

CATTLE BAY MARINA PROJECT EIS

AQUATIC ECOLOGY ASSESSMENT



Fur Seal On Snug Cove Breakwater

Report Prepared for Eden Resort Hotel Pty Ltd

**Marine Pollution Research Pty Ltd
May 2013**

TABLE OF CONTENTS		Page
EXECUTIVE SUMMARY		v
1	Introduction	1
1.1	Project Location	2
1.2	Twofold Bay Aquatic Ecology Literature Review	5
1.3	Threatened Species or Populations and Protected Species	8
1.4	Introduced Marine Species	8
1.5	Commercial Fishing Activities	9
2	AQUATIC HABITATS OF TWOFOLD BAY	10
2.1	Field Studies of Cattle Bay Aquatic Ecology	10
2.2	Cattle Bay Beach and Sub-tidal Sand Habitat	20
2.2.1	Seagrasses	23
2.3	Rocky Shores and Hard Substratum Habitat	27
2.3.1	Intertidal rocky shores	28
2.3.2	Sub-tidal rocky reefs	21
2.3.3	Constructed habitat	33
2.3.4	Possible introduced marine species (IMS) in Cattle Bay	37
2.4	Threatened, Listed and Protected Species in Twofold Bay	40
2.4.1	Threatened species	41
2.4.2	Listed, migratory and protected aquatic species	45
3	IMPACT ASSESSMENT	48
3.1	Construction Impacts	48
3.1.1	Direct impacts of construction	48
3.1.2	Indirect impacts of construction	51
3.2	Operational Impacts	52
3.2.1	Impacts associated with marina operations	52
3.2.2	Cumulative impacts associated with vessel usage	58
4	REFERENCES	61
TABLES		
1	Cattle Bay Surface Sediments particle Size Analysis	21
2	Summary statistics for sediment chemical contamination testing	22
3	Southern Right Whale sightings from Cat Balou Whale Watch Web Log	43
4	Humpback whale sightings and% whale feeding 1995 and 2010	43
5	Proportion of Humpback Whale Age Classes feeding 2006 to 2010	45

FIGURES

0	Fur seal on Snug Cove Breakwater	Frontis
1	Aerial plan view of project site	1
2	Oblique aerial view of project site	2
3	Proposed Marina layout superimposed on Twofold Bay Hydrographic Chart	3
4	Location of Mussel Aquaculture in Twofold Bay	7
5	Eden Main Wharf in 1903	9
6	Portion of NSW Fisheries Twofold Bay marine vegetation map (Map 65)	11
7	Broad-scale Aquatic Habitats in Twofold Bay	12
8	Aquatic ecology habitats in Cattle Bay January 2013	13
9	High view west from eastern shore across Cattle Bay	15
10	View south from Cattle Bay Beach	15
11	View south over wharf	16
12	Cattle Bay Beach and cannery retaining wall	16
13	Cattle Bay Beach shallows grading from bare sand to <i>Posidonia</i> patches	17
14	Cattle Bay intertidal rocky reef habitat	17
15	Cattle Bay vertical intertidal rocky shore habitat	18
16	Shallow reef at the southern end of Cattle Bay east shore	18
17	Shallow sub-tidal reef at the south end of the cattle bay eastern shore	19
18	Rock Rubble western end of Cattle Bay Beach and stormwater pipe outfalls	19
19	Northern end of Cattle Bay western shore with shallow rock rubble reefs	20
20	Edge of eastern shore <i>Posidonia</i> bed next to Kelp on cannery pipeline	23
21	<i>Zostera</i> in the east shore <i>Posidonia</i> bed	24
22	Wide view of main east shore <i>Posidonia</i> bed	24
23	<i>Halophila</i> in the sparse deeper part of the east shore <i>Posidonia</i> bed	25
24	Sparse and patchy <i>Heterozostera tasmanica</i> in the marina footprint	25
25	An isolated denser patch of <i>Heterozostera tasmanica</i> smothered by algae	26
26	An area of drift algae smothering the offshore seabed	26
27	Drift algae and fine filamentous algae smothering offshore seagrass	27
28	School of jack mackerel offshore Cattle bay in the marine footprint	28
29	Black Mussels dominate most rocky reef depth zones.	30
30	Deeper water <i>Barrens</i> habitat off Cattle Bay eastern shore	31
31	Isolated rock pinnacle off south end of Cattle Bay eastern rocky shore	32
32	Attached biota on Cattle Bay wharf piles intertidal to shallow sub-tidal	34
33	Pile biota in deeper waters below the kelp zone	35
34	Biota on rubble under and around wharf	36
35	<i>Sabella</i> type fanworms (probably <i>Sabellastarte australiensis</i>).	38
36	Possible Introduced Crab and Fan Worm on piles & rubble in Cattle Bay	39
37	Humpback Whale feeding patterns offshore of Twofold Bay 2006 to 2010	44

APPENDIX A

A1 Tables 4 and 5 From TEL (2002) Cattle Bay Aquatic Ecology Survey

A2 Bionet and EPBC Search for Threatened Species within 10km of Eden

EXECUTIVE SUMMARY

This report provides an assessment of the potential impacts associated with the construction and operation of a 154 floating berth marina in Cattle Bay at Eden in Twofold Bay on the NSW south coast. The marina would be built out from an existing wharf, the old cannery wharf and will include a fixed wave attenuator structure to dampen incident wave energy to the vessels in the marina.

Twofold Bay provides wharf facilities for a wood chip export operation, for Navy ammunition and for general cargo in East Boyde Bay to the south and docking plus slipping facilities for smaller commercial vessels (fishing vessels, tourist vessels and general trade) in Snug Cove. There are swing moorings for recreational and commercial vessels in Snug Cove including Cattle Bay. There are other swing moorings and a public boat ramp in Quarantine Bay.

Twofold Bay supports a mixed commercial fishery including purse seining and beach hauling and there are two mussel aquaculture facilities, one located south of Cocora Point

Studies by the Australian Museum and CSIRO in the 1980s to 1990s provide a broad ecological context for the aquatic ecology of Twofold Bay, with more recent environmental assessments for particular projects providing specific aquatic ecological detail for commercial and Navy wharf projects in East Boyde Bay and for an earlier marina proposal and a resort proposal in Cattle Bay. Broad based regional aquatic ecological studies for the Twofold Shelf and coastal marine vegetation mapping by government agencies provide further details of the marine ecology and habitats of Twofold Bay.

Given the oceanic nature of Twofold Bay it provides coastal and near oceanic habitat for some 63 listed species including 26 threatened species under the various Commonwealth and State Protected Species legislation; NSW *Threatened Species Conservation Act 1995* (TSC Act), NSW *Fisheries Management Act 1994* (FM Act) and the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). In particular, Twofold Bay and the immediate coastal waters offshore over the relatively narrow continental shelf provide migration corridors and staging plus feeding resources for whales and dolphins, particularly Humpback and Southern Right whales. As a consequence Twofold Bay supported a large whaling industry in the past and now supports a tourist industry around whale and dolphin watching. Common and bottlenose dolphins are regularly reported in Twofold Bay and there may be a resident population of indo-pacific bottlenose dolphins in Twofold Bay.

Due to the long association with port usage, particularly with shipping links to Asia, Twofold Bay also hosts numerous introduced marine species including several priority-listed species such as the Mediterranean fanworm *Sabella spallanzanii*.

Cattle Bay aquatic habitats include a narrow intertidal rocky shore with a broader rock boulder sub-tidal fringe and a predominantly sandy seabed that supports a dense *Posidonia* based seagrass bed along the eastern shore, scattered *Zostera* seagrass amongst the boulder reef along the western shore and sparse plus patchy *Heterozostera* seagrass cover in deeper waters to about -8m depth. The *Heterozostera* distribution is thought to be part of a much larger distribution around the sandy perimeter of Twofold Bay. Analysis of seabed sediment samples indicates that the sediments are not contaminated in respect to the protection of aquatic life.

The combined aquatic habitats support a biota typical of southern coastal rocky bays and, due to depth plus specific habitat restrictions, Cattle Bay does not support permanent populations or individuals of fish and shark species listed as threatened under the FM and EPBC Acts or for threatened marine mammals, reptiles, shore and wading birds listed under the TSC and EPBC Acts, although individuals of threatened species populations could be expected to utilise the resources of the bay from time to time. These include juvenile black cod, great white shark, green and leathery turtles, Australian and NZ fur seals, humpback and southern right whales. Protected species such as syngnathid fish (seahorses and pipe fish) are expected to reside in the aquatic habitats of Cattle Bay and dolphins, little penguins plus a variety of sea and fishing birds utilise the bay for feeding, with fishing birds roosting on shores and structures.

Construction Impact Assessment

Piling works associated with the construction of the marina would be into sand habitat, part of which supports *Heterozostera* seagrass. Given the wide but sparse and patchy distribution of this species, direct loss of individual seagrass shoots to piling works is not considered significant. There is a potential risk of damage to *Heterozostera* and other near-shore seagrass and rocky reef habitats from vessel operations associated with construction (particularly anchoring, dragging of cables through habitats and possible propeller wash or scouring) and this risk can be mitigated to insignificance by the implementation of a specific aquatic construction environmental management plan (Aquatic CEMP) that sets out the conditions and restrictions for construction operations that must be met to protect aquatic ecosystems.

Removal or relocation of moorings and maintenance works for the cannery wharf could disturb and redistribute introduced marine species (IMS). This potential impact can be mitigated by specific disposal measures that would be set out in the Aquatic CEMP.

Noise from construction activities, particularly impulse noise from piling operations can be disruptive for marine mammals particularly whales, with the level of risk depending on when construction works are undertaken in relation to whale migration and calving seasons. This risk can be managed by a marine mammal protection plan (MMPP) which would be developed as part of the Aquatic CEMP.

Operational Impact Assessment

In terms of potential operational impacts there are impacts associated with the marine structure in place, and there are potential impacts associated with marina operation and with vessel operations outside of the marina:

- The risk of total or significant loss of the *Heterozostera* to shading impacts from the marina structure and moored vessels is low, whilst the potential for some measurable loss is possible. Incremental loss of *Heterozostera* under the marina footprint would not be significant for overall *Heterozostera* habitat in Twofold Bay and for the animals that utilise that habitat in Twofold Bay.
- The design of the marina ensures that there are no significant risks to the shallow and shore-based aquatic habitats in Cattle Bay, specifically the shallow *Posidonia* and *Zostera* seagrass plus rock rubble algae beds round the shores.
- The possibility of residual risks to deeper water barrens habitat on pinnacles in the marina fairway that could present navigation hazards will be confirmed as part of the recommended detailed hydrographic survey.
- The design of the marina ensures that there are no significant risks to water circulation in Cattle Bay or Snug Cove generally and detailed breakwater design will ensure that there is no significant residual risk for aquatic biota associated with wave refraction and associated potential Cocora Beach realignment.
- Risks for water pollution are avoided by the marina design including not providing fuel or slipway services, and the marina will be operated on a zero bilge, sewage and ships liquid waste discharge policy. Residual risks associated with sewage and bilge pump-out are minimised by use of a supervised portable pump-out facility.
- Copper ablation to the waters of Cattle Bay from vessel antifoul paint coatings has been assessed against relevant detailed studies for other east-coast coastal marinas and it is concluded that the water quality of the proposed Cattle Bay marina would

meet the ANZECC/ARMCANZ (2000) requirements for the protection of aquatic ecosystems and aquaculture activities in Twofold Bay.

- The shelter afforded to the waters inside the marina and the proximity to human users could result in proportionally more rubbish accumulating in the bay. Marine debris can cause harm to marine vertebrates via entanglement or ingestion and this is listed as a Key Threatening Process (KTP) under both the TSC and EPBC Acts. This risk can be mitigated to insignificance by inclusion of regular beach, surface water and seabed inspections plus collections to be detailed in the Marina Operational Environment Management Plan (OEMP).
- The marina will be providing a large increase in the wetted surface area of hard substratum available for colonisation by aquatic biota. On balance this can be an overall beneficial impact for juvenile reef fish that would utilise the fouling assemblages that grow on the wetted surfaces areas of the marina infrastructure. However, these surfaces may also benefit introduced marine species (IMS), which is listed as a KTP under the FMA (*Introduction of non-indigenous fish and marine vegetation to coastal waters*) and under the EPBC Act (*Novel biota and their impact on biodiversity*) listed on 26 February 2013. This risk can be partially offset by clearing up the accumulated hard substratum rubbish under the existing cannery wharf, and the residual risk would be mitigated by periodic inspections for IMS, which will be detailed in the OEMP.
- Risks of marina noise to marine mammals from the marina are avoided by excluding marine workshop activities in the marina, and residual risk outside the marina is minimised by baffling of noise via the fixed wave attenuation infrastructure and by imposing idle speed limits within the marina and fairway. Potential light pollution from marina lighting attracting sea birds will be mitigated by installing downwards directed lighting with most light fall onto pontoon hard surfaces to minimise light spill into the water, plus efficient light management via, e.g., dimmers or on-demand timed lighting.
- Risks of accidents, collisions and catastrophic marina breakup have been considered and will be managed by marina structural and systems design (e.g., inclusion of appropriate fire fighting and spill containment kits), by marina use protocols (for marina patrons) and marina operational protocols (set out in the OEMP).
- In regard to protection of the commercial fishing and aquaculture activities in Twofold Bay, it is concluded that the proposed location and construction of the marina would not impede these activities in any way and management of the operations of the marina would ensure that there is no significant residual risk to these operations arising from any potential water quality, coastal process or introduced marine species impacts associated with the marina.

- Existing recreational fishing uses of the Cattle Bay shoreline and of the cannery wharf will be affected by vessel movements in and out of the marina and restricted by the placement of a floating marina arm alongside the eastern outer portion of the wharf but will still be possible as the wharf will remain open to the public.
- The cumulative aquatic ecology impacts of the use of the Cattle Bay Marina in conjunction with the approved future Boydetown marina, the proposed POEM marina and the possible increase in commercial and tourism related port activities as espoused by BVSC in its 2006 Snug Cove Master Plan and its 2010 Port of Difference submissions have been considered, and it is concluded that the incremental risk to marine mammals from disturbance including the risk of collision will increase as the number of vessels transiting through and around Twofold Bay increases. This risk can be managed by a combination of education and specific risk management via a Marine Mammal Protection Plan (MMPP).
- Whilst the MMPP should be a considered and produced as a combined government and industry document and protocol, there will still be a need to provide a MMPP for the present Cattle Bay marina to meet the marina's obligations under both the Aquatic CEMP and the OEMP. This will require additional research of available marine mammal sightings at least over the last three years to provide an up-to-date assessment of marine mammal usage of Twofold Bay and immediate environs.
- To this end it is recommended that a cooperative arrangement be made with the owners of the Cat Belou whale watching operation to access their marine mammal observations logs from which up-to-date risk profiles for vessel strike and disturbance for marine mammals of concern can be developed and used to develop an information pack that can be supplied to marina and other Twofold Bay boaters.

It is concluded that protection of the aquatic ecology of Cattle Bay and of Twofold Bay during construction and operation of the proposed Cattle Bay marina can be achieved provided the recommendations for additional studies and the aquatic ecology protection measures recommended for the Construction and Operational Environmental Management Plans are implemented.

The additional recommended studies are as follows:

- Hydrographic survey of Cattle Bay to include the accurate delineation of identified aquatic habitats, including the in-shore and off-shore limits of *Heterozotera* seagrass.
- Modelling and design of the wave attenuator to ensure that any beach realignment of Cocora Beach would not impact offshore seagrass beds.
- Development of up-to-date risk profiles for marine mammal usage of Twofold Bay, Snug Cove and the immediate coastal environments of Twofold bay.

The recommendation for the Aquatic CEMP and the OEMP include:

- A construction vessel mooring, anchoring and vessel wake minimisation plan.
- An IMS protocol for relocation and removal of swing moorings.
- A construction marine mammal protection plan (MMPP).
- A construction marine debris clearance plan to remove and dispose of the accumulated hard substratum rubbish under the cannery wharf.
- An operational water, beach and seabed rubbish collection and disposal plan.
- An operational IMS inspection and removal plan for the marina infrastructure.
- An operational MMPP developed from the risk profile study above and incorporating protocols for assessing likely daily marine mammal encounters via a network of marina, tourist and agency stakeholders.
- A marina user Environmental Harm Minimisation Publication to be provided to marina patron during their inductions and to be available on all vessels leaving the marina.
- Development of appropriate Environmental Harm Minimisation signage for the marina.

1 PROJECT DESCRIPTION

Inspire Urban Design + Planning and Haskoning Australia (IP&HA 2013) are preparing an EIS on behalf of Eden Resort Hotel Pty Ltd under Part 4 of the EP&A Act 2005 for the construction and operation of a floating berth marina in Cattle Bay, Eden (Figures 1 and 2).



Figure 1 Aerial view of north-east portion of Twofold Bay showing relationship of Cattle Bay to the commercial wharves in Snug Cove, Eden.

Figure 3 provides a location plan of the proposal in relation to the Eden Resort Hotel Project, to be built on the old fish cannery site. In terms of aquatic ecology impact assessment, the adopted proposal includes the following features:

- Retention and repair/refurbishment of the existing fish cannery wharf as per the Conditions of Approval for the Eden Resort Hotel approved Concept Plan, to be built on the adjacent old fish cannery site (JBA 2007).
- A 154 berth floating marina south of the cannery wharf with three marina arms orientated generally south-east towards Snug Cove and a northern arm extending along the eastern side of the cannery wharf.
- The marina would provide berthing for 63x12m vessels, 65x15m vessels and 26x18m vessels with temporary berthing for visiting super yachts (2 to 3) and for other vessel pickup and set down needs, both alongside the southern marina floating walkway.



Figure 2 Oblique aerial view of Eden and Twofold Bay from the north- east, showing the relationship of Cattle Bay to the northern shoreline of Twofold Bay.

- The marina layout provides channel widths >25m between the eastern ends of the marina and the -2m ISLW contour offshore from the mainland (see Figure 3).
- The marina will require a wave attenuator to protect the marina from prevailing local seas from the SSW and from refracted ocean swell. This will be a fixed, not floating structure.
- Other than provision of utilities (power, water, sewage pump-out) there will be no additional services available at the marina and there will be no additional works required on land over and above the works already required for the Eden Resort Hotel concept approval.
- The marina will be located more than 500m from the closest mussel farm (located to the west of Cocora Point), more than 170m from the eastern end of Cocora Beach and more than 300m from the wharves in Snug Cove.

1.1 Project Location

Cattle Bay, Eden is located in Snug Cove, in the north-east corner of Nullica Bay, which with Calle Calle Bay north of Eden and East Boyd Bay to the south are the three main embayments of Twofold Bay, the southern-most of five oceanic bays on the NSW coast.

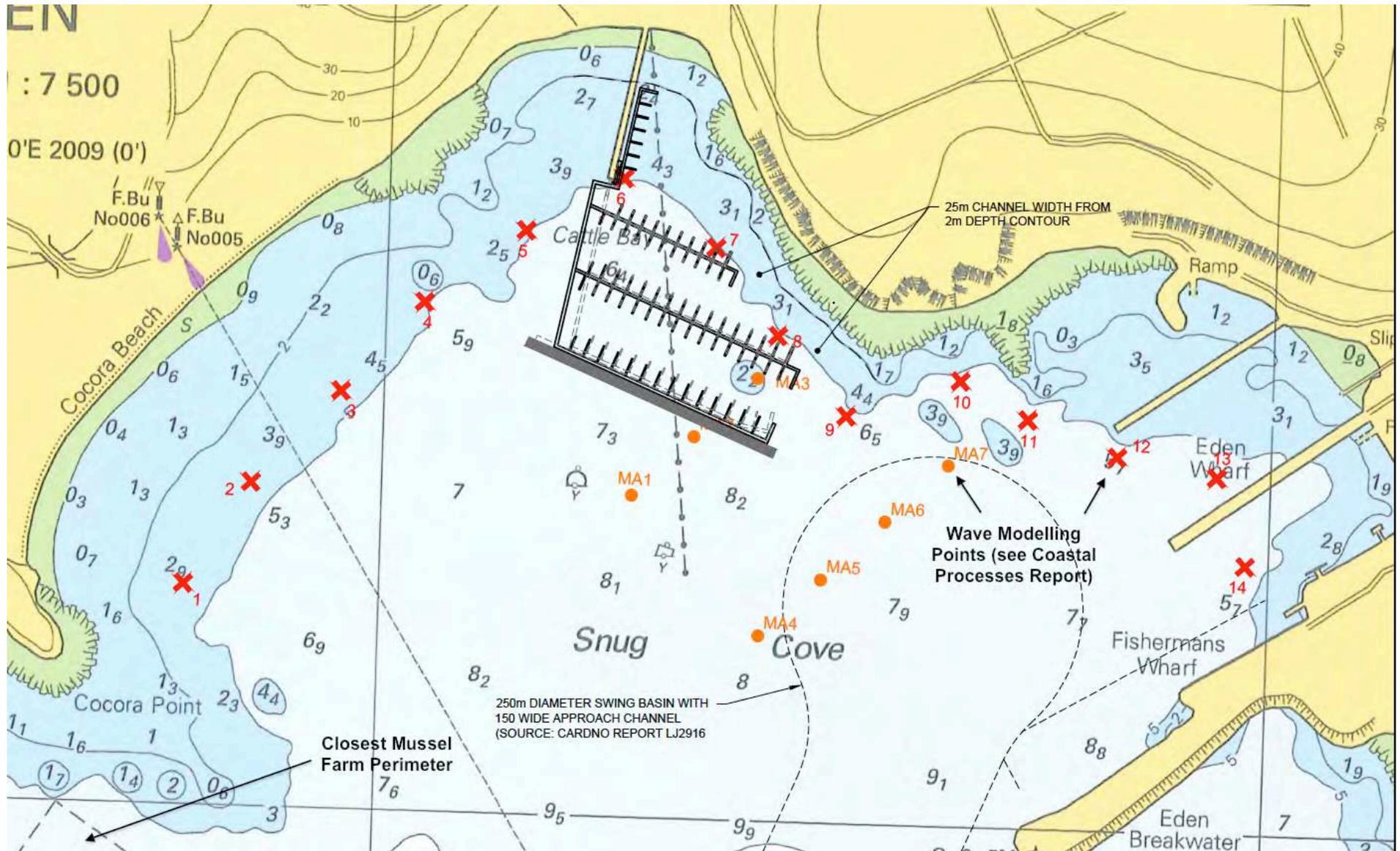


Figure 3 Portion of Adopted Marina Layout Plan for Cattle Bay Marina prepared by Haskoning Australia Pty Ltd dated 13 January 2013.

The total water area of Twofold Bay is 35km² with the bay area south of Eden having an average depth of 10.9m (at 0.6m AHD tide) and a volume of 334,559 ML. Twofold Bay has a medium sized catchment area of 2215km² with two main river discharges, both south of Eden, the Nullica River (catchment size 52km²) and Towamba River (catchment size 1000km²) located 3.5km and more than 4km southwest and south of Cattle Bay respectively. The remainder of the Twofold Bay catchment comprises short coastal creek sub-catchments draining directly to Twofold Bay.

The southern bay (i.e., south of Eden) is exposed to the east to the Tasman Sea and is affected by swell from the north-east to the southeast, which under certain conditions can generate waves up to 3 metres in height. The distance across the entrance to the southern bay – i.e., between Lookout Point Eden and Munganno Point at East Boyd Bay, is 3km and the depth across this entrance is around -20m LAT (Lowest Astronomical Tide). Accordingly, whilst the bay provides various safe anchorages under certain wind and swell conditions, there are few all weather anchorages:

- Port Eden immediately north of Cattle Bay at Eden, is a commercial port with 3 wharves sheltered by a breakwater and several large commercial shipping buoys. This port services a large ocean fishing trawler fleet, local tourist boats and cruise ships that visit the port from time to time.
- The 120m Cattle Bay wharf was originally built in 1945 and rebuilt in 1985 to 150m. The jetty provided offloading facilities for trawlers and factory vessels for the Heinz seafood cannery, one of the largest canneries in Australia prior to its closure in 1999.
- There are two large commercial wharves on the southern side of the bay near East Boyd Bay, one for loading wood chip ships and the other being a general purpose wharf for the loading of ammunition to Navy ships or for general cargo when not in use by the Navy.
- There are several small boat anchorages, the moorings at Cattle Bay and moorings in Quarantine Bay, which is afforded some additional protection by a breakwater.
- There is a commercial boat ramp at Eden and a public boat ramp at Quarantine Bay.
- For the most part the two river mouths are shoaled and can only be navigated by smaller dinghies.
- In 1990 the Minister for Planning granted development consent for a boat harbour and marina at Boydtown that was to provide all weather access via three breakwater

structures to an excavated boat harbour in Boydtown Creek with 250 wet berths, 40 swing moorings and dry storage for up to 70 power boats and 30 yachts.

There are two mussel aquaculture areas; one just south of Cocora Point, some 500m south of Cattle Bay and a second area around Torargo Point, some 2.5 km south of Cattle Bay. The remainder of the bay perimeter comprises two long sandy beaches (Whale Beach at Kiah Inlet and Boydtown Beach, both associated with the two river entrances), or pocket sandy beaches (e.g., Cocora and Bungo Beaches just south of Cattle Bay) constrained by rocky outcrops, some with shallow rocky reefs extending into the bay (e.g., at Munganno, Tororago, Cocora and Lookout Points).

1.2 Twofold Bay Aquatic Ecology Literature Review

There have been a number of studies on the aquatic ecology of Twofold Bay, generally associated with major port developments, the proposed Boydtown marina development and the land based development associated with the present proposal:

- The Boydtown Marina EIS was prepared by SKP& PBP (1989) and was then subject to a Commission of Inquiry in 1992. The marine ecology assessment was based on data from ecology surveys in Twofold Bay by Australian Museum and CSIRO (see below). Inspire Planning (2007) noted that construction works had commenced but not proceeded further, and as such the development has 'physically commenced' in accordance with Section 95(4) of the Environmental planning and Assessment Act and the marina consent would not lapse.
- The Australian Museum undertook replicate surveys of the benthic macrofauna of intertidal and shallow sub-tidal habitats of Twofold Bay during 1984-85 (Hutchings *et al* 1986,1988). These studies originated as a response to concerns from the commercial fishing industry about ballast water discharges into Twofold Bay (see also Section 1.4 below). The study identified over 570 taxa from intertidal and sub-tidal rocky shores and from shallow and deep bay seabed sediments, and included 13 species of demersal fish from the *Posidonia* bed in Quarantine Bay. The studies were subsequently extended into Port of Eden Introduced Marine Pest Species report (CSIRO 1997), with a follow up survey and report by Pollard and Rankin 2003).
- CSIRO Division of Fisheries (1989) undertook marine ecology studies of inshore seabeds and shallow water fish populations off East Boyd, Boydtown and Aslings Beaches with a view to establish possible reference sites for other studies underway for a proposed Navy ammunition loading wharf in Jervis Bay. This project did not proceed, and in 1999 Woodward Clyde prepared an EIS to support a proposal to

build a multi-purpose wharf facility and a munitions storage facility for the Navy at East Boyd, Twofold Bay. The Ecology Lab (TEL 1999) prepared a marine ecology impact assessment for this project. The project was approved and the wharf was constructed in 2002-2003.

- In 1996 Pacific Seafoods Pty Ltd prepared an EIS for mussel farming in Twofold Bay. The project was given staged approval with requirements to monitor water quality and bio-deposition impacts for the Stage 1 developments and monitor the potential for marine mammal entanglement threats. Hoskins and Underwood (1999) reported on preliminary biodeposition impacts and recommended further studies. These were subsequently reported in Lasaik and Underwood (2002). Subsequently New Horizons (2002) prepared a report to support progression to Stage 2, which was approved in 2005. Figure 4 shows the location of mussel aquaculture areas.
- In 2002 Aargus Pty Ltd prepared a marine ecology investigation report for a proposed floating restaurant and 168 berth marina in Cattle Bay. The marine ecology study was undertaken by TEL (2002). Subsequently, JBA (2007) prepared an Environmental Assessment Report for a mixed tourist facility and residential development on the old Heinz Cannery site at Cattle Bay and this report included an assessment of impacts on aquatic marine species (Appendix L) prepared by Cumberland Ecology (2007). This report assessed the impact of the shore based construction works plus the operation of the facility on the marine ecology of Cattle bay including marine mammals. The assessment did not include any new field surveys and relied on the Aargus/TEL 2002 studies for marine ecology assessments.
- There have been two other major projects proposed for the East Boyd site with marine ecology studies undertaken by NGH Environmental (NGHE). (NGHE (2009) undertook marine field surveys of near-shore habitats around Munganno Point for a proposed biomass power plant (URS 2010) and NGHE (2011) undertook a biodiversity assessment of coastal and oceanic birds for the Eden Wind farm project.
- Other marine ecology information is derived from regional studies such as the Twofold Bay Shelf Biodiversity Studies (Breen *et al* 2005, Edmunds *et al* 2005 and DECCW 2010), from the web resources of Bega Valley Shire Council, the Sapphire Coast Marine Discovery Centre (Eden) and the Southern Rivers CMA.
- DECCW (2010) provide detailed epibenthic analysis of 5km of replicated shore normal oceanic rocky reef habitat indicating a general depth zonation of *turf habitat* in shallow sub-tidal waters, a *Phyllospora habitat* to -3m depth dominated by the brown macroalgae *Phyllospora comosa*, an *Ecklonia habitat* below -2m depth, *Barrens habitat* also below -2 m, generally dominated by long-spined sea urchins, *Centrostephanus rodgersii*, a *Pyura habitat* below the kelp/barrens dominated by solitary ascidians *P. gibbosa* and *P. stolonifera* and a *Sponge habitat* in deeper waters. This habitat type is dominant on intermediate and deep reefs.

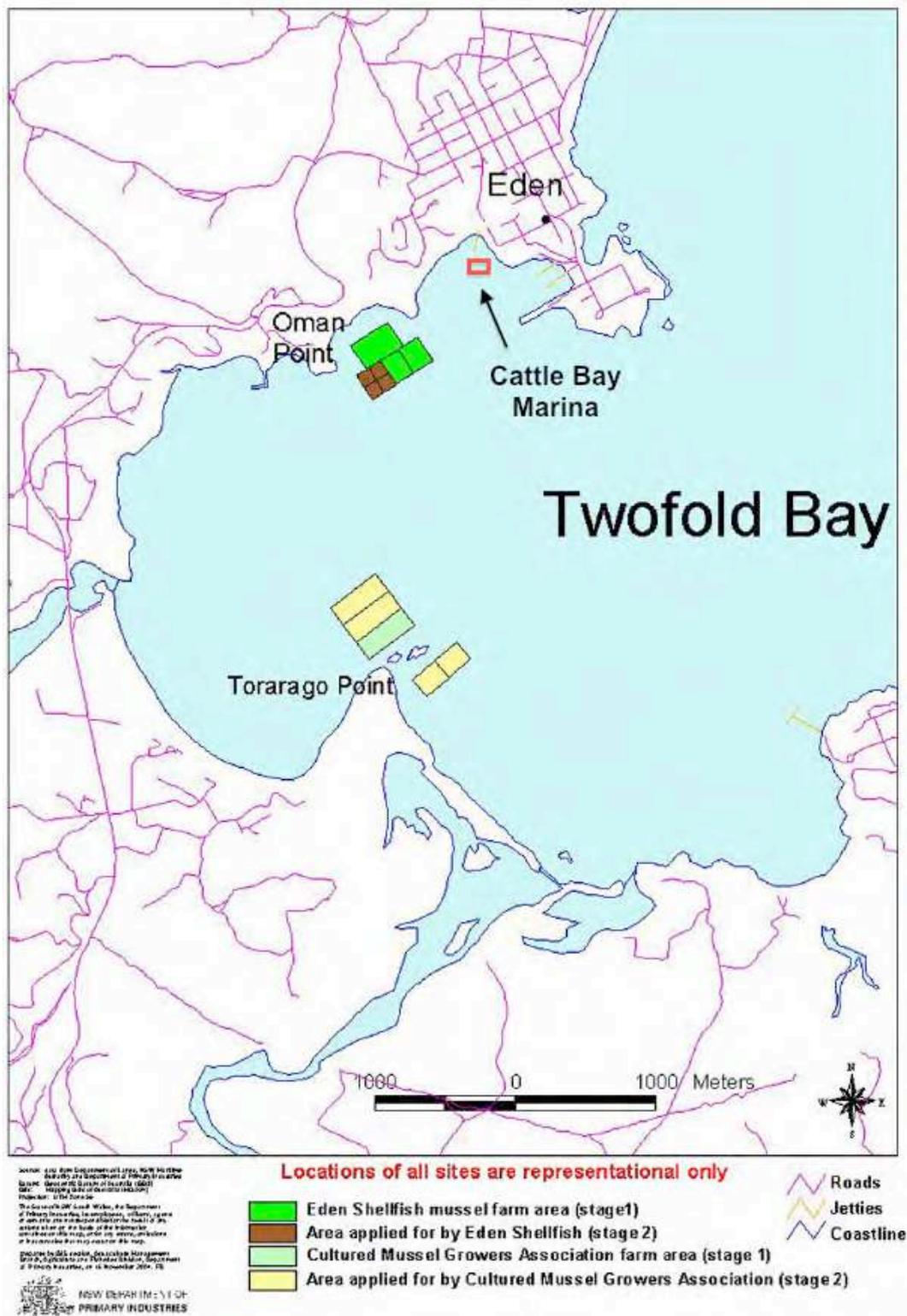


Figure 4 Location of Mussel Aquaculture in relation to Proposed Cattle bay Marina

- DECCW (2010) also noted that Twofold Bay reefs are dominated by barrens habitat with kelp relatively rare and confined to depths below 16m. Some reefs had shallow barrens habitat transitioning to introduced *Watersipioia* bryozoa reefs.
- The Project EIS (IP&HA 2013) refers to another marine proposal, the Port of Eden Marina (POEM) that would be located immediately to the east of the present

proposal and that could provide additional marina berthing for up to 193 vessels. Whilst the proposal is still in development/feasibility stage, the proponents have concluded that the POEM and the Cattle Bay marinas are complimentary.

1.3 Threatened Species or Populations & Protected Species

An assessment of the potential impacts of a proposal on threatened species, populations, ecological communities and critical habitat listed in the NSW *Threatened Species Conservation Act 1995* (TSC Act) and *Fisheries Management Act 1994* (FM Act) must be undertaken in accordance with section 5A of the EP&A Act, and under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act), approval by the environment minister is required if an action is likely to have a significant impact on a matter of national environmental significance.

Database searches for threatened, protected or other listed aquatic species listed on the TSC Act, EPBC Act and FM Act were undertaken using Bionet (TSC Act and FM Act listed species), Wildlife Atlas (TSC Act listed species) and EPBC Protected Matters search tool (EPBC Act listed species). Searches were undertaken within a 10km radius centred on the bay outside the marina footprint proposal site. The Bionet and Wildlife Atlas search tools list species previously recorded within the defined search area. The EPBC Act Protected Matters lists species whose habitat requirements have the potential to occur within the defined search area.

The results of the combined searches have been listed in Appendix A2. With regard to potential aquatic ecology impact there are 63 listed species comprising 14 sea birds, 3 shore bird species, 13 cetaceans (whales and dolphins), 4 reptiles (turtles), 4 sharks and 26 fish (mainly seahorses and pipe fish). Of these there are 26 threatened species; 2 fish, 3 sharks, 2 seals, 3 cetaceans, 4 sea turtles, 6 sea birds, 3 shore birds and 3 raptors. The likelihood of these species occurring in the project area is addressed in Section 2.4 and the possible impact on these species is considered in Section 3.

1.4 Introduced Marine Species (IMS)

Twofold Bay is a natural deepwater harbour and has a long association with the whaling, timber and pastoral industry through to the mid 1900s. The use of Twofold Bay as a port for international and interstate commerce also has a long history, with the construction of the first wooden jetty (Main Jetty in Snug Cove) in 1860 (Figure 5). In the 1900s, continued Eden port development at Snug Cove (including the jetty in Cattle Bay) was centred on accommodating and servicing the ocean trawl fleet and fish cannery. Development of the

East Boyd Bay port facilities commenced with the construction of the woodchip berth in 1969 and continued with the construction of a multi-purpose wharf in 2003.



Figure 5 View of Eden Main Wharf in 1903.

Concerns regarding the importation of IMS to the bay via ballast waters were raised in the mid 1980s with subsequent surveys in 1984-85 (Hutchings *et al* 1986,1988).

Further surveys of the port areas and the adjacent coastline of Twofold Bay were undertaken in November 1996 (CSIRO 1997). The survey detected three Australian Ballast Water Management Advisory Council (ABWMAC) listed introduced target pest species; the European shore crab *Carcinus maenas*, the Mediterranean fanworm *Sabella spallanzanii* and the toxic dinoflagellate *Alexandrium* “*catenella* type”. Follow up monitoring surveys were undertaken between July 1999 and June 2002 (Pollard and Rankin 2003) which confirmed the ongoing presence of all these listed pest species and increased presence of a fourth introduced species, the New Zealand rosy screw shell *Maoricolpus roseus*, previously detected during the 1996 survey. The possibility of IMS in Cattle Bay is considered further in Section 2.3.4.

1.5 Commercial Fishing Activities

Fisheries NSW information on commercial fishing activities and catch data for Twofold Bay are no longer available, but it is known that trawling (i.e., otter or Danish seine trawl nets) is prohibited in Twofold Bay. From past records (SPCC 1990) it is likely that purse seining vessels work offshore and in southern Twofold Bay, with beach hauling occurring at the larger ocean beaches, mainly at Fisheries and Aslings Beaches. It is not know whether prawn trawlers still operate in the bay but in the past they generally worked off the two estuary mouths (i.e., off Boydton Beach and Nullica River).

2 AQUATIC HABITATS OF TWOFOLD BAY

Williams et al (2006) mapped the estuarine vegetation resources of NSW estuaries including Twofold Bay, and DECCW (2010) amalgamated these survey results with other state-wide seabed mapping to provide a broad-scale assessment of the Batemans Shelf and Twofold Shelf Marine Bioregions. The marine vegetation map is shown as Figure 6 and a portion of the Twofold coastal map is shown as Figure 7. This latter figure illustrates the broad aquatic habitats available in the bay with an overlay of the presently known seagrass distribution in the bay:

- The shallow inshore habitats to the 5m depth contour of Twofold Bay comprise marine sand benthic habitat bounded by inshore shallow rocky reef extensions of headlands. DECCW (2010) note that the shallow sand habitat comprises a mosaic of fine- and coarse-grained sand., and that the coarser-grained sand usually had well-defined waves with shellgrit in the troughs.
- Other than the two long beaches associated with the two river shoaling entrances (facing north), the remaining shoreline north to Cattle Bay comprises small pocket beaches constrained by shallow rock reefs. Cattle Bay is also a small pocket beach constrained by shallow rock reef.
- There are seagrass beds on the sandy shallows immediately to the south of the Cattle Bay Wharf (*Zostera muelleri*), in East Boyd Bay either side of the multi-purpose wharf (mixed *Posidonia australis* and Zosteraceae), and offshore from Aslings Beach in Calle Calle Bay (Zosteraceae).
- There are very small Zosteraceae seagrass patches off Boydtown Creek entrance, a patch of *Posidonia australis* inshore in Quarantine Bay and a very small Zosteraceae patch inshore in Eden Harbour.
- The mapping does not include the Cattle Bay eastern shore *Posidonia australis* patch identified in the TEL (2002) report.
- There are no mangroves or saltmarsh on the Twofold Bay shoreline but there are mangroves in the estuaries.

2.1 Field Surveys of Cattle Bay Aquatic Ecology

As noted in Section 1.2, The Ecology Lab (TEL 2002) undertook a detailed field survey of Cattle Bay in relation to an earlier marina proposal for the site. Over two field days in late June 2002, TEL mapped and described the rocky reef, seagrass and jetty pile habitats plus biota either side of (and under) the Cannery wharf and for 10m seaward of the wharf. As this original survey is now 11 years old, and as it did not extend out into the proposed marina footprint for the present proposal, a follow-up aquatic ecology survey was required.



Figure 6 Portion of Fisheries NSW Estuarine Vegetation Map for Twofold Bay (based on field surveys in May 2004).

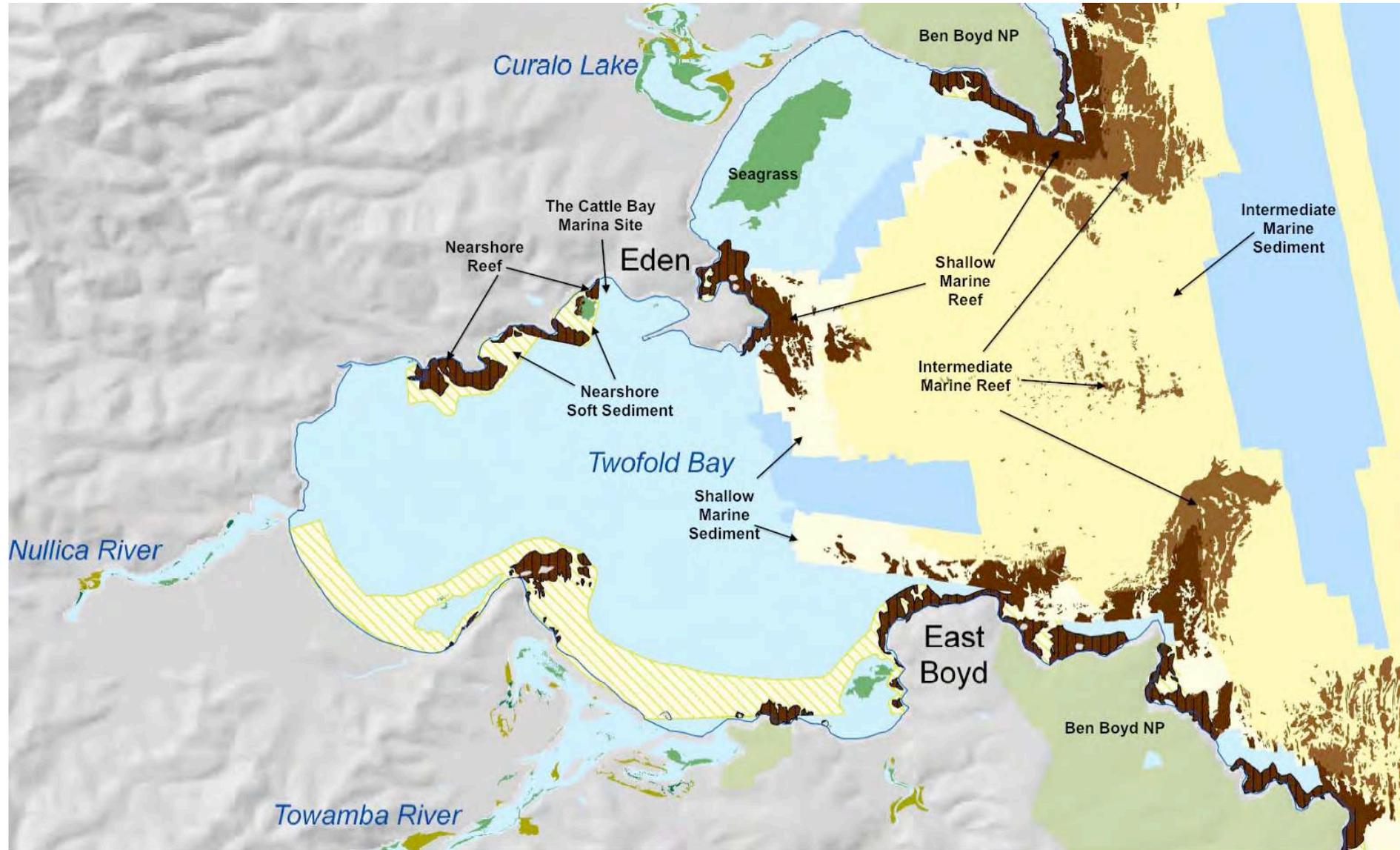


Figure 7 Combined broad-scale sea bed and marine vegetation mapping for Twofold Bay (from DECCW (2010)). The blue areas were not scanned for habitat assessment and the line between the light and dark blue is the -25m depth contour.

Riparian habitats and ecology of the site have been described in the flora and fauna study prepared for the Concept Plan Environmental Assessment by Cumberland Ecology (2007).

The follow-up aquatic ecology field study was undertaken over two days (24 & 25 January 2013), to verify and extend the original survey and include the offshore areas within the proposed marina footprint. The weather for both days was sunny with light north-easterly breezes and no swell effect in Cattle Bay. Unlike the TEL winter clear-water survey (5 to 7m visibility), the bottom water clarity for the January 2013 survey was poor, with visibility limited to about 2m, particularly over soft sediment habitats in deeper (to 8m LAT depth) waters off-shore. The survey included the following tasks:

- Above water photography of the cannery wharf structure (for structural engineers to assess the state of dilapidation).
- Above water views of the site from various vantage points to assess the relationship of the site to the surrounding land uses.
- Detailed inspections of the wharf piles to confirm the original pile habitat zonation and biota and to check for known priority introduced marine species (IMS).
- Inspection of the *Posidonia* seagrass bed along the bay eastern rocky shore.
- Confirmation of the rocky shore zonation and biota.
- Inspection of the rocky reef and *Zostera* distribution on the western side of the jetty.
- Spot dives and random swim transects through the marina footprint to ascertain habitat types and presence of epibenthos.
- Spot dives to collect surface sediments for grain-size and soil contamination analysis. These samples were collected on behalf of Haskoning Australia Pty Ltd who are undertaking the coastal process, water and sediment quality studies for the project.

Figure 8 provides the results of aquatic habitat mapping for Cattle Bay, Figures 9 to 16 provide site location and intertidal habitat photographs and Figures 17 to 36 show aspects of sub-tidal ecology. Note that the locations of habitat boundaries on Figure 8 are based on observations and other field survey reports and they have not been surveyed. The main aquatic habitats in Cattle Bay are as follows:

- Bare sand habitats (the beach, shallow intertidal sands and offshore sands). The sub-tidal sand habitat supports shallow inshore seagrass beds or patches and more sparse and irregular cover of seagrass in deeper waters.
- Rock habitats (intertidal rocky shores and shallow to deep rock reefs or boulder reefs).
- Constructed habitat (the wetted surfaces of the jetty support piles, mooring tackle and pipelines).

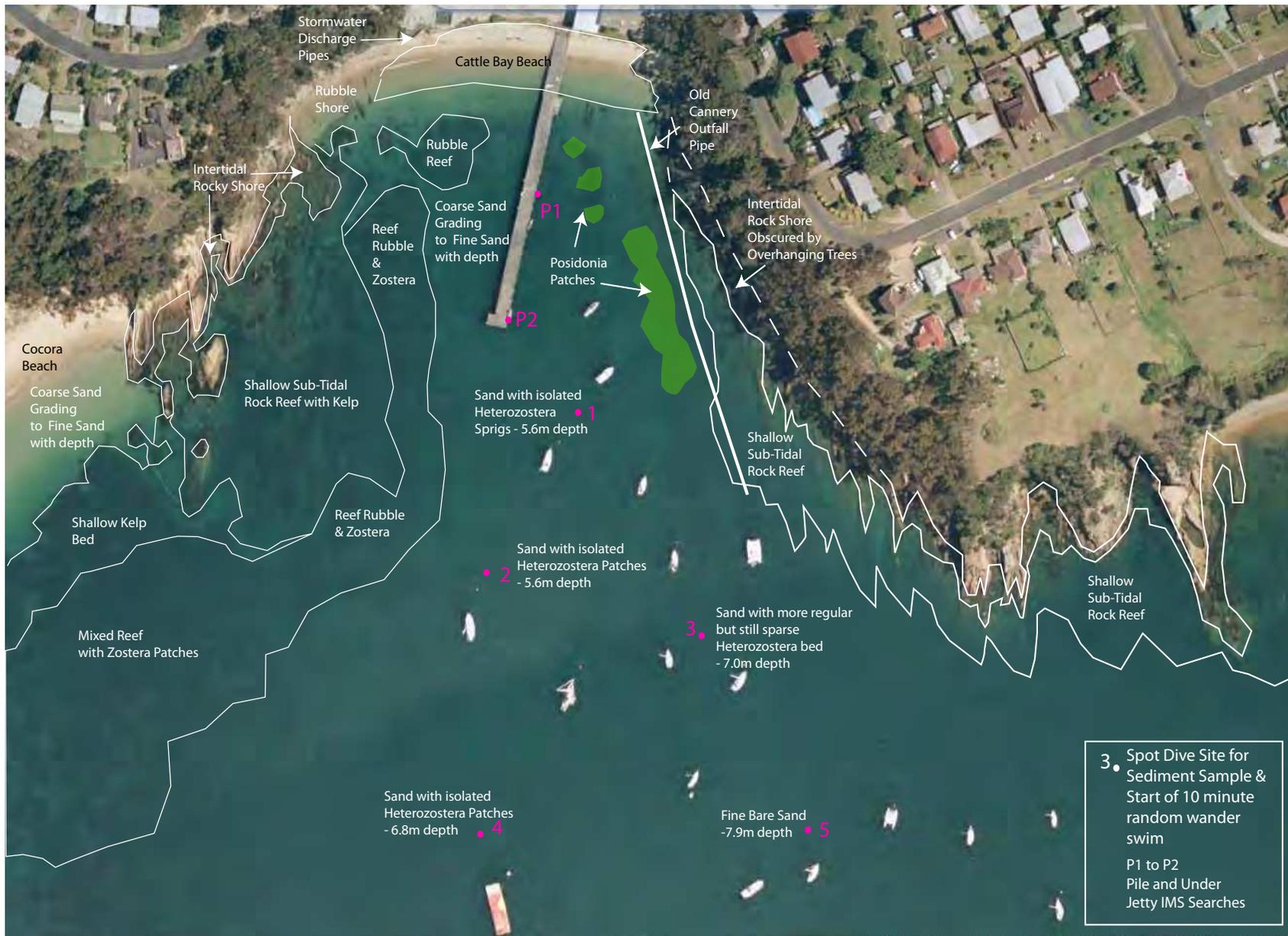


Figure 8
Aquatic Ecology Habitats in Cattle Bay on 24 January 2013

(Base aerial photograph from maps.six.nsw.gov.au)



Figure 9 View from eastern shore looking past cannery wharf towards Cocora Point. The closest mussel aquaculture farm is beyond the point some 500m south-west of the wharf.



Figure 10 View from Cattle Bay Beach to the south east. The harbour breakwater can be seen beyond the rocky reef to the left in the distance. The riparian vegetation behind the beach is all introduced species with all other riparian vegetation being predominantly native species.



Figure 11 View along the wharf to the south. The wharf is used by the public for bathing, sunning, fishing and strolling.

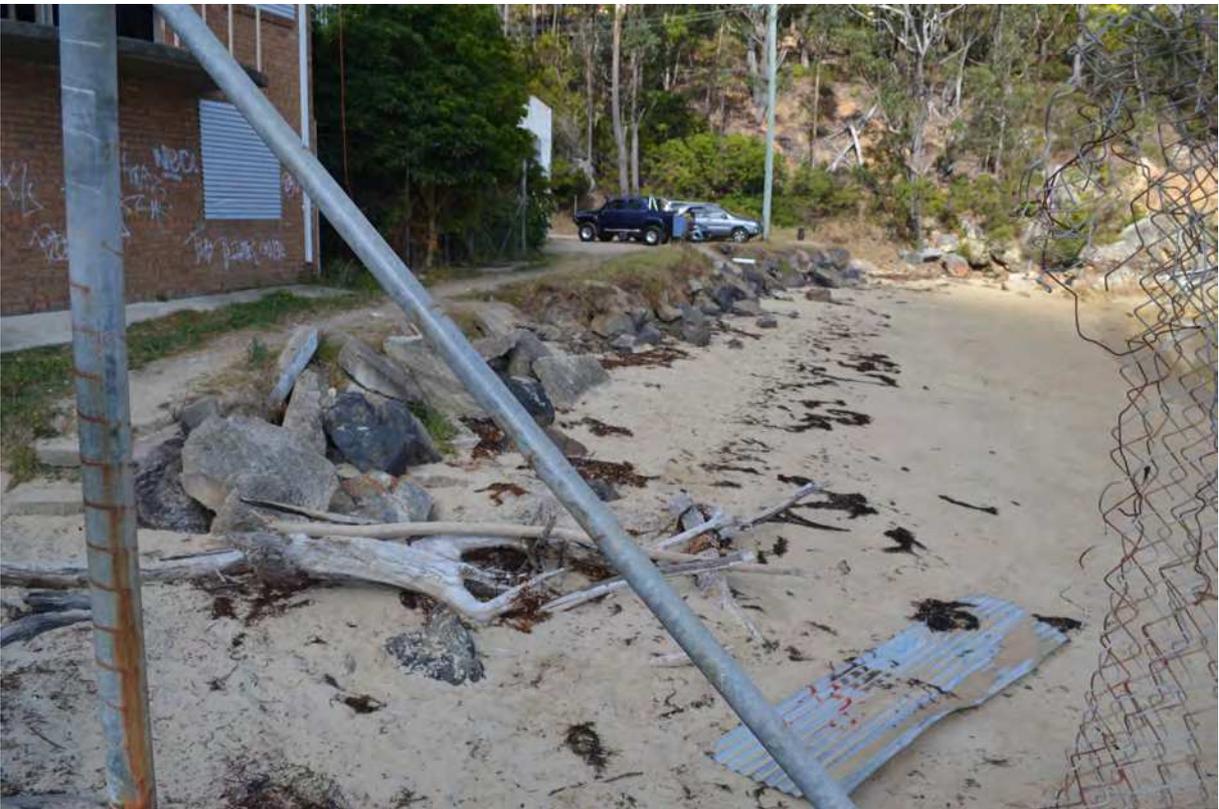


Figure 12 The old cannery building is built on levelled and filled land loosely retained by a derelict rock rubble wall.



Figure 13 The inshore shallows off Cattle Bay Beach showing the transition from bare intertidal sand to *Posidonia australis* seagrass patches extending out along the eastern shore.



Figure 14 The rocky shore provides habitat for a diversity of intertidal organisms and there is an oyster band along the lower intertidal rock surfaces with tube worms, *Ralfsia.sp* an encrusting brown alga occurs at mid-tide with Neptune's Necklace banding in the lower intertidal. There are also bands or patches of barnacles and a variety of molluscs.



Figure 15 The eastern rocky shore steepens to the south. This shows the conspicuous *Ralfsia* and oyster banding in the intertidal, with tufted plus coralline algae in the lower intertidal.



Figure 16 The southern end of cattle bay seen in Figure 14 extends further into Snug Cove as a shallow to deep rocky reef. Note Eden Harbour in the background.



Figure 17 The shallow inshore rocky reef supports a mix of tufted algae, sea squirts, oysters and mussels plus large brown algae, mainly crayweed *Phyllospora comosa* with some kelp *Ecklonia radiata* and *Sargassum spp.* Note the accumulated floating plastic rubbish from the harbour.



Figure 18 Cattle Bay Beach on western side of jetty showing twin pipe stormwater outfall and rock rubble beach (left side of photograph).



Figure 19 Western side of Cattle Bay rock rubble beach and start of western rock intertidal shore. Note dark patches of rock rubble reef offshore from the beach and in the middle foreground of the photo.

2.2 Cattle Bay Beach and Sub-tidal Bare Sand Habitats

Figures 8, 10, 12, 18 and 19 show aspects of Cattle Bay Beach. The back of the beach is constrained by various retaining structures for the old cannery factory and the retaining walls are in various states of disrepair (e.g., Figure 12). There is a twin-pipe concrete stormwater outlet on the western beach that drains over rock rubble and sand (Figure 18). The beach becomes a rock rubble reef to the west of the stormwater outlet and then becomes rocky reef (Figure 19). There is no beach vegetation and the riparian vegetation above the retaining structures is generally wed species (see also Cumberland Ecology 2007 for additional detail of terrestrial flora and fauna).

Sand habitat extends from the beach offshore into the bay and beyond. The sandy sediments that are clean mixed fine and coarse sands on the beaches grading to coarser sand in the intertidal and then grading to mixed fine and coarse sand with depth (in line with descriptions provided in DECCW (2010). TEL (2002) described the sediments as clean and coarse in shallow areas becoming finer with depth.

Fraction Size	Detect Limit	Sample Site					
		1	2	2a	3	4	5
<75µm		6	16	14	16	9	15
+75µm	0.01	22	26	26	21	45	15
+150µm	0.01	40	50	54	40	34	24
+300µm	0.01	15	6	4	12	8	7
+425µm	0.01	9	1	1.5	7	3	7
+600µm	0.01	6	0.5	0	3	0.5	31
+1180µm	0.01	1.5	0	0	0	0	0.5
+2.36mm	0.01	0	0	0	0	0	0
+4.75mm	0.01	0	0	0	0.5	0	0
+9.5mm	0.01	0	0	0	0	0	0
+19.0mm	0.01	0	0	0	0	0	0
+37.5mm	0.01	0	0	0	0	0	0
+75.0mm	0.01	0.5	0.5	0.5	0.5	0.5	0.5
Sample Depth (mLAT)		5.6	6	6.1	7	6.8	7.8
% Silt		6	16	14	16	9	15
% Fine Sand		62	76	80	61	79	39
% Fine to Medium Sand		24	7	5.5	19	11	14
% Med to Coarse Sand		7.5	0.5	0	3	0.5	31.5
% Residual		0.5	0.5	0.5	1	0.5	0.5

Five deep-water sand samples were collected for the present study (see Figure 8 for sample locations) and the results of grain size analysis for the five sediment samples are shown in Table 1. Note that two of the samples were collected from the same site (P2). The results show that the samples are predominantly sand (83 to 94%) and that is generally fine sand (61 to 80% for samples 1 to 4), in line with other studies throughout Twofold Bay. The deepest site 5 (-8m depth) had less fine sand (39%) and the greatest proportion of coarse sand (31% compared to 0 to 7.5% for the remaining samples).

The samples were also analysed for metals, TBT and a range of organic contaminants and the full results of these analyses are presented in the Coastal Process study (Haskoning Australis 2013), and summarised in Table 2 below. The levels of contaminants were compared to ANZECC (2000) guidelines for the protection of benthic (bottom dwelling) organisms (where available) and are summarised as follows:

- Sediment TOC values were low with mean and median values of 0.5%.
- All analyte concentrations were low, and for the metals, TPH, TBT and total PAHs for which ANZECC (2000) guideline values are available, all were well below the ISGQ Low values.

- Notwithstanding the low contamination values, there was one consistent spatial pattern for the data. For all analytes except TOC, the mean values for sites 3 and 5 (i.e., those closer to Eden Port) were higher than the means for sites 2 and 4 (further away). This suggests that there could be a contamination gradient away from the main port.
- For TOC values the higher mean was for the sites closer to the mussel aquaculture facility to the west and this could suggest a gradient of biodeposition away from the mussel farm. In this respect these sites also had the greatest proportion of fine sand but not of silt.
- There was no north to south pattern in the concentrations of contaminants, which could have suggested a Cattle Bay stormwater source for contamination.

Table 2 Cattle Bay Sediment Contamination

Analyte	units	PQL	ANZECC ISGQ low	ANZECC ISGQ high	Min	Median	Mean	SE of Mean	Max
Moisture	content %	1	-	-	24.8	27.1	26.8	0.6	27.9
TOC	%	0.02	-	-	0.46	0.50	0.50	0.01	0.55
Aluminium	mg/kg	50	-	-	2120	2670	2730	218	3310
Iron	mg/kg	50	-	-	5840	7285	7743	941	11700
Antimony	mg/kg	0.5	2	25			<0.5		
Arsenic	mg/kg	1	20	-	5.02	5.29	6.63	1.07	10.70
Cadmium	mg/kg	0.1	1.5	10			<0.1		
Chromium	mg/kg	1	80	370	7.1	7.7	8.1	0.6	10.4
Copper	mg/kg	1	-	-	3.2	4.4	4.5	0.5	6.2
Cobalt	mg/kg	0.5	65	270	1.2	1.5	1.5	0.1	1.9
Lead	mg/kg	1	50	220	4.0	4.8	5.3	0.6	7.5
Manganese	mg/kg	10	-	-	19	23.5	24.0	1.8	31
Nickel	mg/kg	1	21	52	3.1	3.8	3.9	0.3	5.1
Selenium	mg/kg	0.1	-	-			<0.1		
Silver	mg/kg	0.1	1	3.7			<0.1		
Vanadium	mg/kg	2	-	-	11.8	14.2	15.3	2.0	23.4
Zinc	mg/kg	1	200	410	13.7	16.4	18.2	2.2	25.2
Mercury	mg/kg	0.01	0.15	1	0.01	0.010	0.016	0.004	0.03
TPHs	mg/kg	3	550	-			<3		
TBT*	µgSn/kg	0.5	9	70	<0.5	<0.5	0.7	0.3	2.0
PAHs*	µg/kg	4	10,000	50,000	7.7	130.2	97.9	30.1	152.9

Note* Values for TBT and PAH were normalised for TOC prior to calculations

The conclusion that can be made from these results is that the sandy sediments within Cattle Bay would be expected to support a diverse benthic fauna of polychaete worms, molluscs and crustaceans as evidenced by the abundance of borrows observed in the sand.

2.2.1 Seagrasses

As noted on Figure 6, Fisheries NSW have indicated a *Zostera* bed off the northern end of Cocora Beach. In addition to this bed, TEL (2002) reported patchy *Zostera muelleri* in a strip running parallel to the wharf growing between the boulders making up the rubble reef and along the outside of the rubble reef to a depth of 6.9m.

On the eastern side of the bay TEL (2002) reported a strapweed *Posidonia australis* bed running parallel to the shore and parallel to the old cannery effluent pipeline. This bed was about 4m wide inshore and 12m wide offshore. Density was higher in shallow water (5m) and in deeper waters (7m) it was sparse and patchy. This bed was inspected for the present study and Figures 20 to 23 show aspects of the bed. From the present study it is concluded that the bed is similar to that described by TEL (2002) with similar dimensions and density distributions. In addition, the bed also included two other seagrass species, a *Zostera* species (most probably *Zostera muelleri*) and paddle weed *Halophila ovalis*.



Figure 20 Edge of eastern *Posidonia* bed next to Kelp covered cannery effluent pipeline.



Figure 21 Portion of middle *Posidonia* bed on eastern side of bay showing mixed *Posidonia* and *Zostera* growth.



Figure 22 Wide view of dense portion of *Posidonia* bed on eastern side of Cattle Bay.



Figure 23 Paddle weed *Halophila ovalis* bed with sparse *Posidonia* cover in deeper waters on eastern side of bay.



Figure 24 Sparse *Heterozostera tasmanica* seagrass cover on sandy seabeds offshore from Cattle Bay to about 8m depth.



Figure 25 An isolated denser patch of *Heterozostera tasmanica* in the marina footprint. Note accumulation of smothering algae around plants.

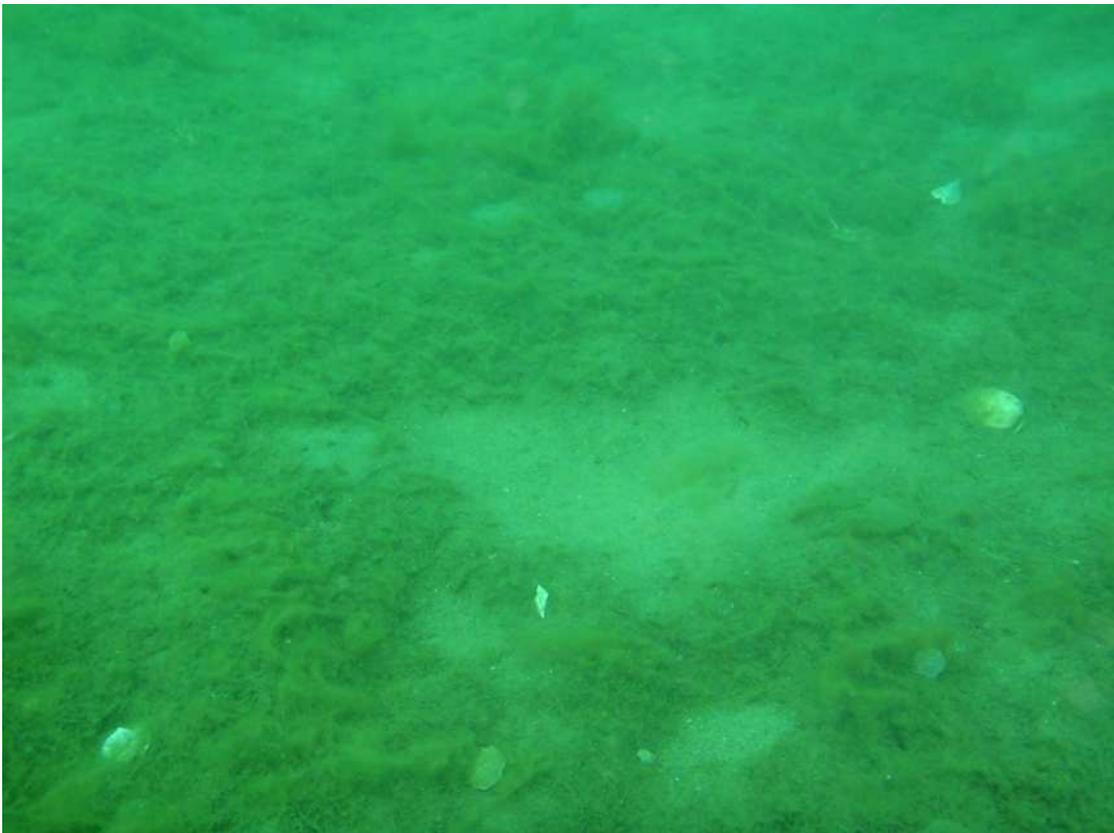


Figure 26 Areas of drift algae smothered parts of the offshore seabed in the marina footprint.



Figure 27 Some deeper seabed areas with sparse *Heterozostera* were completely smothered by drift algae plus fine brown filamentous algae.

For the present survey there was a *Zostera* species (most probably *Heterozostera tasmanica*) reported from four of the five offshore survey sites shown on Figure 8. The offshore seagrass distribution is very patchy and for the most part quite sparse (Figure 24) although there can be more dense patches (Figure 25). Much of the seabed was smothered with drift algae (probably a *Gracilaria* species - Figure 26), and this algae combined with the fine filamentous brown algae noted in Figure 25 was seen to have totally smothered some of the offshore *Heterozostera* seagrass (Figure 27). Although this seagrass distribution has not been reported previously it is likely that it is more widely spread throughout Twofold Bay. CSIRO (1989) reported a *Zostera* species from underwater video transects in water depths to 10 m in Nullica Bay and from 10m depth in Calle Calle Bay in the general locality of the large Calle Calle Bay seagrass area shown on Figure 7. PSM (1996) reported a 20 ha *Heterozostera* bed 400m off Boydtown Beach and NGH Environmental (2009) also reported sparse and patchy *Zostera* sp. seagrass from East Boyd Bay. Given the similarity in description and depth distribution, the seagrass in Calle Calle Bay may be similar to the fine leaved *Heterozostera* observed in Cattle Bay for this survey and off Boydtown Beach by PSM (1996) and there may well be an extended distribution to the south to East Boyd Bay.

Other fauna noted on the sandy seabed included clusters of black mussels, scallops and sand tube worms. Few demersal (bottom dwelling) fish were observed, probably as a result of the high algae mass on the bottom. However, common stingaree, dusky flathead, whiting

and black fish were observed over in-shore bare sandy habitat. One large school of jack mackerel *Trachurus declivis* was observed at the sediment site 3 collecting site (Figure 28).



Figure 28 School of jack mackerel in marina footprint (7m depth).

In regard to possible demersal fish species CSIRO (1989) caught 30 species of fish and 3 invertebrates from 24 seine net samples collected over 4 days in winter 1989 off three beaches in Twofold Bay. All the fish species caught were also caught in Jervis Bay and the researchers concluded that there are similar assemblages of fish over shallow sandy seabeds in both bays. The combined observations of sand substratum fish by TEL (2002) for Cattle Bay and NGH Environmental (2009) for East Boyd Bay support the conclusion that the fish species over sandy habitats of Twofold Bay (including Cattle Bay) are similar to those of other semi-enclosed sandy bays along the NSW south coast.

2.3 Rocky Shores and Hard Substratum Habitats

As noted on Figure 8, the intertidal rocky shores of Cattle Bay are relatively narrow with no wide intertidal rock platforms. In contrast, the subtidal rocky reefs are wider, and extend to boulder or rubble reef on the western side of the bay. The eastern side reefs are narrower and comprise broken basement rock reefs only.

The hard substratum habitat comprises the wetted surfaces of the jetty piles and the accumulated debris under and around the jetty plus at least one pipeline that follows the

eastern shoreline offshore from the reef. This pipeline was said to be an effluent pipeline for the old seafood cannery. The hydrographic chart indicates another pipeline running due south from the inshore end of the jetty (see Figure 3) and the symbols used to indicate the pipeline are for an oil pipeline. The TEL (2002) study made no mention of this latter pipeline and it could not be located for the present survey. This would indicate that it has either been removed or is buried.

2.3.1 Intertidal Rocky Shores

Appendix A1 provides a species lists for intertidal rocky reef habitats (Table 5 from the TEL 2002 report), and Figures 10 and 13 to 19 show aspects of the intertidal rocky shore along the eastern and western sides of the bay. The present survey only added one intertidal species, the introduced Pacific oyster, which has established in many NSW estuaries over the years. It was originally reported from Twofold Bay by Hutchings et al (1986).

The reported and observed species are all common to east coast rocky shores (Hutchings *et al* 1989) and the zonation of species with tide is representative of sheltered oceanic or outer estuary beaches that are protected from swell waves but can be open to local storm waves.

With regard to priority IMS, neither the TEL (2002) survey or the present survey found European shore crabs *Carcinus maenas* on the intertidal shores. This is in line with observations reported in Pollard *et al* (2005) that this introduced species now seems to be confined to tributaries of Twofold Bay.

2.3.2 Sub-tidal rocky reefs

TEL (2002) described the rocky reefs along the western side of the bay as large boulders covered with kelp with an abundance of the solitary ascidian *Herdmania momus*. There were only seven species of fish observed and these occurred in small numbers. In contrast they found more diversity of reef and fish biota on the eastern rocky reef. Appendix A1 provides a fish list for Cattle Bay hard substratum (reef and pile) habitats prepared by TEL (2002) from their winter survey.

For the present survey the rocky reef inspection was concentrated on the eastern shore rocky reef, which would be closest to the proposed marina fairway (Figure 3). These reefs showed a more or less typical depth zonation as described by DECCW (2010). The shallow inshore rocky reef of Cattle Bay supported a mix of tufted and red coralline algae, sea squirts, oysters and mussels in the upper zone with large brown algae, mainly kelp *Ecklonia radiata*, *Sargassum spp.*, and crayweed *Phyllospora comosa* in the sub-tidal waters to the seabed. The understory of the kelp beds supported isolated sponges and solitary ascidians.

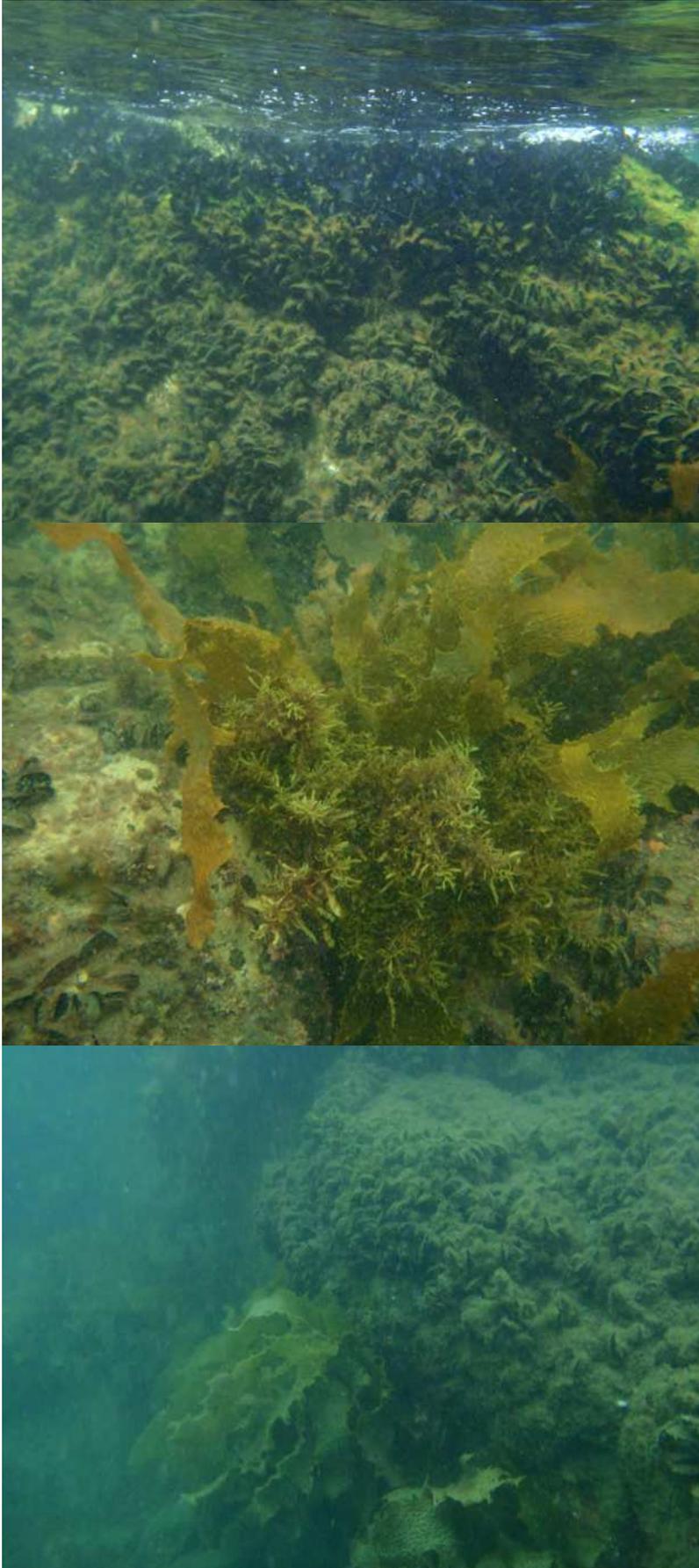


Figure 29

Black mussels dominate most depth zones on the rocky reefs along the southern part of the eastern shore of Cattle Bay.

The top photo shows mussels in the lower intertidal to shallow sub-tidal zone.

The middle photo shows mussels covering the rock in the shallow sub-tidal kelp and crayweed zone.

The lower photo shows the mussel cover in the lower kelp zone. This zone (and the deeper zones below) are also covered in a fine silt/algae matrix.

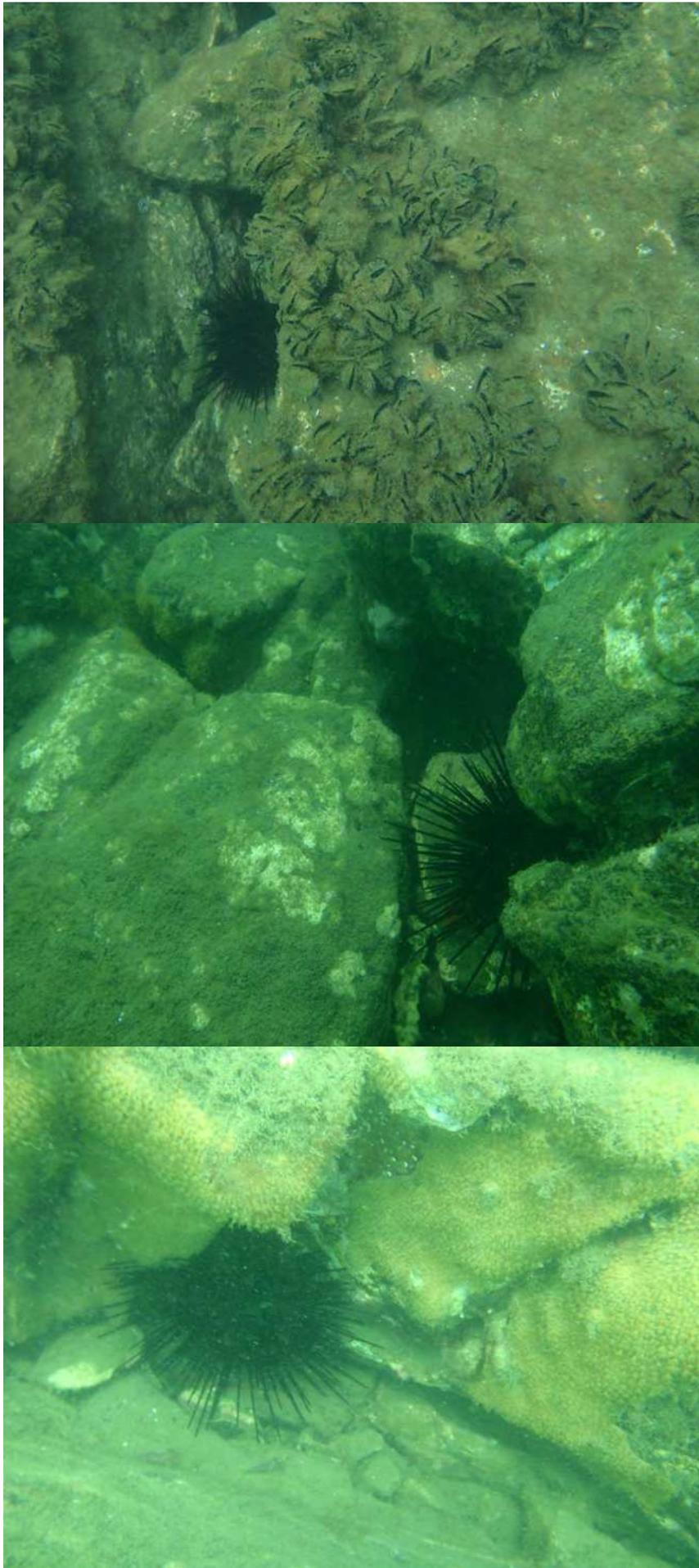


Figure 30

Deeper water barrens habitat on Cattle Bay eastern shore.

Top photo shows patchy mussel cover in barrens habitat and the fine silt/algae matrix covering rock surfaces.

The middle photo shows urchin grazing scars in the silt/algae matrix.

Lower photo shows an area of barrens habitat without the silt/algae matrix that supports an encrusting cold water coral.

There is proportionally more kelp on the sheltered shallow rock reef inside Cattle Bay and proportionally more crayweed in the more open shallow rocky reef towards the south. Whole sections of the outer shallow to mid depth rocky reef along the south-eastern side of Cattle Bay are dominated by mussels that cover most of the rock surfaces and this domination continues through the shallow mixed frondose algae, brown macro algae and barrens zones ((Figure 29). This total cover of mussels through the various depth zones may reflect the pattern of water circulation around the bay which is predominantly clockwise (SKP 1989) and which puts the Cattle Bay rocky reefs immediately downstream of the mussel aquaculture farms off Bungo Beach/Cocora Point.



Figure 31

Isolated rock pinnacle towards the southern end of the eastern rock reef.

The top section is barrens habitat (top photograph) and the lower photograph shows solitary ascidians *Herdmania momus* on deeper parts of the pinnacle rock.

These deeper rocky reef barrens of the Cattle Bay eastern shore typically have very little kelp cover, as attached algae are kept in check by the grazing activity of black sea-urchin *Centrostephanus rodgersii* (Figure 30), as described by Hill *et al* (2003). The Cattle Bay outer eastern shore barrens habitat is atypical in respect to the large clumps of attached black mussels (as described above), and as the rock substratum is largely smothered by a fine silt and algae matrix that also smothers attached fauna (Figure 30). This silt and algae matrix is generally more typical of inner nutrient-rich riverine estuaries with a high sediment load. The persistence of the smothering silt/algae matrix may explain the comparative lack of other barrens habitat species such as encrusting sponges, deep water ascidians and bryozoans.

Whilst the deeper rocky reef is generally continuous from inshore to the offshore edge at least one isolated pinnacle was noted towards the southern end of the eastern shore. The pinnacle supported no algae (i.e., was all barrens habitat) in the shallower waters, with black urchins and some solitary tunicate *Herdmania momus* cover on the lower rock surfaces (Figure 31).

Whilst there were few fish species observed on the deep southern parts of the reef for the present survey (mainly luderick, yellowfin bream and goatfish on adjacent sandy bottoms), the shallower inshore reefs supported a variety of reef fish typical of an outer estuary, limited-shelter reef locality. TEL (2002) recorded only seven fish species from the rocky reefs on the west side of Cattle Bay and 29 species from the eastern inshore reef and immediately adjacent sandy bottom and waters, for a total abundance of 1298 individuals comprising mainly schools of predatory fish (1000 striped sea pike, 100 sand whiting, 70 luderick and 50 silver trevally). TEL (2002) also recorded 5 blue grouper including at least one large male indicating a resident population. These would have been expected for the present survey over the deeper eastern shore reefs but were not observed, presumably due to the very limited visibility. More recently, NGH Environmental (2009) recorded 34 fish species from sites in East Boyds Bay around the wood chip wharf. This is a more open exposed oceanic site and consequently the site supported proportionally more sharks (Port Jackson and draughtboard sharks) and rays (two stingarees and the eastern banded ray). All the reef fish reported for the two studies are common to east coast reefs.

2.3.3 Constructed habitat

The main constructed habitats in Cattle Bay are the wetted surface areas of the Cannery Wharf, the old cannery effluent steel pipeline alongside the eastern shore rocky reef, the mooring tackle (ropes, chains and blocks) for moored vessels and assorted cannery wharf jetsam (old piles, buffer timbers, tyres and other hard rubbish) on the seabed around the cannery wharf.



Figure 32

Attached biota on Cattle Bay wharf piles – Intertidal to mid – depths.

Top photograph: intertidal barnacles, black mussels and tubeworms *Galeolaria caespitosa*.



Middle photograph: shallow subtidal cunjevoi *Pyura stolonifera*, tufting and frondose red and green algae, barnacles, purple and orange sponges, bryozoans and ascidians *Herdmania momus*.



Lower photograph: Kelp zone below tufted algae zone, still



Figure 33

Pile biota in deeper waters below the kelp zone.

The three photographs show the variety of encrusting and branching sponge, solitary and colonial ascidians, and bryozoan fauna on the lower pile surfaces.

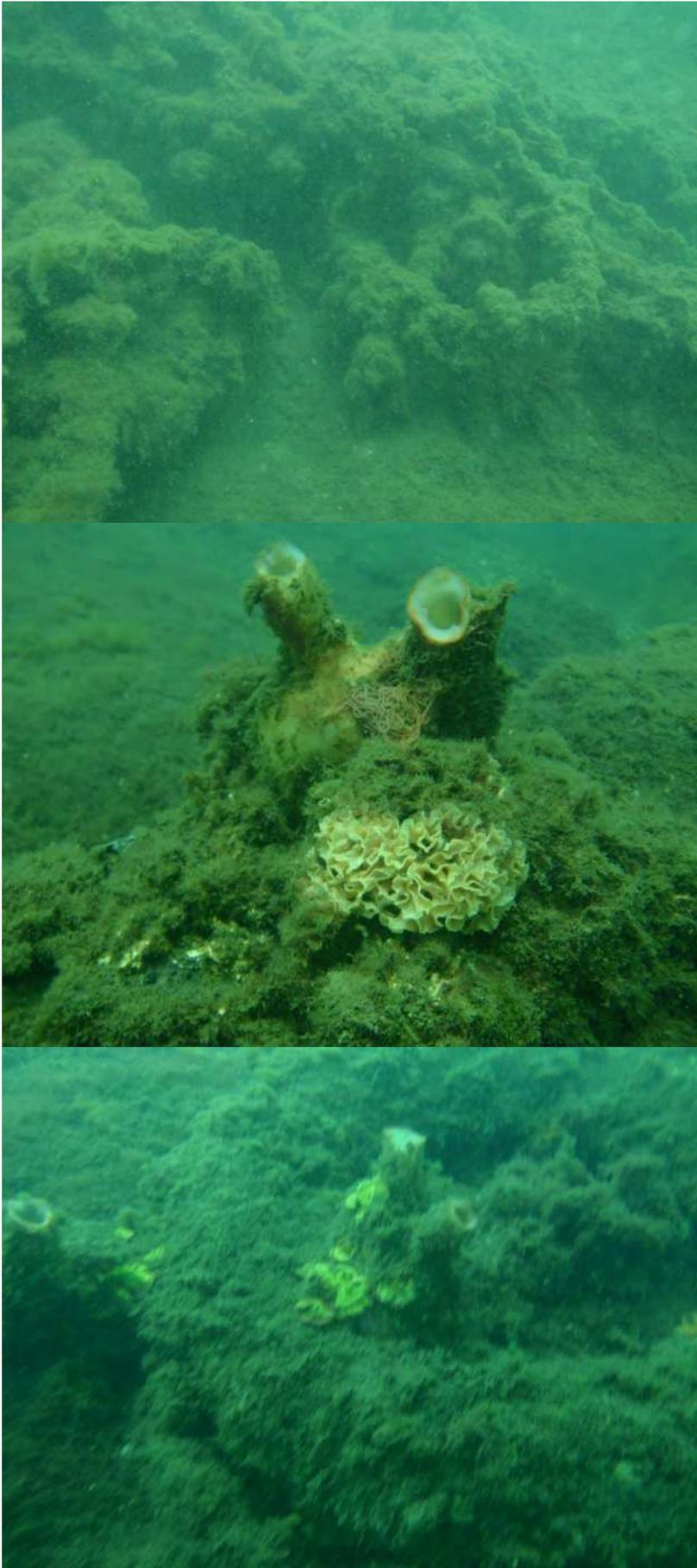


Figure 34

Biota on rubble under and around wharf

Rubble in the shallows supported kelp and various algae. Rubble in deeper waters supported progressively more sediment in a silt/algae matrix (top photograph) with various attached fauna such as aboresent bryozoans lace coral bryozoa (such as *Triphyllozoon sp.* iillustrated), solitary ascidians *Herdmania momus* and yellow sponges.

TEL (2002) provided a list of common encrusting species and of observed fish on the cannery wharf and their results are summarised in two tables provided here at Appendix A1. They noted that the most abundant alga was kelp with small amounts of other brown algae, whilst the fauna included solitary and colonial tunicates, sponges and arborescent bryozoans. They also noted Sabellid type fan worms and reported red bait crabs *Plagusia chabrus*. There were 18 species of fish observed from the piles, rubble, seabed and immediate waters around the piles for a total of 1194 individuals. As for the reef fish census, the main fish numbers were predatory schooling fish (1000 striped sea pike, 100 silver trevally and 20 tailor). There were also 30 mullet larvae and 10 unidentified juvenile fish reported.

For the present survey the piles and the seabed under and immediately around the wharf were resurveyed. The depth zonation of attached biota on the piles was the same as that described by TEL (2002). Figure 32 shows pile biota to mid depth, Figure 33 shows pile biota from mid depth to the seabed and Figure 34 shows rubble on the seabed:

- Black mussels and tubeworms dominated the intertidal to shallow sub-tidal pile surfaces.
- The immediate sub-tidal below this supported a mixed frondose and tufting algae flora with cunjevoi and barnacles.
- Below the wave zone in the sub-tidal, the piles supported kelp through to mid depths with solitary ascidians, sponges and bryozoa attached to the piles. There were also crabs on the piles.
- The pile surfaces below the kelp zone in mid waters supported progressively less kelp and a greater variety of encrusting fauna including branching sponges, lace coral bryozoa *Triphyllozoon sp.*, and other arborescent bryozoans.

The disused iron cannery effluent pipe supported kelp and *Herdmania momus* for most of its length with less kelp and more bryozoans and sponges towards the deer outlet end.

2.3.4 Possible introduced marine species (IMS) in Cattle Bay

Approximately 50 species of marine organisms are considered to have been introduced into NSW coastal waters, some having significant impacts on indigenous species (Fisheries Scientific Committee (2004)). For example, the invasive alga *Caulerpa taxifolia* has been introduced to several NSW estuaries, where it has replaced seagrass beds that were important fish habitats. Several toxic dinoflagellates have been introduced to NSW waters, including *Alexandrium catenella*, one of the causative agents of paralytic shellfish poisoning.



Figure 35 *Sabella* type fan worms found on piles (top photo), deep rocky reef (middle photo) and on isolated rubble under and around the wharf.

These are thought to be the feather duster fan worms *Sabellastarte australiensis*.

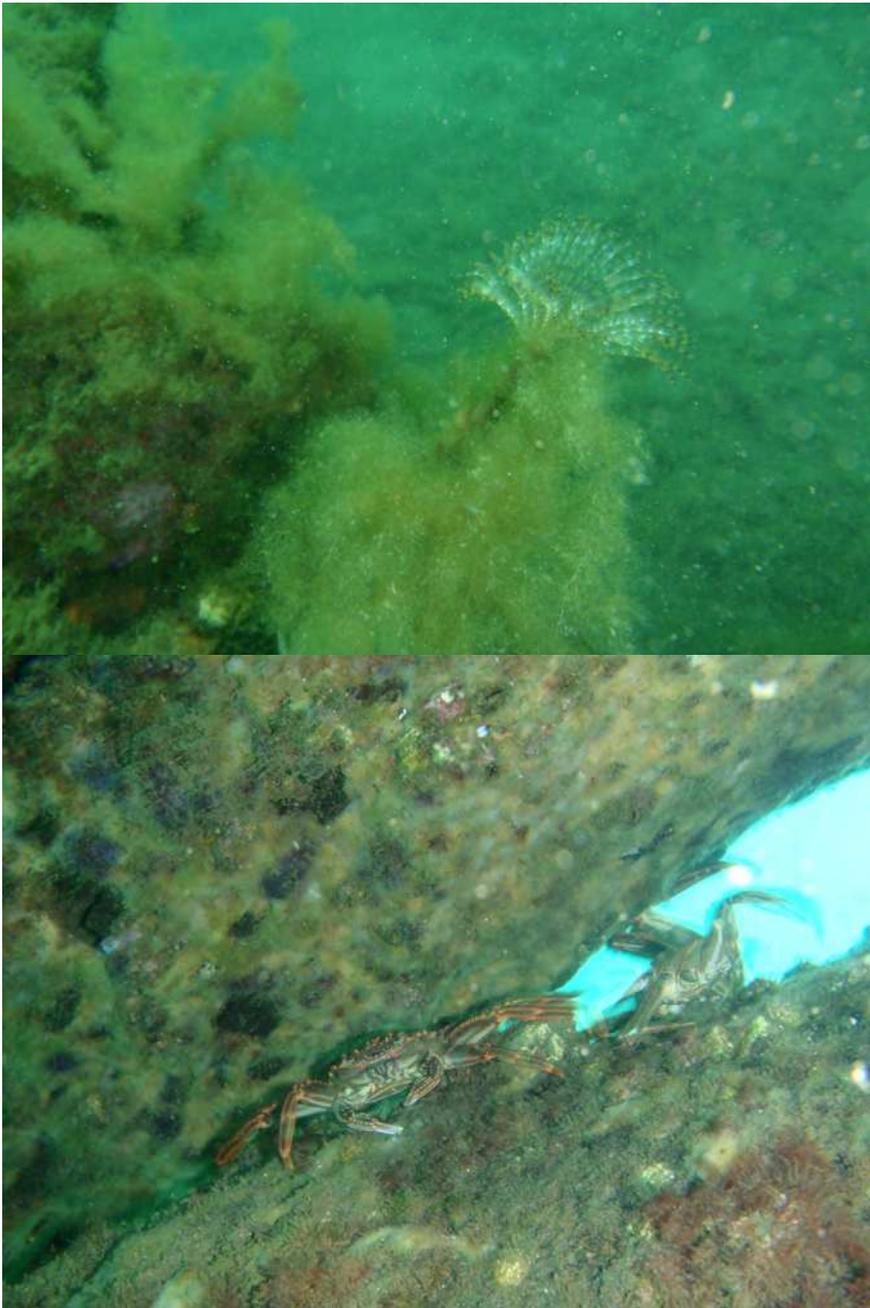


Figure 36
Two possible IMS from
Cattle Bay.

Top photograph: The fan worm feeding tentacles appear to have a spiral form typical of *Sabella spallanzanii*. This specimen was on an isolated piece of rubble in the marina footprint.

Bottom photograph: Crabs on the Cattle Bay piles were abundant, and are either the common red shore crab *Plagusia chabrus* or the introduced New Zealand piecrust crab, *Cancer novaezelandiae*, known from Snug Bay wharves.

Other introductions to NSW marine waters include the European shore crab (*Carcinus maenas*), the European fanworm (*Sabella spallanzani*) and the Pacific oyster (*Crassostrea gigas*). In regard to IMS present in Twofold Bay Pollard and Rankin (2003) found that:

- *Alexandrium* “catenella type” dinoflagellates occurred in low abundance in Twofold Bay plankton hauls and as cysts in sediments.
- European shore crabs occurred in high numbers in the tributaries draining to Twofold Bay but not on the more marine shores of Twofold Bay.
- 34 Mediterranean fanworms were detected and removed from wharf pilings, rubble and under wharves in Snug Cove with two collected from a mooring 500m outside the harbour. None were collected from the cannery wharf in Cattle Bay.

- The New Zealand rosy screw shell *Maoricolpus roseus*, were found throughout the bay and were extremely abundant in seagrass beds in East Boyd Bay and in deeper waters offshore from Twofold Bay.
- *Theora fragilis*, which is known from most NSW estuaries, was abundant in Cattle Bay sediments during the original 1997 IMS survey (CSIRO 1997).
- The New Zealand piecrust crab, *Cancer novaezelandiae*, was collected throughout the Snug Cove area during the initial port survey (CSIRO 1997).
- In March 2010 a suspected incursion of the invasive colonial sea squirt *D. vexillum* was reported from the multi-purpose wharf in Twofold Bay. Following extensive searches and collection of suspected specimens for referral to international experts it was concluded that the majority of the specimens were the native *Didemnum patulum* with a small number of native *Didemnum incanum* (see top photograph Figure 33).

For the present field survey of Cattle Bay, *Sabella* fan worms were found on all hard substrata, sub-tidal rocky reef, rock and timber rubble, moorings and wharf piles. Whilst most appeared to be feather duster fan worms *Sabellastarte australiensis* (Figure 35), one specimen found on an isolated piece of rubble in the marina footprint could be a European fanworm (Figure 36).

There were numerous crabs noted on the Cattle Bay wharf piles and TEL (2002) previously reported red bait crabs *Plagusia chabrus* as abundant on deeper piles. These crabs can look very similar to New Zealand piecrust crab, *Cancer novaezelandiae*, and these may well be now present on the wharf (Figure 36).

The pest algae species *Caulerpa taxifolia* has not been reported previously from Twofold Bay and none of the marine ecology studies undertaken in Twofold Bay since 2000 have reported it. Specific searches were made for *Caulerpa taxifolia* during the present field studies and it was not found in Cattle Bay.

2.4 Threatened, Listed and Protected Aquatic Species in Twofold Bay

Aquatic habitats, flora and fauna of conservation significance are protected under both State and Federal legislation. In NSW, threatened species, populations and ecological communities of animals and plants are protected under the *Threatened Species Conservation Act 1995 (TSC)*. Threatened species, populations and ecological communities of fish and marine vegetation are protected under the *Fisheries Management Act 1994 (FMA)*. The TSC and FMA also list a number of key threatening processes (KTPs) that may threaten the survival of species, populations and ecological communities. The *Environment Protection and Biodiversity Conservation Act 1999 (EPBC)* protects wetlands of international importance, Commonwealth Marine Areas, nationally threatened species and ecological

communities. All three acts also provide specific protection for non-threatened species that are listed as protected or are listed as protected migratory species.

Over and above the data-base reviews as discussed in Section 1.3 several of the more recent Twofold Bay studies provide reviews of specific threatened aquatic species that may occur in Twofold Bay and specifically in Cattle Bay:

- TEL (2002) undertook eight-part testing under the FMA and TSC for considered the impacts of the earlier marina proposal for Cattle Bay on the following species that do or could occur in Twofold Bay; Black Cod, Grey Nurse Shark, Great White Shark, Southern Right Whale, Humpback Whale and Australian Fur Seal. TEL (2002) undertook a generic eight-part test for Blue, Fin and Sperm Whales plus Spinner dolphins and for Whale sharks as they are considered oceanic species that would not occur in Twofold Bay. Cumberland Ecology (2007) provided an additional impact assessment on these ten aquatic marine species for the proposed Eden Resort at Cattle Bay.
- NGH Environmental (2009) considered the impacts of a proposed power plant cooling water discharge at the Woodchip Wharf in East Boyd Bay and undertook seven part tests (FM and TSC Acts) and assessments of significance (EPBC Act) were undertaken on seven threatened species identified as having the potential to be impacted by the proposal; Black cod, Australian grayling, Southern right whale, Humpback whale, Australian fur seal and the Green turtle.

2.4.1 Threatened Species

From the combined reviews presented above and from the data-base searches the following threatened aquatic species have been considered in relation to the marina proposal in Cattle Bay:

Fish and Sharks

- Black cod *Epinephelus daemeli* is listed as a vulnerable species under the FMA and the EPBC Act. Whilst there is at least one record from Twofold Bay (an Australian Museum specimen from Boydtown, Nullica Bay, the black cod is towards its geographical limit at Twofold Bay, and it is considered unlikely that there are resident populations. NHG Environmental (2009), TEL (2002) and the present study included specific searches for Black cod and none were found. It is concluded that the rocky reefs of Cattle Bay do not provide suitable microhabitat (caves and crevices that can be used by adults to establish territories. Transient juveniles could be expected to use the rocky reef habitats from time to time.

- Grey Nurse sharks (east coast population *Carcharias taurus* are listed as critically endangered under the FM and EPBC Acts. Cattle Bay lacks the coastal rocky reef adjacent to drop-offs with microhabitats such as ledges, caves and small sandy gutters preferred by Grey Nurse sharks so they are unlikely to reside in or utilise Cattle Bay.
- Great white sharks *Carcharodon carcharias* are listed as Vulnerable under the FM and EPBC Acts. They frequent coastal waters, often close to shore and have very wide ranges. Whilst they can take up residence off rocky shores where there are seal colonies they are more often thought to follow large schools of migrating fish such as sea mullet and Australian salmon, or migrating whales with calves. Accordingly they could be expected to travel into Twofold Bay from time to time but would not be expected to be resident in the bay.
- Whale sharks *Rhincodon typus* are listed as Vulnerable under the EPBC. These are all essentially oceanic species that may occur in coastal waters off Twofold Bay from time to time.

Pinnipeds

- The Australian fur seal *Arctocephalus pusillus doriferus* is listed as Vulnerable under the TSC Act. Whilst fur seals are known from Twofold Bay, particularly basking on the Eden Breakwater, there are no permanent local populations and breeding occurs on exposed oceanic sites in Bass Strait from October to January. Fur seals may use the seabed and rocky reefs of Cattle Bay for feeding on fish and cephalopods from time to time, but habitats for these prey species are abundant throughout Twofold Bay so Fur seals can be expected throughout Twofold Bay.
- The New Zealand fur seal *Arctocephalus forsteri* is listed as Vulnerable under the TSC Act. It occurs as an occasional non-breeding vagrant in NSW southern coastal waters up to locations north of Sydney. Its use of Twofold Bay would be similar to that of the Australian fur seal (i.e., feeding and basking).

Cetaceans

The proximity of Eden to the continental shelf, only about an hour steaming, means that many species of whales that travel along continental margins can be seen in these waters as they travel relatively close to shore. The majority of whales sighted in the Eden area are Humpback whales seen on their southern migration. At the start of the season it is mainly sub adults, followed by mother/calf pods, which quite frequently come right into Twofold Bay, giving the calves a chance to rest. Other species including Southern Rights, Blue, Dwarf Minke, Bryde's, Orca, Pilot, Sperm and several species of Beaked Whales have also been sighted off the coast of Eden in recent years (Cat Balou Cruises web sight March 2013).

- Southern right whales *Eubalaena australis* had its listing increased from Vulnerable to Endangered under the TSC Act (NSW Scientific Committee 2011) and is also listed as Endangered under the EPBC Act. A recovery plan has been recently updated for 2011 to 202 under the EPBC Act (DSEPC 2011). The major habitats for Southern right whales are the feeding areas of the Southern Ocean, the mating and calving aggregation areas in the Great Australian Bight and calving areas along the east (and west) coasts of Australia. Twofold Bay is considered as a potentially biologically important area (BIA) for East Coast Southern Right Whale population recovery (DSEPC 2011) as it is known historically to be an important calving and resting area where calving females or females with young travelling south may remain in shallow waters of 5 to 10m depth (Pirzl 2008 in NSW Scientific Committee 2011). The majority of sightings in Twofold Bay occur from July to September (analysis of Cat Balou Cruises whale sighting data by PSM 1996 and see also Table 3 for analysis of most recent data).

Table 3 Southern Right Whale Sightings from Cat Balou Web Cruises Diary 2010 to 2012 Seasons

Date	Adults	Sub-Adult	Calve	Movements
19-Aug-10	1			Eden close to lookout
20-Aug-10	1			Ross Bay to Aslings Beach and back
29-Aug-10	2			Quarantine Bay
17-Sep-10	2			Ross Bay to Boydtown Beach
18-Sep-10	2			East Boyde
1-Oct-10	2			Between Woochip and Navy Wharves
29-Aug-11	2			Twofold bay
6-Sep-11	1			150m off Aslings Beach
16-Sep-11	1			At South Head
25-Sep-11	1			Off Eden Lokout
2-Oct-11	2			Off Aslning Beach
4-Jul-12		1		Off Honysuckle Bay to Whale Beach
17-Jul-12	2			Aslings Beach
5-Aug-12	mother		1	Calle Calle Bay to Nullica Bay
6-Aug-12	2			Whale Beach to East Boyd
7-Aug-12	2			Ross Bay to Boydtown Beach
8-Aug-12	3			Off Whale Beach

- Humpback whales *Megaptera novaeangliae* are listed as Vulnerable under the TSC and EPBC Acts. They feed and grow in the Southern Ocean during the summer months followed by a northwards migration along the east Australian coast between June and October to subtropical waters to mate and calve. The east coast population migrates along the continental shelf north past Twofold Bay from late autumn to

winter and south past Twofold Bay in late spring and early summer, accompanied by new born calves (principally from September through November). On the southern migration Humpbacks regularly enter Twofold Bay or delay their migrations in coastal waters offshore of Twofold Bay to feed on coastal krill (*Nyctiphanes australis*) and small teleost fish, including sardines, particularly when up-wellings provide suitable feeding conditions. Silva *et al* (2011) have combined the Cat Balou Cruises whale watching data with their own data for the years 1995 to 2010 (Table 4) and have mapped feeding congregations between 2006 and 2010 (Figure 37). They note that whale concentrations tended to shift from year to year over an area up to 20 km offshore within the study area. About half of the feeding whales (46.7%) were sub-adults and calves were present in most years with (see Table 5).

Table 4 – Total humpback whale sightings and the percentage of whale feeding between 1995 and 2010 (Reproduced from Table 1 from Silva et al 2011).

Year	Total whales sightings	Whales not feeding	Whales feeding	% whales feeding
1995	100	51	49	0.49
1996	217	212	59	0.27
1997	477	441	36	0.08
1998	461	439	22	0.05
1999	288	281	7	0.02
2000	278	248	30	0.11
2001	357	357	0	0
2002	282	268	14	0.05
2003	309	287	22	0.07
2004	304	298	8	0.03
2005	345	266	79	0.23
<i>2006</i>	<i>60</i>	<i>43</i>	<i>17</i>	<i>0.28</i>
<i>2007</i>	<i>189</i>	<i>133</i>	<i>56</i>	<i>0.30</i>
2008	917	566	351	0.38
<i>2009</i>	<i>392</i>	<i>126</i>	<i>266</i>	<i>0.68</i>
<i>2010</i>	<i>269</i>	<i>169</i>	<i>100</i>	<i>0.37</i>

Notes: Data from 1995 to 2005 and 2008 were collected from operators of whalewatch vessel Cat Balou and data in 2006, 2007, 2009 and 2010 (in italics) were collected as part of the research effort from R/V Naiad.

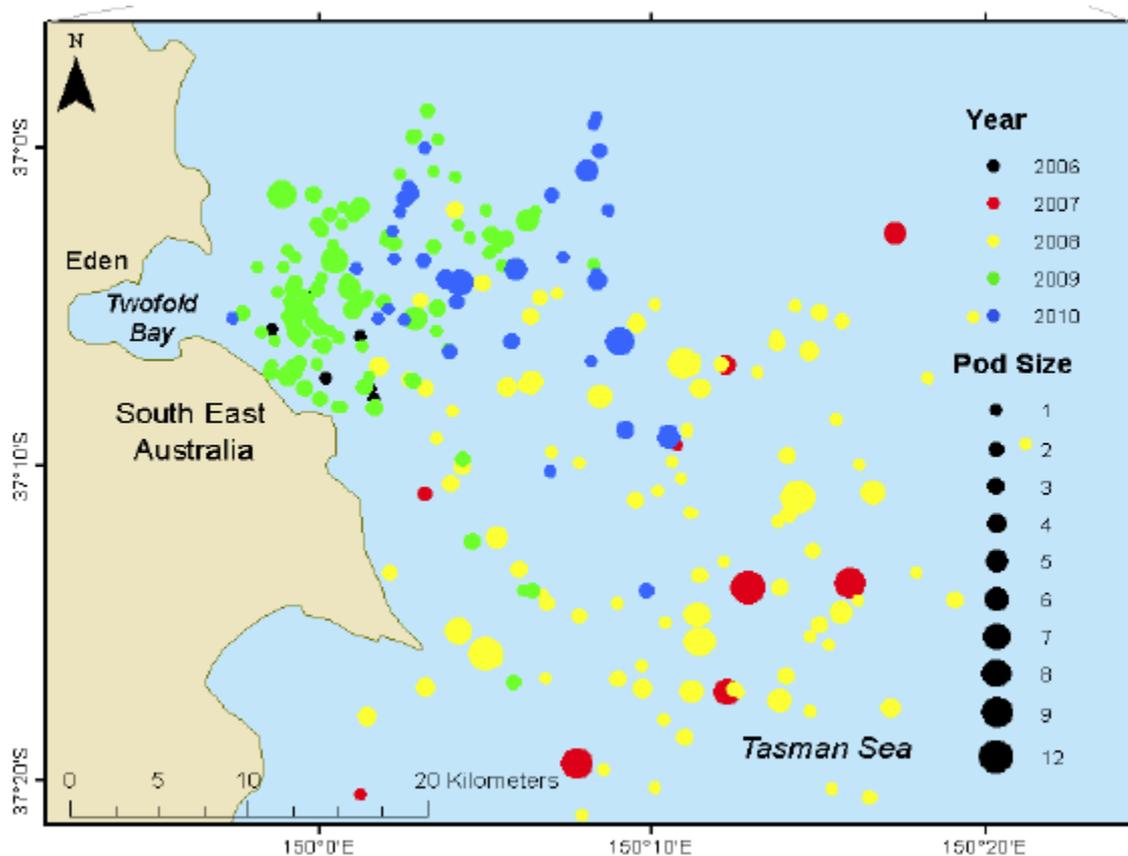


Figure 37 Humpback Whale Feeding Aggregations 2006 to 2010 (Fig 8 from Silva *et al* (2011))

Year	Adults	Percentage Sub-Adults	Calves
2006	18	36	0
2007	21	36	8
2008	43	57	11
2009	55	77	53
2010	31	62	5

- The Blue whale *Balaenopter musculus* is listed as Endangered under the EPBC Act. It is an essentially oceanic species that may occur rarely in coastal waters off Twofold Bay but is not expected in Twofold Bay (Cat Blou Cruise Data 1990 to 1994 in PSM 1996 and inspection of on-line cruise log for 2010 to 2012).

Marine Turtles

- The Green Turtle *Chelonia mydas* is listed as Vulnerable under the TSC and EPBC Acts. Usually widespread in warm tropical waters and found in coastal waters of the NSW north and central coast it is becoming more frequent in south coast waters, including around Eden. It could occur in Cattle Bay from time to time.
- The Leathery turtle *Dermochelys coriacea* is listed as Vulnerable under the TSC and EPBC Acts and is known from ocean waters around Australia with nesting in

tropical climates. It is generally found well at sea with more frequent sightings inshore at nesting sites. It is seen along the south coast; Over the three year period June 2010 to December 2012, Cat Balou Cruise notes record 2 leathery turtles offshore 'east of Eden' on 24 September 2010 remarking that this is the first sighting for at least two years. The Cat Balou cruise log only noted two other 'large turtle' sightings in the same period, both offshore.

2.4.2 Listed, migratory and protected aquatic species

Of the non-threatened listed, and protected aquatic species identified from the locality, the following species were targeted or considered for the TEL (2002), NGH environmental (2009) and present surveys:

- There was a little penguin *Eudyptula minor* breeding colony at Eagles Claw Nature Reserve with 24 breeding pairs around the time of the Plan of Management for the Nature Reserve (NSW NPWS 1992) but the colony was decimated by dogs in 1993 and has never recovered. Notwithstanding, little penguins are regular visitors to Twofold Bay (Cat Balou on-line cruise log), most likely sourced from the large colonies at Montague Island (6000 breeding pairs) and Gabo Island (18,000 breeding pairs).
- Weedy seadragon *Phyllopteryx taeniolatus* is protected under the FM and EPBC Acts and occurs in Twofold Bay around the Woodchip Wharf, at Fisheries Beach and East Boyd Bay. TEL (2002) made specific searches for the weedy sea-dragons and found none in Cattle Bay. None were found for the present study of Cattle Bay but the study was limited by poor visibility.
- The eastern blue devil fish is protected under the FMA and TEL (2002) made specific searches for this species in Cattle Bay but did not find any.
- The killer whale *Orcinus orca* is listed as a migratory species under the EPBC. It occurs in oceanic and shelf waters and along the continental slope but may also occur around seal colonies and whales with calves.
- More generally, Syngnathiformes (seahorses, sea-dragons, pipefish, pipe-horses and sea-moths) are protected under the FM and EPBC Acts and the TEL (2002) plus the present survey made specific searches for Syngnathiformes on the wharf piles and over the *Posidonia* seagrass bed but none were found.

Neither of the above reports considered non-listed dolphins, even though they are commonly seen in the bay and near-shore coastal waters off Eden. The Cat Balou Cruise notes for 2010 through to December 2012 record common dolphins *Delphinus delphis* both within and outside the bay on almost every day of their three year log (averaging 75 to 90 days per year from June to December) and there are 38 reports of bottlenose dolphins from inside Twofold

Bay. The majority of sightings (12) were ‘near the wharf of off the breakwater’ with 6 from ‘Twofold Bay’, five off The Lookout, five in Honeysuckle Bay (including pods of 20 individuals or more and a sighting of a mother and ‘tiny’ calf), 4 off Aslings Beach and the remainder (6) in the southern bay (East Boyde, Whale Beach and Whale Spit, and off Kiah Inlet. There is no distinction in the sightings between bottlenose dolphins *Tursiops truncatus* that are more common offshore, and the related indo-pacific bottlenose dolphin, *T. aduncus* that forms large more or less closed population groups in large embayments such as Port Stephens and Jervis Bay (Moller and Beheregaray 2004). Whilst there do not appear to have been any published surveys of *T. aduncus* in Twofold Bay, it is likely that many of the sightings recorded from the bay are from a resident population.

3 IMPACT ASSESSMENT

As noted in Section 1, the adopted proposal includes the following features:

- Retention and repair/refurbishment of the existing fish cannery wharf as per the Conditions of Approval for the Eden Resort Hotel approved Concept Plan, to be built on the adjacent old fish cannery site (JBA 2007).
- A 154 berth floating marina south of the cannery wharf with three marina arms orientated generally south-east towards Snug Cove and a northern arm extending along the eastern side of the cannery wharf.
- The marina would provide berthing for 63 x 1 2m vessels, 65 x 15m vessels and 26 x 18m vessels with temporary berthing for visiting super yachts (2 to 3) and for other vessel pickup and set down needs, both located alongside the southern marina floating walkway.
- The marina layout provides channel widths >25m between the eastern ends of the marina and the -2m ISLW contour offshore from the mainland (see Figure 3). In this respect there may be an isolated pinnacle of rock that may need to be removed (see project EIS for details).
- The marina will require a wave attenuator to protect the marina from prevailing local seas from the SSW and from refracted ocean swell. This will be a fixed, not floating structure some 230m long and aligned more or less parallel to the shore. The structure will comprise a series of raked and vertical piles that support precast concrete panels held off the seabed but with sufficient distance below the water level to provide the required wave attenuation
- Other than provision of fixed utilities (power, communications, fire fighting and potable water) and the provision of a mobile sewage pump out unit (see project EIS for details), there will be no additional services available at the marina and there will be no additional construction works required on land over and above the works already required for the Eden Resort Hotel concept approval.
- The marina will be located more than 500m from the closest mussel farm (located to the west of Cocora Point), more than 170m from the eastern end of Cocora Beach and more than 300m from the wharves in Snug Cove.

3.1 Construction Impacts

3.1.1 Direct impacts of construction

The potential direct impacts of construction include disturbance of the seabed for the remediation works required for the cannery wharf, for the placement of piles for the wave attenuator and for the floating marina and for moving plus holding floating plant in place:

Piling Works:

- Remediation and piling works for the wharf refurbishment will be into bare sand habitat that has a patchy cover of assorted timber, tyre and metal rubbish associated with the old cannery.
- Piling works would displace sand habitat with some minor loss of benthic (sediment dwelling) organisms (molluscs, polychaete worms and crustaceans). Given the relatively tiny amount of habitat displaced compared to the overall available sandy benthic habitat this loss is not considered significant.
- Placement of piles for the wave attenuator and for the floating marina would be in water depths between -6 and -7m chart datum, and some of the piles would be placed over the sparse *Heterozostera* seagrass identified for the present survey. Given the general low density and patchiness of the *Heterozostera* cover, the size of the bed in this locality and the high likelihood that *Heterozostera* has a much greater distribution over the 6 to 10m depth band around the whole of the Twofold Bay eastern shore (see Section 2.2.1), it is concluded that *Heterozostera* loss to piling works would not be significant.
- Disturbance of sediments during piling works has the potential to cause turbidity and release contaminants into the water column. However, given the sandy nature of the sediments plumes from individual piling operations would be short lived and localised around the pile.
- Given the low concentrations of contaminants found in the sediments (Section 2.2), the short lived and localised pulse disturbances of the sediments by piling operations would not result in any measurable changes to water quality.

Anchoring, Mooring & Vessel Movements:

The wharf remediation and marina construction works will require floating plant (pile driver, crane for lifting piles and other elements into place and barges to bring piles and marine elements to the site). Unless barges with retractable spuds are used, floating plant will need to be anchored or moored to keep them on station during the construction works and will require anchoring gear with long cables to achieve stability in low swell conditions:

- Anchors for barges undertaking wharf remediation works could be placed into adjacent seagrass and rock boulder habitats including the *Posidonia australis* bed and patches along the eastern shore, and the *Zostera mulleri* plus rock boulder habitats to the west of the wharf. This possibility can be avoided by ensuring that contractors are provided with an accurate geo-referenced map of the habitat limits and are instructed that they cannot place anchors or other mooring apparatus into these habitats nor allow cables to trail on the seabed and ‘scalp’ these habitats.
- Anchors for barges undertaking marina construction works could be placed into the

sparse offshore *Heterozostera* beds with direct loss to anchor strike, potential additional loss to anchor drag and potential additional loss to cable scalping as cables are dragged back and forth over the seabed during laying and retrieval and when *in-situ* as a result of swell action. This possibility can be avoided by providing contractors with an accurate geo-referenced map of the inshore and offshore depth limits of these habitats so that anchors can be located over bare sandy habitat. The potential impact of cable scalping can be mitigated by the use of floating lines rather than sinking cables. If sinking cables are to be used, they would need to be buoyed off the seabed.

- The movement of floating plant into place has the potential to disturb bottom sediments via propeller wash. Whilst this potential disturbance risk is low for works in deeper water (the wave attenuator and floating marina construction) it is higher for shallow water remediation works on the inner cannery wharf. This potential risk can be satisfactorily mitigated by instructing contractors to minimise wash by avoiding weather and tide conditions that could heighten the risk (e.g., planning shallow water work for early morning, high or rising tide conditions and avoiding shallow water work during periods of swell that could increase the risk of ‘bottoming out’).

Possible requirement to remove an isolated rock pinnacle in the proposed fairway:

- As noted in the Haskoning Australia 2013 report there may be an isolated rock pinnacle in the proposed fairway that could pose a hazard to vessels in the fairway (see Figure 31 above). Subject to a detailed bathymetric survey to confirm this obstruction, the Haskoning Australia report suggests that the rock could be lowered by hydraulic hammer from a barge mounted excavator or by drilling holes and using a non explosive rock splitting expansive agent to lower the rock.
- As noted in Section 2.3.2 and as can be seen in Figure 31, this rock supports a barrens habitat with few attached biota (solitary ascidians and isolated sponges) and removal of the upper portion of the pinnacle would not have any substantial impact on the aquatic ecology of the location. The excised top portion of rock would fall to the bottom where it would form part of the existing rock rubble seabed.

Removing or relocating existing swing moorings:

As noted in the project EIS report, some 24 moorings may need to be removed or relocated. Whilst removal of the moorings has a low risk of direct impact on aquatic ecosystems, the moorings themselves may support introduced marine species (IMS) of concern and these could be transported to other locations in Twofold Bay (if relocated) or could fall to the seabed in other locations during removal activities. This risk can be minimised by ensuring that fouling organisms from moorings to be removed are collected and disposed of to appropriate landfill areas and not allowed to be disposed to the waters of the bay.

Alternatively, IMS surveys of the moorings to be removed/relocated could be undertaken prior to the activity with any priority IMS collected and disposed of by the IMS survey team.

3.1.2 Indirect impacts of construction

Indirect impacts from construction works are associated with disturbance to fauna within or near Cattle Bay including construction noise impacts, vessel or cable strike and construction related liquids or solid material spills.

Noise and Vessel or Cable Strike:

- There are two main sources of construction noise, background vessel and equipment engine noise, and impact or high frequency pulse noise from use of equipment (e.g., piling, hammering, cutting and drilling tools). For the most part, the impacts of these activities are more likely to affect marine mammal behaviour (cetaceans – whales and dolphins and pinnipeds – seals and sea lions) than fish. Given the proximity of the site to the Port of Eden, the incremental impacts of engine noise are likely to be low in relation to the general background noise from vessels using the port. The pulse impact noises are more likely to result in startle responses with animals turning away (avoiding) the noise source.
- Whilst the overall risk of construction noise directly affecting marine mammals is low, the chance of disruptive behavioural responses (animals moving away from the area) is high, particularly for cetacean pods of mothers and calves. This potential impact can be avoided by minimising construction works in the core whale visitation season (i.e., mid September to end November) and/or undertaking work in the shoulder periods August to September and November to December within the framework of a Marine Mammal Protection Plan (MMPP) that sets out the requirements for monitoring marine mammal proximity and protocols for ceasing and resuming works related to the proximity. Such plans are routinely used to manage potential conflicts with marine mammals (e.g., recent port construction and high tension cable laying projects in Botany Bay).
- Cable strike or entanglement associated with the proposed construction works are related to anchor cables that stretch and slacken in the water column and is generally a greater risk for young cetaceans and pinnipeds than for older animals, although all animals are susceptible to slashing injuries from cables movement in the water column if they are swimming over or under the cable at the time. The risk is heightened at night when floating plant is left on site with multiple anchors/moorings. The potential risk is also related to the number of animals in the area, which in turn is related to the time of year. Accordingly, the overall risk can be managed by avoiding the peak marine mammal visitation period and by

undertaking work in the framework of a MMPP. The risk of overnight cable strike can be minimised by placing floating plant on a swing mooring rather than leaving plant in a fixed mooring configuration as the reliance on a single swing mooring line will minimise cable oscillation.

- The potential spillage of liquids and solids is related to both vessel management (i.e., fuel, bilge and on-board fuel tank and material lifting (crane) regulation) and over water work practices on the wharf for the remediation works and on the floating pontoons for the installation of services. The risk of fuel, transfer and construction spillages can be mitigated to insignificance by the implementation of a Construction Environmental Management Plan (CEMP) that addresses these issues.

3.2 Operational Impacts

Once built, the marina will accommodate up to 154 vessels mostly ranging from 12 to 15m length with mooring provision for several super yachts. In terms of potential operational impacts there are impacts associated with the marine structure in place and there are potential impacts associated with marina operation and with vessel operations outside of the marina.

3.2.1 Impacts associate with marina operations

Potential shading impact:

The marina structure with associated vessels will create shading on the seabed, which has the potential to affect the *Heterozostera* seagrass.

- The orientation of the structure to the available sunlight, combined with the width of the fairways between the moored vessels is such that there would be periods of direct sunlight penetration to most of the seabed, and the depth of the waters means that there would also be refracted and reflected sunlight reaching the seabed. Accordingly it is considered that the risk of total or significant loss of the *Heterozostera* under the marina footprint is low whilst the potential for some measurable loss is possible.
- Notwithstanding this conclusion, and as argued in Section 3.1 above, the patchiness and sparseness of the seagrass plus the probability that the distribution of this seagrass throughout Twofold Bay is much greater than currently known would indicate that an incremental loss of some *Heterozostera* under the marina footprint would not be significant for overall *Heterozostera* habitat in Twofold Bay and for the animals that utilise that habitat in Twofold Bay.
- The potential for this loss can be further quantified by the recommended survey to delineate the depth limits of the bed (as required for managing construction anchoring – see Section 3.1.1) coupled with the recommended detailed bathymetric

survey of the seabed in the marina footprint and production of shade diagrams.

Potential impacts associated with water circulation and wave attenuation:

- As the marina comprises mainly floating pontoons, and the breakwater is suspended some 4 to 6 m off the seabed, the marina is not expected to affect tidal water movement or bay water circulation to any great degree (see also Project EIS).
- The floating structures will create wind breaks, attenuate and reflect or refract swell waves and there is a potential for beach realignment at Cocora Beach associated with the proposed breakwater alignment. Whilst the risk of impact on the near-shore seagrass bed off Cocora Beach from beach realignment is probably low, this will need to be confirmed by the more detailed modelling for the breakwater proposed in the Project EIS. The Project EIS also notes that the beach realignment risk can be mitigated by re-shaping the wave attenuator, subject to the detailed design considerations.
- The marina will likely act to accumulate floating rubbish inside the marina brought in via wind waves and wind action from the south east to east or direct rubbish to the beach via wind waves and action from the south-west to south. If not removed on a regular basis this rubbish can cause harm to marine vertebrates via entanglement or ingestion and this is listed as a Key Threatening Process (KTP) under both the TSC and EPBC Acts. A key threatening process is a process that ‘threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community’.
- The risk of ingestion of, or entanglement in this debris by turtles, cetaceans, pinnepeds and marine birds that could be expected in and around the waters of the marina from time to time can be mitigated by instigating a marina Operational Environmental Management Plan (OEMP) that includes provision for inspection and regular clearing of marine debris from the waters inside the marina and along the Cattle Bay beach-line. The regular inspection should include a periodic inspection of the seabed in the marina to clear out any accumulated rubbish that could threaten marine life.
- The shape of the marina has the potential to funnel surface breathing animals (seals, whales, and to a lesser extent dolphins and turtles) into the bay shallows via the main fairway along the eastern shoreline. For the most part these animals can escape to waters to the west by swimming under the floating walkway that connects the marina arms and accordingly the potential for trapping marine mammals or stranding them in the shallows is considered low. A similar low risk is associated with animals approaching the bay from the west and encountering the connecting floating walkway and inshore berthing pens located on the east side of the cannery wharf.

Potential for decreased water quality:

There are two main issues in regard to water pollution, the risk of pollution via hydrocarbon spills, bilge and sewer pumpout and the risks associated with ablation of chemicals (mainly copper) from vessel antifouling paints. These risks are particularly important for the protection of the mussel aquaculture farms to the west of the marina:

- In regard to minimising the risk of hydrocarbon spills the marina will not be providing fuel services or any form of mechanical servicing at the marina, which is to be managed entirely as a boat storage facility. Therefore vessel masters that require fuel, oils or servicing will need to travel elsewhere (generally to the port facilities in Snug Cove).
- The marina will be operated on a zero bilge, sewage and ships liquid waste discharge policy, meaning vessels will not be allowed to discharge bilge, grey or black waters to the bay whilst in the marina.
- The marina will not be providing a public sewage pump out facility but will be providing a managed sewage pumpout facility via a portable collection system mounted on a trolley that can be brought to a vessel along the marina walkway and which would be taken ashore for collected sewage to be disposed at an appropriately sited connection to the council sewer (i.e., with no risk of sewage spills to the waters of Twofold Bay). The trolley transport system will have safeguards to ensure that there cannot be accidental spillages, particularly if the trolley is accidentally knocked into the marina waters. This will ensure that there can be no risk of human pathogens reaching the waters of Twofold Bay from the marina operations.
- In regard to water pollution via vessel antifouling, studies undertaken by MPR in Coffs Harbour Marina in 2003 indicated that the mean copper concentration within the marina met the ANZECC/ARMCANZ (2000) Table 4.4.3 default trigger value of 5µg/L total copper for the protection of aquaculture species and biologically available copper) was close to or marginally less than the present guideline value of 1.3 µg/L. The results showed a ratio of biologically available to total copper of 40 % and that there was no correlation between copper concentrations and water suspended solids concentrations. That is, the copper was generally in a dissolved form with about 60 % in organic complexes (non-toxic) and 40 % labile (toxic).
- Extensive studies of the potential fate of copper from vessels into the coastal waters of Shellharbour from the 300 vessel Shell Cove marina currently under construction, have concluded that copper sourced from vessels in the marina would not have a significant impact on rocky reef aquatic ecosystems immediately outside the marina, with predicted total copper levels between 0.3 and 0.5µg/L (PBP 2005). The modelling took into account the following factors:
 - Calculations for copper ablation rates assumed a mix of recreational and commercial high speed vessels using the marina, considered typical usage patterns based on similar

operating marinas including with watching and game fishing charter operators, and considered the likely replacement frequency plus mix of hard, ablating soft and self polishing soft copper based antifoul paints.

- Calculations for biologically available copper (labile copper) considered total copper partitioning between particulate forms, dissolved complexed forms and dissolved labile forms, as per ANZECC/ARMCANZ (2000).
- The waters outside the entrance are exposed to wave generated and tidal currents that will tend to transport water away from the entrance area between tides. Water flowing across the seaward boundary on the flood tide was assumed to have the background ocean concentration for total copper of 0.3µg/L (Batley 1995, Apte et al 1998).

The proposed Cattle Bay Marina has fewer vessels, much greater exposure to wave and tidal currents, and is not constrained with breakwater entrances, as are the Shell Cove and Coffs Harbour marinas. Also, the general current movement across the front of Cattle Bay is clockwise, which would ensure that flushing water carries any residual contaminants away from the nearest mussel farm for most of the time. It is concluded that the water quality of the proposed Cattle Bay marina would meet the ANZECC/ARMCANZ (2000) requirements for the protection of aquatic ecosystems and aquaculture activities in Twofold Bay.

Potential for increased settlement of introduced marine species (IMS):

The marina will be providing a large increase in the wetted surface area of hard substratum available for colonisation by aquatic biota.

- This is an overall beneficial impact in that the shallow wetted surface areas of floating pontoons, piles and the breakwater will provide suitable habitats for a frondose and tufted algae based biota that will attract juvenile fish and the deeper wetted surface areas would be colonised by kelp and encrusting biota similar to the assemblages on the existing wharf piles, also providing additional fish habitat.
- Notwithstanding this benefit the increased area for colonisation also increases the risk of settlement by known IMS in Twofold Bay (e.g., Mediterranean fan worms) and provides suitable habitat for new IMS entering the bay via vessel fouling, potentially from international vessels using the marina.
- This risk also a KTP under the FMA; *Introduction of non-indigenous fish and marine vegetation to coastal waters* (FSC 2004) and a KTP under the EPBC Act *Novel biota and their impact on biodiversity* listed on 26 February 2013.
- In regard to this risk Pollard and Rankin (2003) recommended that “*any new underwater structures in Twofold Bay (e.g. wharves under construction in Edrom Bay, and those proposed for the Heinz Cannery site) should also be monitored for the settlement of Sabella and other introduced marine pest*

species". This recommendation should be adopted into the marina OEMP.

- The risk of IMS in the marina footprint also extends to the present wharf and the accumulated rubbish under the wharf, and any survey for IMS would need to include these areas. Further, the overall risk can be measurable lowered if the rubbish on the seafloor under the existing wharf is cleared. This will also lessen the time required for future marina IMS surveys. Accordingly, it is recommended that the rubbish under the existing wharf be removed prior to or as a part of remediation works on the wharf and the collected material be disposed to a suitable landfill site to prevent re-introduction of attached IMS to Twofold Bay.

Potential for impacts from marina noise and marina lighting:

Operation of the marina will result in an increase in overall ambient engine noise and the marina will require suitable lighting (including navigational lighting) for pedestrian and vessel safety management:

Underwater noise can disrupt behaviour patterns in fish and marine mammals and cause marine mammal aggregations or pods to be disrupted. Carlton and Dabs (2009) provided a review of shipping noise on aquatic biota and NGH Environmental (2009) provided a review of this issue in relation to the proposed cooling water outlet at East Boyde. The main source of operational noise from the marina that would have the potential for impacting on aquatic biota would be engine noise from vessels transiting in and out of the marina. In regard to water transmission of this noise outside the marina, much of the noise generated within the marina would be directed towards the shore and would be absorbed by the sloping intertidal beach to the north and by the rock rubble and seagrass/algae complexes to the east and west. A proportion of the noise transmitted south would be reflected from the wave attenuator structure back towards the shores. Accordingly residual underwater noise would be attenuated reflected or refracted noise. Based on the reviews of potential operational noise impacts and the consideration of noise attenuation for the marina presented above it is concluded that the overall increase in background noise from operation of the marina against the existing noise sources from the port in Snug Cove would not be significant and would not pose a risk to marine biota including fish, cetaceans, pinnipeds and turtles. This conclusion is in line with the conclusions of the 2011 Conservation Management Plan for Southern Right Whales, where on a conservative approach, it was concluded that shipping noise risk was minor (i.e., individuals may be affected but there is no affect at the population level.

Light pollution from inshore and offshore structures has been found to be a hazard for some aquatic animals especially marine birds such petrels, as that are attracted to the lights,

disrupting their flight patterns and feeding regimes (Reed et al 1985, Montevecchi 2006). In near-shore waters light pollution can attract insects that then provide a food source for birds including seagulls. Light reflected into the water can attract various aquatic species, particularly cephalopods that in turn can attract avian and piscine predators. On balance the potential impact on migratory seabirds is greater than the adjustment of aquatic feeding guilds around lights at night and the most common mitigation measures to protect overall aquatic species is to install downwards directed lighting with most light fall onto pontoon hard surfaces to minimise light spill into the water. These systems can be supplemented with dimmer systems, or timed lights with trip mechanisms as necessary. Use of such systems would also diminish another potential navigation hazard for masters of vessels entering Twofold Bay that could have their night vision compromised by strong lighting at the marina.

Consequences of marina breakup

The Project EIS considers a number of potential hazards associated with the marina operation including fire, vessel collisions and structural failure of the marina.

- Fires could result in vessels sinking with possible fuel spillages. The marina will have statutory fire fighting systems in place and will have spill containment materials and protocols in place, all detailed in the marina OEMP. Consequently the risk of vessel sinking from fires is considered low and the combined risk of a vessel sinking due to fire with consequent fuel spillage that cannot be contained within the marina confines would be low and the consequences for aquatic ecosystems and for mussel aquaculture would not be significant.
- Collisions within the confines of the marina are not likely to present any risk to aquatic ecology by virtue of the low vessel speeds that would more likely result in vessel hull damage with little risk of fuel spills. There remains a low risk of vessels grounding in the fairway when avoiding collisions or when vessels are disabled due to engine or steering problems. Due to the low vessel speeds in the fairway and the protection afforded the fairway by the wave attenuator it is unlikely that vessels would be badly damaged by groundings to the extent that there could be vessel sinking or loss of vessel fuel. Consequently the risks for aquatic ecosystems and mussel aquaculture are considered negligible.
- The Project EIS provides a detailed explanation of the structural integrity that will be required for the marina that would make structural failure unlikely. Notwithstanding this explanation, if there were catastrophic structural failure this would most likely be associated with a very large storm. If the wave attenuator were to break up, the elements would sink to the seabed. Exposed pontoons would either sink if damaged or be forced inshore along with moored and loose vessels. Given the enclosed nature of Cattle Bay the damaged vessels, infrastructure and spillages caused by vessel

damage would most likely be retained in the bay, piled up on the shore with fuel rapidly dispersed or diluted by wave action.

In regard to the impacts of collisions, fire and structural failure on fisheries and aquaculture in Twofold Bay the overall conclusion of this assessment is that collision and fire related accidents within the confines of the marina would be successfully contained with no impacts outside the marina. In regard to large-scale structural failure it is concluded that the conditions under which this would occur would most likely also cause structural damage to Twofold Bay aquaculture infrastructure and that marina infrastructure and vessel damage resulting from catastrophic failure during a major storm would be confined to Cattle Bay with most structural items and vessels washed to shore or sunk in the confines of the bay.

3.2.2 Cumulative impacts associated with vessel usage outside the marina

The marina will provide berths for 154 vessels, ranging from 12 to 15m length and the close proximity to open coastal waters would indicate that for the most part the non-sailing vessels in the marina could be expected to utilise waters of Twofold Bay and associated coastal waters out to the continental shelf. The travel time to reach the edge of the shelf from Eden is around one hour at moderate speeds. In this respect, the proximity of Eden to the continental shelf means that the marina is conveniently located for deep-sea fishers targeting fish utilising the many under sea canyons along the continental slope.

The narrowness of the shelf in this location also means that the water flowing through these canyons is often directed upwards bringing with it warmer currents and associated fish. Further, deep nutrient rich waters brought into the coastal waters via up-wellings onto the coast, can also trigger plankton blooms that also attract assemblages of fish and krill that are exploited by marine mammals (particularly humpback whales, see Section 2.4.1), seabirds and predatory fish, with the larger fish then also targeted by humans.

As a consequence the overall increase of high speed vessels in these waters and the possibility of more high speed vessels once the Boydtown marina is built and if the Port of Eden Marina (POEM) proposal also goes ahead (see Project EIS), increases the risk for marine mammals and reptiles of behaviour disruption from vessel noise and harassment, for injuries or death from ingesting marine debris and from vessel strike:

- As discussed above in relation to vessel noise in the marina, marine mammals will generally avoid vessels on the basis of noise. However, the relationship between noise and marine mammal behaviour is complex, as evidenced by the continued bow riding behaviour by dolphins, following behaviour of marine mammals associated with fishing vessels and circling plus and nudging behaviour of stationary vessels by

whales (e.g., Hale 2002). The impacts of vessel noise can also be linked to vessel interactions with marine mammals (i.e., recreational whale and dolphin watching) and there is a large literature available on both the potential impacts of these activities and the available protocols to minimise the risk to marine mammals from these interactions, many of them enshrined into legislation.

- The risk from marine debris is entirely one of educating boaters to adopt the concept of everything that is carried onto the boat goes back to shore and nothing is thrown overboard. This can be part of the information pack given to boaters using the marina.
- The overall mitigation measure for excessive vessel noise and for marine animal interactions is education, with protocols and specific information on the marine animals that boaters are likely to encounter at various times of the year, and the steps that boaters should take to minimise their impact on these animals, including lower speeds and minimum off-set distances. These information packages should be made available to all boat owners in the marinas.
- In relation to vessel strike, this is a world-wide problem (Marsh et al 2003), and there is a clear relationship between the number of vessels within a given area of marine mammal and reptile activity and the incident of vessel strike. In this respect the 2011 Conservation Management Plan for Southern Right Whales, concluded that from an east Australian coast population perspective, vessel collision risk was **moderate** (i.e., population recovery could be stalled or even reduced).
- Management of this risk requires a mix of both education (i.e., passive management tools such as information packs given to boaters, signage at the marina), active management such as daily information on known marine mammal activity (via close relationships with the existing network of whale watchers – residents, commercial fishers, mussel farmers, NPWS whale-watch and particularly with the Cat Belou Cruise operators, as the latter currently act as a central locus for this information in Twofold Bay.
- In this respect, the Cat Belou Cruise operators have a wealth of diverse gps-logged location information (including pod sizes, age groups and mother calve sighting) collected over a long time base for a variety of marine mammals, reptiles and aquatic birds such as little penguin within the Twofold Bay and immediate offshore coastal waters, and these data are essential as a basis for the preparation of the information packs to assist marina operators and their clients in mitigating the potential impacts of recreational boating activities on these animals. The value of the data is evident in the information sourced from the Cat Belou records for humpback whale feeding aggregations as shown in Figure 37 above, (from the scientific report by Silva *et al* (2011), also cited above).
- It is recommended that the Cat Belou operators be approached to allow a suitable scientific evaluation of their existing marine mammal sighting data with a view to

developing up-to-date risk profiles for vessel strike and disturbance for marine mammals of concern and to develop an information pack that can be supplied to marina and other Twofold Bay boaters.

- Given the real need to reduce the potential for vessel strike on southern right whales as the number of recreational vessels from Twofold Bay increases, and the enhanced risk of vessel strike on humpback whales when in feeding aggregations, there may well be a need in the future for variable or zoned (time and place) speed limits to be imposed.

It is important to emphasize that the potential consequences and therefore the necessary additional 'research' for cumulative impact on marine mammals from more vessels using the waters outside the marina is a community need and that the implementation of the recommendations for mining of the Cat Belou data and for producing information packs based on these data should be borne by the boating community that utilises these waters (commercial fishers, navy, commercial shipping, cruise ship operators and marinas - including the approved Boydetown marina), by Bega Shire Valley Council in regard to their promotion of the Port of Eden upgrade - including the Port of Eden Marina (POEM) proposal in relation to tourism and employment, and by the regulators who need to balance state recreational boating growth with environmental protection.

4 REFERENCES

Aargus Pty Ltd (2002)

Marine Ecology Investigation, Eden White Whale Resort, Aargus Pty Ltd, Sydney

ANZECC (2000)

Australian National Guidelines for Cetacean Observation & Areas Of Special Interest for Cetacean Observation. Australian and New Zealand Environment and Conservation Council (ANZECC). Environment Australia, February 2000.

ANZECC/ARMCANZ (2000)

Australian Water Quality Guidelines for Fresh and Marine Waters. National Water Quality Management Strategy. ANZECC November 1992.

Apte, S.C., Batley, G.E., Szymczak, R., Rendell, P.S., Lee, R. & Waite, T.D. (1998)

Baseline trace metal concentrations in New South Wales coastal waters. *Mar. Freshwater Res.* 49: 203–214.

Baker A N (1983)

Whales and Dolphins of New Zealand and Australia. Victoria University Press, Wellington New Zealand.

Batley, G.E., and Gardner, D., (1978).

Copper, lead and cadmium speciation in some estuarine and coastal marine waters. *Estuar. Coastal Mar. Sci.*, 7, 59-70.

Batley, G.E., (1995).

Heavy metals and tributyltin in Australian coastal and estuarine waters. State of the Marine Environment Report for Australia, Technical Annex 2, Pollution, L.P.Zann and D.C. Sutton, eds., Department of the Environment, Sport and Territories, pp 63-72.

Breen, D.A. Avery, R.P. and Otway N.M. (2005).

Broadscale biodiversity assessment of marine protected areas in the Batemans Shelf and Twofold Shelf marine bioregions. Final report for the NSW Marine Parks Authority.

Carlton, JS, and Dabbs, E, (2009)

The influence of ship underwater noise emissions on marine mammals. Lloyd's Register Technology Day Proceedings, February 2009.

CSIRO Division of Fisheries (1989)

Twofold Bay A Preliminary Survey. 41pp, July 1989

CSIRO (1994)

Jervis Bay Baseline Studies - Final Report. Report prepared for Commonwealth Dept of Defence . Report prepared by CSIRO Division of Fisheries.

CSIRO Marine Research (1997)

Introduced species survey, Eden and Twofold Bay, New South Wales. CSIRO Marine Research, Hobart, Tasmania, 50 pp.

Cumberland Ecology (2007)

Flora and Fauna Impact Assessment under Part 3A development application, Cattle Bay, Eden Prepared for Eden Hotel Resort Pty Ltd.

Cumberland Ecology (2007)

Cattle Bay, Eden: Assessment of Impacts on Aquatic Marine Species for a Major Project Application. Prepared for Eden Hotel Resort Pty Ltd, Final Report, September 2007. Cumberland Ecology, Carlingford.

DECCW (2010)

Seabed habitat mapping of the continental shelf of NSW. Report prepared by NSW Department of Environment, Climate Change and Water, December 2010.

DEH (2002)

White shark (*Carcharodon carcharias*) Recovery Plan.

DEH (2005a)

Southern Right Whale Recovery Plan 2005 2010.

DEH (2005b)

Humpback Whale Recovery Plan 2005 2010.

Dexter, D M. (1984). Temporal and spatial variability in the community structure of the fauna of four sandy beaches in south-eastern NSW. *Aust. J. Mar. Freshwater. Res.*, 35: 663-672.

DSEWCP (2011)

Conservation Management Plan for the Southern Right Whale 2011–2021. A Recovery Plan under the *Environment Protection and Biodiversity Conservation Act 1999*. Prepared by the Department of Sustainability, Environment, Water, Population and Communities.

DPI (2005)

Determination - Mussel Aquaculture in Twofold Bay. Stage 1 review and determination of progression to Stage 2. 22 February 2005.

Edmunds, M, Hart P S and Ingwersen C (2005)

The reef biota at Marine Protected Areas in the Twofold Shelf region. Parks Victoria Technical Series No 23. Victorian Subtidal Reef Monitoring Program, March 2005.

Ehmann H (1992)

Encyclopaedia of Australian Animals - Reptiles.

Faraghers, R.A. (1999)

A survey of the threatened fish species, Australian grayling *Prototroctes maraena* Gunther: distribution and abundance in New South Wales. CRC for Freshwater Ecology, NSW Fisheries Research Institute, NSW, Australia.

Fisheries Scientific Committee NSW (2004)

Key Threatening Process: Introduction of non-indigenous fish and marine vegetation to coastal waters, February 2004.

Hacking N (1996)

Tidal Movement of Sandy Beach Macrofauna. *Wetlands (Aust)* 15 (2): 55 - 71.

Hale P (2002)

Interactions Between Vessels And Dolphins In Port Phillip Bay. Final Report, September 2002. Prepared for Victorian Department Of Natural Resources And Environment. Ecology Centre & CRC for Sustainable Tourism, Queensland Uni.

Hill, N A, Blount C, Poore A G B, Worthington D & Steinberg P D (2003)

Grazing effects of the sea urchin *Centrostephanus rodgersii* in two contrasting rocky reef habitats: effects of urchin density and its implications for the fishery. *Marine and Freshwater Research* 54(6) 691 - 700

Hoskin. M.G., & Underwood. A.J. (1999)

Examination of Potential Ecological Effects of Mussel Culture in Twofold Bay, NSW. University of Sydney; November 1999.

Hutchings, P.A., Van der Velde, J.T. & Keable, S.J., (1986)

Colonisation of NSW by nonindigenous marine species. Baseline studies at Twofold Bay, NSW (FIRTA 84-49). Final Report to the Fishing Industry Research Committee, Australian Museum, Sydney, 71pp.

Hutchings P A, Van Der Velde, J T & Keable , S J (1989)

Baseline Survey of the Benthic Macrofauna of Twofold Bay, N.S.W., with a discussion of the Marine Species Introduced into the Bay. *Proceedings Of The Linnean Society Of New South Wales* (1989) 110 (3/4),pp 339-367

Inspire Planning (2007)

Boydton Concept Master Plan. Prepared for Lyon Group Australia. Inspire Urban Design + Planning. February 2007.

IP & HA (2103)

Cattle Bay Marina Environmental Impact Assessment. Report prepared for Eden Resort Hotel Pty Ltd by Inspire Urban Design + Planning and Haskoning Australia Pty Ltd.

JBA Planning (2007)

Environmental Assessment Report Concept Plan. Cattle Bay, Eden. Mixed use tourist facility/residential development. Prepared for Eden resort Hotel Pty Ltd by JBA Urban Planning Consultants Pty Ltd, Sydney.

Jeffries S W (1981)

Phytoplankton Ecology - With particular Reference to the Australasian Region. Chapt 10 IN *Marine Botany. An Australian Perspective*. Eds M N Clayton and R J King. Longman Cheshire Melbourne.

Kaufman, G.D, Forestell, P.H, Butt, R. & Lehman, S (2006)

The Importance of Eden, NSW as an Opportunistic Feeding Area for Southbound East Australian Humpback Whales. DEH Australia: Cetacean Research Priorities Conference, Adelaide, South Australia, Australia: 21-22 February.

- Lasiak, T.A., & Underwood, A.J. (2002)
Experimental Assessment of Potential Ecological Effects of Mussel Farming in Twofold Bay, Eden. University of Sydney, February, 2002.
- McEnally, J.M., Eskdale, I.W. and Thompson, G.B., (1990)
Coastal Resource Atlas for Oil Spills In and Around Twofold Bay. Prepared for NSW State Pollution Control Commission.
- Marsh H, Arnold P, Freeman M, Haynes D, Laist D, Read A, Reynolds J & Katuya T (2003)
Strategies for conserving marine mammals. In Gales I, Hindell M & Kirkwood R (Eds) *Marine mammals. Fisheries, Tourist and Management Issues*. CSIRO 2003.
- McNeill S E, Worthington D G, Ferrell D J and Bell J D (1992)
Consistently outstanding recruitment of five species of fish to a seagrass meadow in Botany Bay, NSW. *Aust. J. of Ecol.* 17: 359 - 366.
- Middleton M J, Bell J D, Burchmore J J, Pollard D A and Pease B C (1984)
Structural differences in the fish communities of *Zostera capricorni* and *Posidonia australis* seagrass meadows in Botany Bay, NSW. *Aquatic Botany* 18: 89-109.
- Möller, L. M. (2001)
Social organisation and genetic relationships of coastal bottlenose dolphins in southeastern Australia. Ph.D. thesis, Macquarie University, Sydney, NSW.
- Möller, L. M & Beheregaray L B (2004)
Genetic evidence for sex-based dispersal in resident bottlenose dolphins (*Tursiops aduncus*).
- Montevecchi W, A. (2006)
Influences of artificial light on marine birds in Ecological consequences of artificial night lighting. Island Press.
- Moran P J (1982)
The Effects of Industrial Pollution on the Larval Settlement, Development and Succession of Marine Fouling Communities in Port Kembla Harbour. PhD Thesis, University of Wollongong, NSW.
- Morrisey D J, Howitt L, Underwood A J and Stark J S (1992)
Spatial variation in soft sediment benthos. *Mar. Ecol. Progress Series*. 81: 197 - 204.
- Morrisey D J, Stark J S, Howitt L and Underwood A J (1994)
Spatial variation in concentrations of heavy metals in marine sediments. *Aust. J. Mar. Freshwater Res.* 45: 177 - 184
- New Horizons (2003)
Proposed progression to Stage Two of Mussel Farming Determination. Report prepared for Eden Shellfish Pty Ltd and NSW Cultured Mussel Growers Association Inc. New Horizons Pty Ltd, Boydtown, November 2003.
- NGH Environmental (2009)
Aquatic Biodiversity Assessment, Proposed Biomass Power Plant for South East Fibre Exports, Pty Ltd.

NGH Environmental (2011)

Biodiversity Assessment, Eden Windfarm. Report prepared for Epuron Projects Pty Ltd, June 2011.

NSW Fisheries (1999)

Policy and Guidelines Aquatic habitat Management and Fish Conservation. Eds., A K Smith and D A Pollard. NSW Fisheries. Sydney. 76 pp.

NSW Heritage Office (2002)

Shipwrecks of Twofold Bay and Disaster Bay. Wreck Inspection Report, by Tim Smith, October 1996. Report edited and formatted in July 2002.

Patterson Britton & Partners (2005)

Shell Cove Boat Harbour: Section 96 Modification of Consent 95/133 – Support Information. Report prepared for Australand Holdings Ltd and Shellharbour City Council, Issue No.4, December 2005.

Pollard and Rankin (2003)

Port of Eden Introduced Marine Pest Species Study. Report to Coasts & Clean Seas Program. NSW Fisheries Final Report Series No. 46

PSM (1996)

Environmental Impact Statement (incorporating Fauna Impact Statement): evaluating mussel aquaculture in Twofold Bay. Report prepared by Pacific Seafood Management Consulting Group Pty Ltd, 178 pp.

Reed, J.R., Sincock, L.R. and Hailman, J.P. (1985)

Light attraction in endangered procellariiform birds: reduction by shielding upward radiation. *Auk* 102, 377-383

Sanchez-Camara J, Booth J D, Murdock J, Watts D, Turon X (2006)

Density, habitat use and behaviour of the weedy seadragon *Phyllopteryx taeniolatus* (Teleostei: Syngnathidae) around Sydney, NSW, Australia. *Mar. & Freshwater Res.* 57: 737-745.

Silva, I F, Kaufman, G D, Hutsel, A, Macie, A, Maldini, D. & Rankin, R W (2011)

Mid-migration humpback whale feeding behavior off Eden, NSW, Australia.

Document SC/63/SH12 presented to the IWC Scientific Committee, Tromso, Norway: 11-14 July.

SKP and PBP (1989)

Boydton Boatharbour & Marina Development. EIS prepared for Boydton Pty Ltd by Sinclair Knight & Partners and Patterson Britton & Partners.

SPCC (1981a)

The Ecology of Fish in Botany Bay. Environmental Control Study of Botany Bay. BBS 23, SPCC Sydney.

SPCC (1981b)

The Ecology of Fish in Botany Bay - Community Structure. Environmental Control Study of Botany Bay. BBS 23A, SPCC Sydney.

SPCC (1981c)

The Ecology of Fish in Botany Bay - Biology of Commercially and Recreationally Valuable Species. Environmental Control Study of Botany Bay. BBS 23B, SPCC Sydney.

TEL (1999)

Twofold Bay Multi Purpose Wharf and Naval Ammunitions Storage Facility. Marine Ecology Technical Report in Woodward-Clyde (1999). Report prepared by The Ecology Lab, Sydney.

TEL (2002)

Marine Ecology Investigation, Eden White Whale Resort. The Ecology Lab, Sydney.

Underwood A J (1981)

Structure of a Rocky Intertidal Community in New South Wales: Patterns of Vertical Distribution and Seasonal Changes. J. Exp. Mar. Biol. Ecol. 51, 57 - 85.

Underwood A J (1993)

The mechanics of spatially replicated sampling programmes to detect environmental impacts in a variable world. Aust. J. Ecol. 18 (1), 99 – 116

URS (2010)

Environmental Assessment. South East Fibre Exports 5.5MW Biomass Power Plant. Report prepared for South East Fibre Exports Pty Ltd, March 2010.

Wiese, F. K., Montecchi W, A., Davoren, G.K, Huettmann, F., Diamond, A.W and Linke, J (2001)

Seabirds at risk around offshore oil platforms in the North-west Atlantic. Marine Pollution Bulletin. Vol 42, No. 12, 1285-1290

Williams R J, G. West, D. Morrison and R.G. Creese, (2006)

Estuarine Resources of New South Wales, prepared for the Comprehensive Coastal Assessment (DoP) by the NSW Department of Primary Industries, Port Stephens.

West R J, Thorogood C A, Walford T R and Williams R J (1985)

An Estuarine Inventory for NSW. Fisheries Bulletin 2. Fisheries Research Institute, NSW Fisheries Department.

Woodward-Clyde (1999)

Twofold Bay Multipurpose Wharf and Naval Munitions Storage Facility—Draft Environmental Impact Statement prepared for Department of Defence & NSW Waterways Authority.. Woodward-Clyde, St Leonards, March 2000

APPENDIX A

A1

Tables 4 and 5

From

TEL (2002) Cattle Bay Aquatic Ecology Survey

A2

Bionet and EPBC Web Based Searches

for

Threatened Species within 10km of Eden

Table 3: Description of the 150 m long Greenseas cannery jetty, Cattle Bay. Abundant species where noted at the top mid and bottom of piles at depths ranging from 1-4m deep.

Depth (m)	Top	Mid	Bottom
1	<i>Siphonaria denticulata</i> <i>Galeolaria caespitosa</i>	<i>Mytilus edulis</i> <i>Oulactis muscosa</i>	<i>Pyura stolonifera</i> <i>Antidotea albocincta</i>
2	<i>Tetractitella purpurascens</i> <i>Chthamalus antennatus</i> <i>Galeolaria caespitosa</i>	<i>Pyura stolonifera</i> <i>Plagusia chabrus</i>	<i>Herdmania momus</i> <i>Botryllodes</i> spp. <i>Ecklonia radiata</i> <i>Triphylozoon moniliferum</i> <i>Plagusia chabrus</i>
3	<i>Chthamalus antennatus</i> <i>Siphonaria virgulata</i> <i>Galeolaria caespitosa</i> <i>Chiton pelliserpentis</i>	<i>Pyura stolonifera</i> <i>Ecklonia radiata</i> <i>Botryllodes</i> sp. <i>Plagusia chabrus</i>	<i>Herdmania momus</i> <i>Ecklonia radiata</i> <i>Plagusia chabrus</i>
4	<i>Siphonaria virgulata</i> <i>Chthamalus antennatus</i> <i>Galeolaria caespitosa</i> <i>Chiton pelliserpentis</i> <i>Tetractitella purpurascens</i> <i>Mytilus edulis</i>	<i>Pyura stolonifera</i> <i>Botryllodes</i> sp. Arborescent Bryozoan <i>Sabellidae</i> spp. <i>Plagusia chabrus</i>	<i>Herdmania momus</i> <i>Ecklonia radiata</i> <i>Botryllodes</i> spp. <i>Darwinella</i> spp. <i>Plagusia chabrus</i>

Table 5: Description of intertidal rocky shores on the eastern side of Cattle Bay. Abundant species where noted at the low, mid and high shore.

Location	Low Shore	Mid Shore	High Shore
Beach End	<i>Galeolaria caespitosa</i> <i>Chiton pelliserpentis</i> <i>Siphonaria virgulata</i> <i>Siphonaria denticulata</i> <i>Pyura stolonifera</i> <i>Ralfsia</i> spp. <i>Endarachne</i> spp. <i>Montfortula rugosa</i> <i>Caulerperateria</i> spp. <i>Saccostrea glomerata</i>	<i>Saccostrea glomerata</i> <i>Nerita atramentosa</i> <i>Cellana tramoserica</i> <i>Bembicium nanum</i> <i>Austrococchlea porcata</i> <i>Morula marginalba</i> <i>Caestania spengleri</i> <i>Tetractitella purpurascens</i> <i>Hormosira banksii</i>	<i>Noddilittorina unifasciata</i> <i>Tetractitella purpurascens</i> <i>Lichen</i> spp.
Mid section	<i>Ralfsia</i> spp. <i>Siphonaria virgulata</i> <i>Siphonaria denticulata</i> <i>Chamaesipho tasmanica</i> <i>Chiton pelliserpentis</i> <i>Oulactis muscosa</i>	<i>Cellana tramoserica</i> <i>Chamaesipho tasmanica</i> <i>Nerita atramentosa</i> <i>Bembicium nanum</i> <i>Morula marginalba</i> <i>Austrococchlea porcata</i> <i>Montfortula rugosa</i> <i>Agnewia tritoniformis</i>	<i>Noddilittorina unifasciata</i> <i>Tetractitella purpurascens</i> <i>Noddilittorina pyramidalis</i> <i>Chamaesipho tasmanica</i> <i>Galeolaria caespitosa</i>
Far section	<i>Galeolaria caespitosa</i> <i>Chiton pelliserpentis</i> <i>Saccostrea glomerata</i> <i>Siphonaria virgulata</i> <i>Siphonaria denticulata</i> <i>Ralfsia</i> spp. <i>Corallina officinalis</i>	<i>Saccostrea glomerata</i> <i>Cellana tramoserica</i> <i>Austrococchlea porcata</i> <i>Bembicium nanum</i> <i>Chamaesipho tasmanica</i> <i>Nerita atramentosa</i> <i>Agnewia tritoniformis</i> <i>Morula marginalba</i>	<i>Noddilittorina unifasciata</i> <i>Lichen</i> spp.

Table 4. Fish species found around the jetty and eastern shore on the 26-27 June 2002

Family	Species	Common name	Eastern shore	Jetty	Total no. spp
Urolophidae	<i>Trigloporus lestaes</i>	Common stingaree	2		1
	<i>Urolophus cruciatus</i>	Banded stingaree	1		1
Syngnathidae	<i>Phyllopteryx taeniolatus</i>	Weedy sea dragon	1		1
Fistulariidae	<i>Fistularia</i> sp.	Flutemouth	2		1
Scorpaenidae	<i>Centropogon australis</i>	Fortesque		1	1
Platycephalidae	<i>Platycephalus fuscus</i>	Dusky flathead		1	1
Serranidae	<i>Hypoplectrodes unicoloratus</i>	Half-banded sea perch	1	1	1
Plesiopidae	<i>Trechtopus taeniatus</i>	Hula fish	2		1
Apogonidae	<i>Siphonina cephalotes</i>	Wood's siphon fish	1		1
Pomatomidae	<i>Pomatomus saltatrix</i>	Tailor		20	1
Coruagidae	<i>Pseudocaranx dentex</i>	Silver trevally	50	100	1
	<i>Trachurus novaezeelandiae</i>	Yellowtail		15	1
Sillaginidae	<i>Sillago ciliata</i>	Sard whiting	100		1
Mullidae	<i>Parrpenaeus signatus</i>	Black saddle goatfish	9		1
	<i>Lipeneichthys porosus</i>	Red mullet	4	1	1
Girellidae	<i>Girella tricuspidata</i>	Luderick	70		1
Sparidae	<i>Acanthopagrus australis</i>	Yellowfin bream	2		1
	<i>Pagrus auratus</i>	Snapper		1	1
Scorpididae	<i>Atypichthys strigatus</i>	Mado	6		1
	<i>Scorpius lineolatus</i>	Sweep	10	1	1
Pomacentridae	<i>Parina microlepis</i>	White ear		5	1
	<i>Medaenichthys immaculatus</i>	Inmaculate darter	1		1
Aplodactylidae	<i>Cinolus lophodon</i>	Rock gale	2		1
Cheilodactylidae	<i>Cheilodactylus fuscus</i>	Red morwong	2		1
Labridae	<i>Achoerodus viridis</i>	Blue groper	5		1
	<i>Eupetrichthys argusipes</i>	Snake-skin wrasse	2		1
	<i>Notolabris gymnotus</i>	Purple banded wrasse	5		1
	<i>Ophthalmolepis lineolatus</i>	Maori wrasse	6		1
	<i>Pictilabrus laticlavus</i>	Senator wrasse	6	3	1
	<i>Pseudolabrus gemiferi</i>	Rainbow wrasse	1		1
Mugilidae	-	Unidentified larvae		30	1
Sphyraenidae	<i>Sphyraena obtusata</i> (?)	Striped sea pike (S)	1000	1000	1
Trypterigiidae	<i>Norfolkia clarki</i>	Tripple fin	1		1
	-	Unidentified small juveniles		10	1
Monacanthidae	<i>Nelussetta nyrondi</i>	Chinaman leatherjacket		2	1
	<i>Metuschenia freycineti</i>	Variable leatherjacket		1	1
	<i>Scobinichthys granulatus</i>	Rough leatherjacket	1	1	1
Ostracidae	<i>Anoplocapros inermis</i>	Eastern smooth boxfish	1		1
Diodontidae	<i>Dicotilichthys punctulatus</i>	Porcupine fish	1	1	1
Total Number of Species			29	18	40
Total Number of Individual fi			1298	1194	



EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 25/03/13 14:13:41

[Summary](#)

[Details](#)

[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)



This map may contain data which are
©Commonwealth of Australia
(Geoscience Australia), ©PSMA 2010

[Coordinates](#)

[Buffer: 1.0Km](#)



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	27
Listed Migratory Species:	27

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As [heritage values](#) of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	46
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

Place on the RNE:	None
State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora epomophora Southern Royal Albatross [25996]	Vulnerable	Species or species habitat may occur within area
Diomedea epomophora sanfordi Northern Royal Albatross [82331]	Endangered	Species or species habitat may occur within area
Diomedea exulans antipodensis Antipodean Albatross [82269]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans gibsoni Gibson's Albatross [82271]	Vulnerable	Species or species habitat may occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant-Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Species or species

Name	Status	Type of Presence
Thalassarche cauta salvini Salvin's Albatross [82343]	Vulnerable	habitat may occur within area Species or species habitat may occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris impavida Campbell Albatross [82449]	Vulnerable	Species or species habitat may occur within area
Fish		
Epinephelus daemeli Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat may occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Petrogale penicillata Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Sharks		
Carcharias taurus (east coast population) Grey Nurse Shark (east coast population) [68751]	Critically Endangered	Species or species habitat may occur within area
Carcharodon carcharias Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species

[[Resource Information](#)]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable*	Species or species habitat may occur within area
Diomedea epomophora (sensu stricto) Southern Royal Albatross [1072]	Vulnerable*	Species or species habitat may occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Species or species habitat may occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered*	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant-Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Sterna albifrons Little Tern [813]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta (sensu stricto) Shy Albatross, Tasmanian Shy Albatross [64697]	Vulnerable*	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross [64459]	Vulnerable*	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable*	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Species or species habitat may occur within area
Migratory Marine Species		
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Carcharodon carcharias Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable*	Species or species habitat may occur within area
Diomedea epomophora (sensu stricto) Southern Royal Albatross [1072]	Vulnerable*	Species or species habitat may occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Species or species habitat may occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered*	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel [1060]	Endangered	Species or species

Name	Threatened	Type of Presence
Macronectes halli Northern Giant-Petrel [1061]	Vulnerable	habitat may occur within area Species or species habitat may occur within area
Sterna albifrons Little Tern [813]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta (sensu stricto) Shy Albatross, Tasmanian Shy Albatross [64697]	Vulnerable*	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross [64459]	Vulnerable*	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable*	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Species or species habitat may occur within area
Fish		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Bigbelly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus minotaur Bullneck Seahorse [66705]		Species or species habitat may occur within area
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypsognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species

Name	Threatened	Type of Presence
Lissocampus runa Javelin Pipefish [66251]		habitat may occur within area Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal		Species or species

Name	Threatened	Type of Presence
[21]		habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Whales and other Cetaceans		[Resource Information]
Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding likely to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

Coordinates

-37.08633 149.90278

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Department of Environment, Climate Change and Water, New South Wales](#)
- [-Department of Sustainability and Environment, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment and Natural Resources, South Australia](#)
- [-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts](#)
- [-Environmental and Resource Management, Queensland](#)
- [-Department of Environment and Conservation, Western Australia](#)
- [-Department of the Environment, Climate Change, Energy and Water](#)
- [-Birds Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-SA Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Atherton and Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence](#)
- [-State Forests of NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

© Commonwealth of Australia

Department of Sustainability, Environment, Water, Population and Communities

GPO Box 787

Canberra ACT 2601 Australia

+61 2 6274 1111

Data from the BioNet Atlas of NSW Wildlife website, which holds records from a number of custodians. The data are only indicative and cannot be considered a comprehensive inventory, and may contain errors and omissions.

Species listed under the Sensitive Species Data Policy may have their locations denatured (^ rounded to 0.1; ^^ rounded to 0.01).

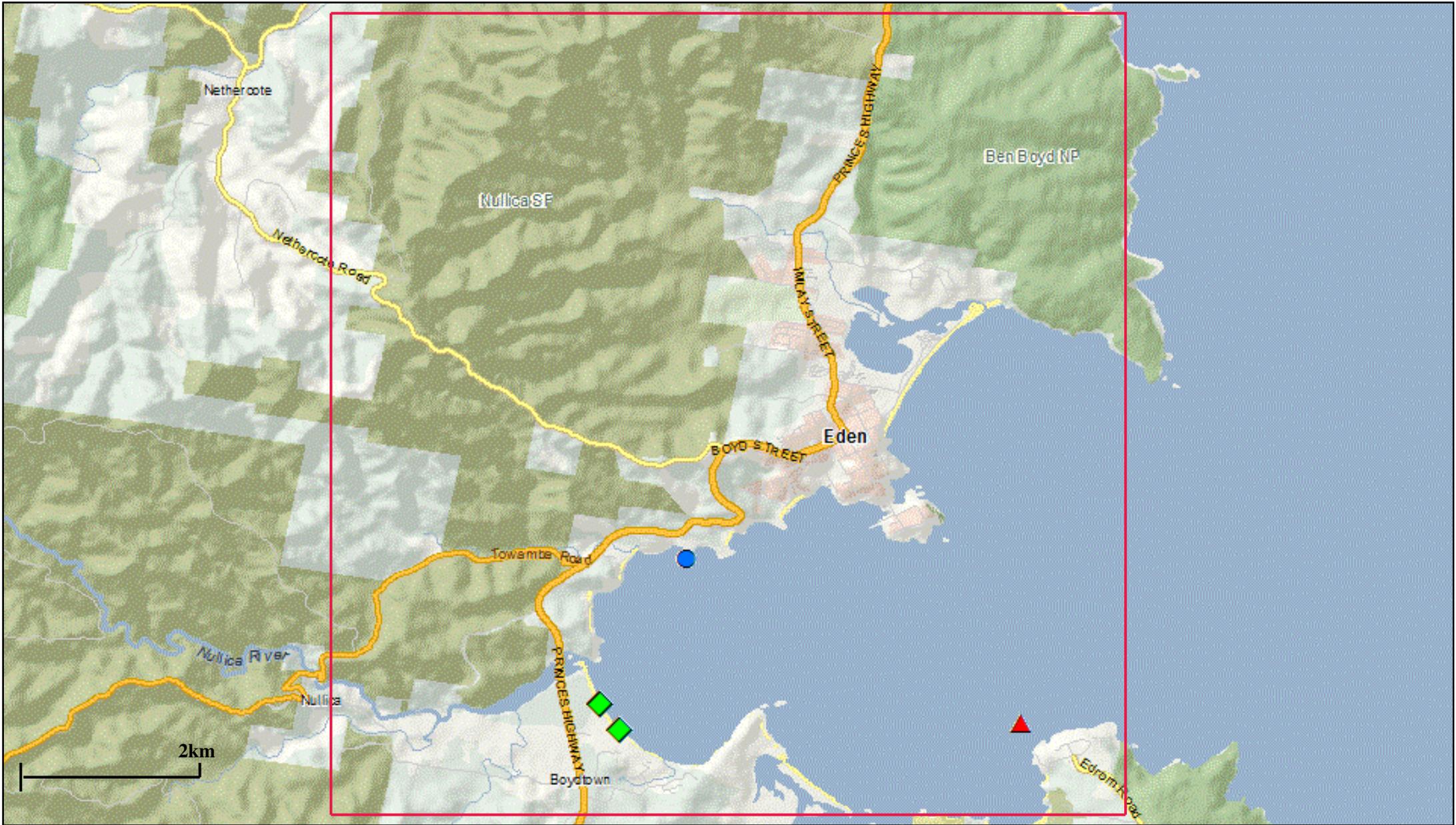
Copyright the State of NSW through the Office of Environment and Heritage.

Search criteria : Public Report of all Valid Records of Threatened (listed on TSC Act 1995) or Commonwealth listed Animals in BEGA VALLEY LGA returned a total of 11,064 records of 119 species.

Report generated on 25/03/2013 3:40 PM

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status	Records	Info
Animalia	Amphibia	Myobatrachidae	3042	<i>Heleioporus australiacus</i>		Giant Burrowing Frog	V,P	V	84	
Animalia	Amphibia	Myobatrachidae	3073	<i>Mixophyes balbus</i>		Stuttering Frog	E1,P,2	V	12	
Animalia	Amphibia	Myobatrachidae	3075	<i>Mixophyes iteratus</i>		Giant Barred Frog	E1,P,2	E	1	
Animalia	Amphibia	Myobatrachidae	3119	<i>Pseudophryne corroboree</i>		Southern Corroboree Frog	E4A,P,2	E	K	
Animalia	Amphibia	Hylidae	3166	<i>Litoria aurea</i>		Green and Golden Bell Frog	E1,P	V	24	
Animalia	Amphibia	Hylidae	3172	<i>Litoria castanea</i>		Yellow-spotted Tree frog	E4A,P	E	K	
Animalia	Amphibia	Hylidae	3039	<i>Litoria littlejohni</i>		Littlejohn's Tree Frog	V,P	V	3	
Animalia	Amphibia	Hylidae	3207	<i>Litoria raniformis</i>		Southern Bell Frog	E1,P	V	K	
Animalia	Amphibia	Hylidae	3907	<i>Litoria verreauxii alpina</i>		Alpine Tree Frog	E1,P	V	K	
Animalia	Reptilia	Cheloniidae	2007	<i>Chelonia mydas</i>		Green Turtle	V,P	V	K	
Animalia	Reptilia	Pygopodidae	2144	<i>Aprasia parapulchella</i>		Pink-tailed Legless Lizard	V,P	V	P	
Animalia	Reptilia	Pygopodidae	2159	<i>Delma impar</i>		Striped Legless Lizard	V,P	V	K	
Animalia	Reptilia	Agamidae	2824	<i>Tympanocryptis pinguicolla</i>		Grassland Earless Dragon	E1,P	E	K	
Animalia	Reptilia	Varanidae	2287	<i>Varanus rosenbergi</i>		Rosenberg's Goanna	V,P	V	P	
Animalia	Reptilia	Elapidae	2676	<i>Hoplocephalus bungaroides</i>		Broad-headed Snake	E1,P,2	V	P	
Animalia	Reptilia	Elapidae	2727	<i>Suta flagellum</i>		Little Whip Snake	V,P	V	K	
Animalia	Aves	Anseranatidae	0199	<i>Anseranas semipalmata</i>		Magpie Goose	V,P	V	1	
Animalia	Aves	Anatidae	0216	<i>Oxyura australis</i>		Blue-billed Duck	V,P	V	2	
Animalia	Aves	Anatidae	0214	<i>Stictonetta naevosa</i>		Freckled Duck	V,P	V	K	
Animalia	Aves	Columbidae	0023	<i>Ptilinopus superbus</i>		Superb Fruit-Dove	V,P	V	1	
Animalia	Aves	Oceanitidae	0944	<i>Fregatta grallaria</i>		White-bellied Storm-Petrel	V,P	V	K	
Animalia	Aves	Diomedidae	0846	<i>Diomedea antipodensis</i>		Antipodean Albatross	V,P	V	K	
Animalia	Aves	Diomedidae	0086	<i>Diomedea exulans</i>		Wandering Albatross	E1,P	E,J	4	
Animalia	Aves	Diomedidae	0847	<i>Diomedea gibsoni</i>		Gibson's Albatross	V,P	V	1	
Animalia	Aves	Diomedidae	0092	<i>Phoebastria fusca</i>		Sooty Albatross	V,P	V	K	
Animalia	Aves	Diomedidae	0091	<i>Thalassarche cauta</i>		Shy Albatross	V,P	V	7	
Animalia	Aves	Diomedidae	0088	<i>Thalassarche melanophris</i>		Black-browed Albatross	V,P	V	8	
Animalia	Aves	Procellariidae	0072	<i>Ardena carneipes</i>		Flesh-footed Shearwater	V,P	J,K	1	
Animalia	Aves	Procellariidae	0929	<i>Macronectes giganteus</i>		Southern Giant Petrel	E1,P	E	K	
Animalia	Aves	Procellariidae	0937	<i>Macronectes halli</i>		Northern Giant-Petrel	V,P	V	1	
Animalia	Aves	Procellariidae	8684	<i>Pterodroma leucoptera leucoptera</i>		Gould's Petrel	V,P	E	K	
Animalia	Aves	Procellariidae	8993	<i>Pterodroma neglecta neglecta</i>		Kermadec Petrel (west Pacific subspecies)	V,P	V	K	
Animalia	Aves	Procellariidae	0955	<i>Pterodroma nigripennis</i>		Black-winged Petrel	V,P	V	1	
Animalia	Aves	Procellariidae	0971	<i>Pterodroma solandri</i>		Providence Petrel	V,P	J	3	
Animalia	Aves	Procellariidae	0067	<i>Puffinus assimilis</i>		Little Shearwater	V,P	V	K	
Animalia	Aves	Sulidae	0105	<i>Sula dactylatra</i>		Masked Booby	V,P	J,K	K	
Animalia	Aves	Ardeidae	0197	<i>Botaurus poiciloptilus</i>		Australasian Bittern	E1,P	E	5	
Animalia	Aves	Ardeidae	0196	<i>Ixobrychus flavicollis</i>		Black Bittern	V,P	V	3	
Animalia	Aves	Accipitridae	0218	<i>Circus assimilis</i>		Spotted Harrier	V,P	V	2	
Animalia	Aves	Accipitridae	0225	<i>Hieraaetus morphnoides</i>		Little Eagle	V,P	V	38	
Animalia	Aves	Accipitridae	0230	<i>Lophoictinia isura</i>		Square-tailed Kite	V,P,3	V	25	
Animalia	Aves	Accipitridae	8739	<i>Pandion cristatus</i>		Eastern Osprey	V,P,3	V	19	
Animalia	Aves	Falconidae	0236	<i>Falco hypoleucos</i>		Grey Falcon	E1,P,2	V	1	
Animalia	Aves	Burhinidae	0174	<i>Burhinus grallarius</i>		Bush Stone-curlew	E1,P	V	1	
Animalia	Aves	Burhinidae	0175	<i>Esacus magnirostris</i>		Beach Stone-curlew	E4A,P	V	1	
Animalia	Aves	Haematopodidae	0131	<i>Haematopus fuliginosus</i>		Sooty Oystercatcher	V,P	V	72	
Animalia	Aves	Haematopodidae	0130	<i>Haematopus longirostris</i>		Pied Oystercatcher	E1,P	V	290	
Animalia	Aves	Charadriidae	0141	<i>Charadrius leschenaultii</i>		Greater Sand-plover	V,P	C,J,K	K	
Animalia	Aves	Charadriidae	0139	<i>Charadrius mongolus</i>		Lesser Sand-plover	V,P	C,J,K	1	
Animalia	Aves	Charadriidae	0138	<i>Thinornis rubricollis</i>		Hooded Plover	E4A,P	V	160	
Animalia	Aves	Jacaniidae	0171	<i>Irediparra gallinacea</i>		Comb-crested Jacana	V,P	V	2	
Animalia	Aves	Rostratulidae	0170	<i>Rostratula australis</i>		Australian Painted Snipe	E1,P	V	1	
Animalia	Aves	Scolopacidae	0166	<i>Calidris alba</i>		Sanderling	V,P	C,J,K	5	
Animalia	Aves	Scolopacidae	0161	<i>Calidris ferruginea</i>		Curlew Sandpiper	E1,P	C,J,K	11	
Animalia	Aves	Scolopacidae	0165	<i>Calidris tenuirostris</i>		Great Knot	V,P	C,J,K	K	
Animalia	Aves	Scolopacidae	0167	<i>Limicola falcinellus</i>		Broad-billed Sandpiper	V,P	C,J,K	K	
Animalia	Aves	Scolopacidae	0152	<i>Limosa limosa</i>		Black-tailed Godwit	V,P	C,J,K	1	

Animalia	Aves	Scolopacidae	0160	<i>Xenus cinereus</i>	Terek Sandpiper	V,P	C,J,K	K	
Animalia	Aves	Laridae	0972	<i>Gygis alba</i>	White Tern	V,P		K	
Animalia	Aves	Laridae	0120	<i>Onychoprion fuscata</i>	Sooty Tern	V,P		K	
Animalia	Aves	Laridae	0117	<i>Sterna albifrons</i>	Little Tern	E1,P	C,J,K	254	
Animalia	Aves	Cacatuidae	0268	<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V,P,3		597	
Animalia	Aves	Cacatuidae	8857	<i>Calyptorhynchus banksii samueli</i>	Red-tailed Black-Cockatoo (inland subspecies)	V,P,2		1	
Animalia	Aves	Cacatuidae	0265	<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V,P,2		1009	
Animalia	Aves	Psittacidae	0259	<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet	V,P,3		K	
Animalia	Aves	Psittacidae	0260	<i>Glossopsitta pusilla</i>	Little Lorikeet	V,P		56	
Animalia	Aves	Psittacidae	0309	<i>Lathamus discolor</i>	Swift Parrot	E1,P,3	E	47	
Animalia	Aves	Psittacidae	0305	<i>Neophema chrysogaster</i>	Orange-bellied Parrot	E4A,P,3	CE	P	
Animalia	Aves	Psittacidae	0302	<i>Neophema pulchella</i>	Turquoise Parrot	V,P,3		5	
Animalia	Aves	Psittacidae	8913	<i>Pezoporus wallicus wallicus</i>	Eastern Ground Parrot	V,P,3		468	
Animalia	Aves	Strigidae	0246	<i>Ninox connivens</i>	Barking Owl	V,P,3		33	
Animalia	Aves	Strigidae	0248	<i>Ninox strenua</i>	Powerful Owl	V,P,3		917	
Animalia	Aves	Tytonidae	0250	<i>Tyto novaehollandiae</i>	Masked Owl	V,P,3		198	
Animalia	Aves	Tytonidae	9924	<i>Tyto tenebrosa</i>	Sooty Owl	V,P,3		741	
Animalia	Aves	Climacteridae	8127	<i>Climacteris picumms victoriae</i>	Brown Treecreeper (eastern subspecies)	V,P		10	
Animalia	Aves	Dasyornithidae	0519	<i>Dasyornis brachypterus</i>	Eastern Bristlebird	E1,P	E	266	
Animalia	Aves	Acanthizidae	0500	<i>Calamanthus fuliginosus</i>	Striated Fieldwren	E1,P		116	
Animalia	Aves	Acanthizidae	0504	<i>Chthonicola sagittata</i>	Speckled Warbler	V,P		1	
Animalia	Aves	Meliphagidae	0603	<i>Anthochaera phrygia</i>	Regent Honeyeater	E4A,P	E	6	
Animalia	Aves	Meliphagidae	0448	<i>Epthianura albifrons</i>	White-fronted Chat	V,P		49	
Animalia	Aves	Psophodidae	0437	<i>Cinlosoma castanotum</i>	Chestnut Quail-thrush	V,P		2	
Animalia	Aves	Neosittidae	0549	<i>Daphoenositta chrysoptera</i>	Varied Sittella	V,P		123	
Animalia	Aves	Pachycephalidae	0405	<i>Pachycephala olivacea</i>	Olive Whistler	V,P		77	
Animalia	Aves	Petroicidae	8367	<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)	V,P		9	
Animalia	Aves	Petroicidae	0380	<i>Petroica boodang</i>	Scarlet Robin	V,P		315	
Animalia	Aves	Petroicidae	0382	<i>Petroica phoenicea</i>	Flame Robin	V,P		230	
Animalia	Aves	Petroicidae	0383	<i>Petroica rodinogaster</i>	Pink Robin	V,P		9	
Animalia	Aves	Estrildidae	0652	<i>Stagonopleura guttata</i>	Diamond Firetail	V,P		20	
Animalia	Mammalia	Dasyuridae	1008	<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V,P	E	129	
Animalia	Mammalia	Dasyuridae	1017	<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V,P		14	
Animalia	Mammalia	Dasyuridae	1069	<i>Sminthopsis leucopus</i>	White-footed Dunnart	V,P		57	
Animalia	Mammalia	Peramelidae	1710	<i>Isoodon obesulus obesulus</i>	Southern Brown Bandicoot (eastern)	E1,P	E	279	
Animalia	Mammalia	Phascolarctidae	1162	<i>Phascolarctos cinereus</i>	Koala	V,P	V	817	
Animalia	Mammalia	Burramyidae	1150	<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V,P		73	
Animalia	Mammalia	Petauridae	1136	<i>Petaurus australis</i>	Yellow-bellied Glider	V,P		2243	
Animalia	Mammalia	Petauridae	1137	<i>Petaurus norfolcensis</i>	Squirrel Glider	V,P		2	
Animalia	Mammalia	Potoroidae	1179	<i>Potorous longipes</i>	Long-footed Potoroo	E1,P	E	66	
Animalia	Mammalia	Potoroidae	1175	<i>Potorous tridactylus</i>	Long-nosed Potoroo	V,P	V	467	
Animalia	Mammalia	Macropodidae	1215	<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	E1,P	V	3	
Animalia	Mammalia	Pteropodidae	1280	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V,P	V	76	
Animalia	Mammalia	Emballonuridae	1321	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V,P		2	
Animalia	Mammalia	Molossidae	1329	<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V,P		12	
Animalia	Mammalia	Vespertilionidae	1353	<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V,P	V	P	
Animalia	Mammalia	Vespertilionidae	1372	<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V,P		104	
Animalia	Mammalia	Vespertilionidae	1369	<i>Kerivoula papuensis</i>	Golden-tipped Bat	V,P		9	
Animalia	Mammalia	Vespertilionidae	1346	<i>Miniopterus australis</i>	Little Bentwing-bat	V,P		2	
Animalia	Mammalia	Vespertilionidae	1834	<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	V,P		132	
Animalia	Mammalia	Vespertilionidae	1357	<i>Myotis macropus</i>	Southern Myotis	V,P		41	
Animalia	Mammalia	Vespertilionidae	1361	<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V,P		28	
Animalia	Mammalia	Muridae	1438	<i>Mastacomys fuscus</i>	Broad-toothed Rat	V,P		K	
Animalia	Mammalia	Muridae	1458	<i>Pseudomys fumeus</i>	Smoky Mouse	E4A,P	E	124	
Animalia	Mammalia	Dugongidae	1558	<i>Dugong dugon</i>	Dugong	E1,P		1	
Animalia	Mammalia	Otariidae	1543	<i>Arctocephalus forsteri</i>	New Zealand Fur-seal	V,P		2	
Animalia	Mammalia	Otariidae	1882	<i>Arctocephalus pusillus doriferus</i>	Australian Fur-seal	V,P		17	
Animalia	Mammalia	Balaenidae	1561	<i>Eubalaena australis</i>	Southern Right Whale	E1,P	E	2	
Animalia	Mammalia	Balaenopteridae	1567	<i>Balaenoptera musculus</i>	Blue Whale	E1,P	E	K	
Animalia	Mammalia	Balaenopteridae	1575	<i>Megaptera novaeangliae</i>	Humpback Whale	V,P	V	9	
Animalia	Mammalia	Physeteridae	1578	<i>Physeter macrocephalus</i>	Sperm Whale	V,P		1	
Animalia	Insecta	Petaluridae	1007	<i>Petalura gigantea</i>	Giant Dragonfly	E1		1	



Legend

-  Green Turtle (*Chelonia mydas*)
-  Sooty Oystercatcher (*Haematopus fuliginosus*)
-  Pied Oystercatcher (*Haematopus longirostris*)

Atlas of NSW Wildlife records



Data from the BioNet Atlas of NSW Wildlife website, which holds records from a number of custodians. Location accuracy varies. Maps from the website are interactive: map displays can be modified from the original extent and a maximum of 5 species can be selected to display. Map may contain errors and omissions. Neither the Office of Environment and Heritage nor any other data custodian will accept liability for any loss, damage, cost or expenses incurred as a result of the use of, or reliance upon, the information in the map. Map copyright the State of NSW through the Office of Environment and Heritage.

Your Selection: Public Report of all Valid Records of Animals in selected area [North: -37.01 West: 149.84 East: 149.94 South: -37.11] recorded since 01 Jan 2000 until 25 Mar 2013 returned a total of 1,156 records of 175 species.

Report generated on 25/03/2013 3:22 PM