boating and aquaculture. Addressing the new arrival also had severe local consequences for existing native life. The three marinas were quarantined, the entrances closed and tonnes of sodium hydrochlorite and copper sulphate dumped inside, eradicating the mussels but there 'was also considerable, but not complete, mortality of other marine life' in the marinas<sup>93</sup>.

Invasive marine species can also be carried in the ballast water of large ships. Although this is yet to occur in Darwin Harbour, the risk will increase as Darwin Port is expanded and existing and new industrial processing plants generate more visits by large ships.

### Cultural impact

The Larrakia people of the Darwin region were finally granted their Kenbi land claim in 2016 after 37 years. Under the settlement, 52,000 hectares on the Cox Peninsula becomes Aboriginal land, with another 13,000 hectares on the peninsula and parcels of land in Darwin granted as freehold.

The *Darwin Regional Land Use Plan 2015*, which was released prior to the settlement of the claim, mapped out development of the Cox Peninsula: 'The regional plan anticipates long term development for a range of urban purposes including residential and associated community facilities and services, and commercial and industrial uses on the northern half of Cox Peninsula'<sup>94</sup>. It also saw 'opportunities for deep water ports and associated strategic industry development on Cox Peninsula' and indicated that a 'feature of the northern and western parts of the peninsula, rare in the Darwin region, is a coast largely free from mangroves and other coastal wetlands. This feature can contribute to environmentally attractive urban areas with high amenity for residents and visitors'<sup>95</sup>.

In 2018, Australian Venture Consultants released the *Northern Territory Marine Science End User Knowledge Needs Analysis*, a comprehensive review of the marine issues for the Territory and the information needed to resolve them. The North Australian Indigenous Land and Sea Management Alliance submission to the consultants identified Larrakia concerns about urban development in the Darwin Harbour region:

- 'In Darwin, increasing urbanisation has led to a corresponding alienation from country and limits on customary access to country. The ability of Traditional Owners to access and use country for customary purposes is increasingly constrained by urbanisation. Examples cited by respondents included overuse, foreshore closures and pollution of local creeks and Darwin Harbour constraining access to and/or edibility of bush tucker. Respondents stressed how difficult it was to manage land and sea in an urban centre.
- "We can't even swim or fish in Rapid Creek now because it's polluted." (Darwin, Larrakia respondent).
- 'Increases in traffic in Darwin Harbour as a result of port development has led to pollution from spills and bilge toxins leading to calls for a marine sanctuary to be established in the Harbour and independent monitoring of the Harbour health.
- "They are poisoning our water and we don't have a say." (Darwin, Larrakia respondent)<sup>96</sup>.

The Australian Venture Consultants' needs analysis also identified a number of concerns held by Indigenous people in Darwin Harbour and other regions that included:

- 'Port development and operations, commercial fishing activity, increased and unregulated vessel traffic, defence operations and marine noise (including seismic noise) is placing adverse pressure on marine mammal populations, principally because of dredge spoil and footprint, boat strike, pollution generally and as by-catch'<sup>97</sup>;
- 'Over-harvest and failure to observe size and other restrictions may be influencing the abundances of giant mud crabs and orange mud crabs'<sup>98</sup>;
- 'Aspects of the benthic topography in Darwin Harbour also have important cultural heritage significance. There is concern that changing sea-levels associated with climate change and the impacts of development are altering the benthic environment and topography in Darwin Harbour'<sup>99</sup>;

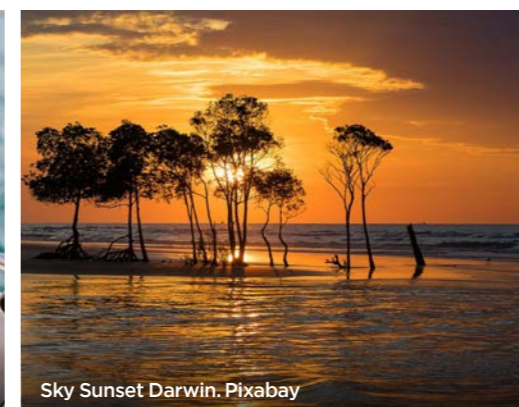
- 'Ongoing loss of ecosystem services and cultural values from the Northern Territory marine environment is a result of limited participation of Aboriginal people in decisions pertaining to the marine conservation estate'<sup>100</sup>;
- 'Unauthorised access to Aboriginal waters and lands from commercial, recreational and/or fishing tourism operators results in gross offence, loss of trust and confidence in management authorities and fishers and an unwillingness to grant further access. Furthermore, it can result in damage and other violations of sacred sites, other illegal activity such as taking of wildlife or discarding fishing gear and further conflicts between interests in the fishery'<sup>101</sup>.

### The disappearing dolphins

Small numbers of Australian snubfin, Indo-Pacific bottlenose and Australian humpback dolphins feed and breed in Darwin Harbour but their numbers are in decline. Research by Carol Palmer from DENR revealed that the humpback dolphin numbers dropped from 88 in 2011 to 50 in 2017, while the bottlenose dolphin population dropped from 28 in 2011 to 23 in 2016 (none were found in 2017) and the snubfin dolphin population dropped from 32 in 2011 to 24 in 2017<sup>102</sup>. The possible reasons for the decline include increasing underwater noise, fewer prey animals, increased water temperatures due to climate change, habitat loss, commercial and recreational fisheries and boat strikes<sup>103</sup>.



Image: Helen Orr



Sky Sunset Darwin. Pixabay



Walker St Beach Nightcliff Darwin. Glenn Walker



Nicholas Gouldhurst

## SAFEGUARDING Darwin Harbour AND OUR TOP END COASTS

In the past two decades there have been many isolated strategies for Darwin Harbour that have lacked direction from an overarching plan. These have covered stormwater, water quality, dredging, port development, migratory birds, water sensitive urban design, and integrated monitoring and research. But without an overarching Harbour-wide plan, adequate funding and implementation, these plans will fail to safeguard the health of Darwin Harbour.

The history of pollution, degradation and ad-hoc management actions in Darwin Harbour also provides important lessons for how we can better manage and protect Territory coasts. The Northern Territory has lagged far behind all other Australian states with its glaring lack of marine conservation and management, until recently when the Territory's first ever plan for the coasts, *NT Coastal and Marine Management Strategy*, was released.

This plan sets the course for the management and protection of the Northern Territory's coastal and marine environments over the next 10 years. It commits to safeguarding Top End coasts and seas, ensuring they are healthy and productive, their cultural significance is recognised, and that they continue to support the Territory's unique lifestyle and livelihoods on the water.

Now is our chance, as a community of proud Territorians, to shape the future for our coasts, lifestyle and economy.

We have a Plan and now it's time to put it into action. We must provide Territory style solutions like Sea Country Indigenous Protected Areas, recreational fishing opportunities, and more marine parks like Limmen Bight that deliver jobs for tourism and Indigenous Rangers. Importantly, our tropical rivers must continue to flow and support our fishing lifestyle to help sustain our regional economies.

It's time to put the Plan for our coasts into action, to help recover our Top End economy and safeguard our fishing, culture and lifestyle.

### To safeguard Darwin Harbour and our Top End coasts it is recommended to:

1. Implement the Darwin Harbour Strategy, taking into account the issues raised in the Keep Top End Coast Healthy submission<sup>†</sup>;
2. Conduct a Strategic Environmental Assessment of Darwin Harbour, including Middle Arm;
3. Develop an integrated and Harbour-wide Dredge Management Plan, and
4. Implement the NT Coastal and Marine Management Strategy, the Territory's first ever plan to safeguard Top End coasts.

Sunrise over Rocky Bay Nightcliff Darwin. Glenn Walker

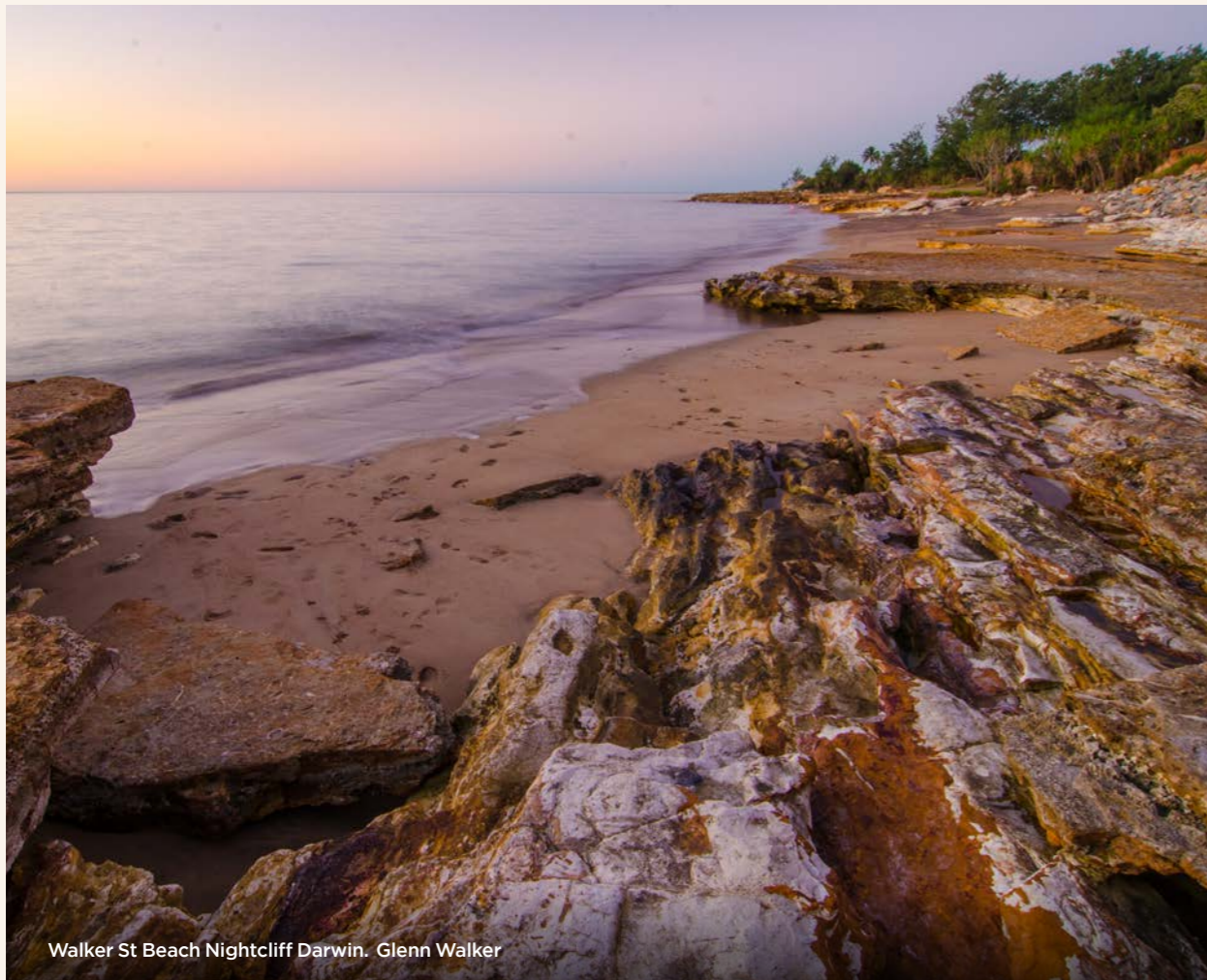
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- <sup>100</sup> Australian Venture Consultants 2018, p.80.
- <sup>101</sup> Australian Venture Consultants 2018, p.82.
- <sup>102</sup> Barden J 2018, 'Darwin Harbour scientist calls for research funds as dolphin populations drop', *ABC News*, 30 November 2018, <<https://www.abc.net.au/news/2018-11-30/darwin-Harbour-dolphin-population-decline-worries-scientist/10157960>>.
- <sup>103</sup> Barden J 2018.



Nicholas Gouldhurst



Walker St Beach Nightcliff Darwin. Glenn Walker





Photo: Helen Orrs

# A lifestyle worth protecting

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Published by the Australian Marine Conservation Society for the Keep Top End Coasts Healthy alliance.

Printed on 100% recycled paper.