Flinders Pier Marine Ecology and Pier Removal Impact Assessment 2021

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Marine Ecology
and
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Executive summary

Flinders Pier is located on the western shore of Western Port within Kennon Cove, adjacent to the town of Flinders near West Head (Figure 1). The present 320 m long Flinders Pier structure is the product of episodes of construction, maintenance, removal and reconstruction activities by various pier managers over the 150 years since the pier was first built in about 1870. Parks Victoria is responsible for the management of the pier, as legislated in the *Parks Victoria Act 2018*, Crown Land Allotment 16B.

Flinders Pier structure traditionally comprises pairs of wooden piles that support a wooden deck, hand rails, steps and loading landings located approximately midway along the pier and at the end of the pier. A steel structure comprising steel piles and a concrete deck was added parallel to the inner 180 m length of the pier in about 2013 due to the deterioration of the old pier and to provide access and service for vehicles accessing the loading and unloading of commercial vessels associated with the Flinders Aquaculture Zone. The first 180 m of the wooden jetty was to be removed on completion of the steel structure due to the deteriorated state of the piles at that time. However, the removal was delayed and Parks Victoria proposes to remove the inner 180m of the pier in 2021/22 to reduce the increasing risk to public safety resulting from further deterioration of the structure.

Works on the pier will require approval under the *Marine and Coastal Act 2018* (MaCA). This report provides documentation of marine ecosystem conditions at the pier, an assessment of potential effects of the removal and mitigation concepts to inform the ecosystem-based management requirements for approval under the Act.

Flinders Pier is a popular location for a range of activities for local residents and visitors. Like Portsea Pier, the wooden structure of Flinders Pier creates a traditional maritime ambiance that adds to the experience of activities at these locations. The ready access to the shoreline and nearshore waters makes the piers focal points for divers using snorkels of SCUBA to explore the marine environment beneath the piers. Both piers have become known as ideal locations for observing the State marine emblem the weedy seadragon *Phyllopteryx taeniolatus.* The search for these seadragons at Flinders and Portsea piers introduces many divers to an appreciation of the many other forms of marine life under the piers and a broader appreciation of Victoria's marine ecosystem, apart from catching fish from the deck of a jetty or boat.

The characteristics of the marine ecological community at the Pier was documented during a marine ecological survey in December 2020 following the same approach as a marine ecological baseline study in 2007. The studies documented a range of marine plant, invertebrate and fish species at the pier that were common to other parts of the Western Entrance and nearby Bass Strait waters and more widely in the Central Victorian Marine Bioregion.

The predominant natural habitat at and around the jetty is meadows of the seagrass *Amphibolis antarctica*. These meadows extend long the western shore of the Western Entrance from West Head to Balnarring and the eastern shore of Phillip Island from Sealers Cove (Cat Bay) to Cowes. *Amphibolis* meadows are distributed along the Victoria open coast from Wilsons Promontory to Portland, and extend as far as Carnarvon in Western Australia. The weedy seadragon *Phyllopteryx taeniolatus* is often associated with *Amphibolis* meadows, but their habitat preference is not limited to *Amphibolis.* They are also found associated with kelp and other reef habitat to more than 50 m depth. Their geographic range extends from Newcastle in New South Wales to as far as Geraldton in Western Australia.

Approximately 120 m of the 180 m length of wooden pier proposed for removal is above the low tide mark. The seabed over the first 80 m comprises bare, flat fine sand and the lower parts of the pier piles close to the low tide mark are sparsely inhabited by common invertebrates including barnacles, limpets and marine snails. Sparse ephemeral *Zostera muelleri* seagrass extends alongside the pier from 80 m (just above low tide) to 140 m along the pier at about 1 m below low tide. The seabed beside the remaining 40 m of wooden pier to be removed is habitat for the seagrass *Amphibolis antarctica*. However, the seabed beneath the pier is bare of seagrass because of insufficient light caused by shading from the deck of pier.

The remaining 140 m of wooden pier and the steel and concrete structure provides most of the marine ecosystem values of Flinders Pier including both the natural seagrass habitat and the artificial habitat created by the landing decks and the wooden and steel pier piles. These will be unaffected by the removal of the inner 180 m length of wooden pier.

Flinders Pier is located within extensive *Amphibolis antarctica* seagrass beds that are distributed all along the southwestern shore of Western Port. The artificial structure and conditions at the pier mimic natural reef habitats and conditions that are more dispersed in the natural environment around Kennon Cove and nearby Western Port and Bass Strait. The biota around and under the pier and attached to the pier piles are representative of those in surrounding natural environment.

The potential impact pathways of the possible pier removal works and associated risks to the marine ecosystem have been identified in this study. The potential effects of the proposed works on marine ecosystem values are localised and temporary. Scheduling of the works for the autumn through winter period, when biological activity in Western Port is naturally low and natural disturbance to the ecosystem through waves and sediment movement is higher than works effects, will reduce the potential works effects on most marine ecosystem values.

The unavoidable effect of the works will be the removal of marine invertebrates, macroalgae and perhaps small cryptic fish such as gobies, blennies and pipefish inhabiting portions of the permanently submerged piles that will be removed. These species are represented on natural reefs in the area as well as the remaining wooden piles and the steel piles installed in 2013.

Risks from removal of the inner wooden length of Flinders Pier to State or Commonwealth protected and threatened species are negligible.

No seagrasses will be removed and any minor, temporary disturbance to seagrasses can be mitigated through good works procedures. Seagrass is likely to re-establish in the nearshore area of seabed presently shaded by the existing wooden deck that is proposed to be removed.

Fish and seadragons are mobile relative to the spatial scale and speed of the proposed works. Most fish are associated with the middle and end landings that will not be affected by the works. Most seadragons are associated with the edges of the seagrass beside the pier or the piles along the pier offshore of the landing. These will be unaffected by the works. Those There is less than 40 lineal metres of remaining habitat that will be affected. It is expected that fish and seadragons will be capable of avoiding direct disturbance and potential effects are likely to be negligible.

Good works practices managed through an approved Construction Environmental Management Plan for the pier removal works will ensure all risks to the marine ecosystem are minimised. A Construction Environment Management Plant (CEMP) will be required for the works. A framework for the CEMP will accompany the MaCA consent application. Details of the CEMP for the works will be prepared specific to the procedures and equipment proposed by the contractor.

Flinders Pier provides a relatively safe and confined area of focus for snorkellers and divers to see a range of marine biota that are otherwise naturally dispersed over a wider area of the Flinders coast. The pier provides a formal and informal venue for public marine environmental education and appreciation of a range of ecosystem components and general natural history of the locality.

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1 Introduction

Flinders Pier is located on the western shore of Western Port within Kennon Cove, adjacent to the town of Flinders near West Head (Figure 1). Parks Victoria is responsible for the management of the pier, as legislated in the *Parks Victoria Act 2018*, Crown Land Allotment 16B.

Figure 1. Location of Flinders Pier

The Pier was renovated in 2013 with the construction of a steel and concrete pier parallel to the nearshore wooden length of pier and the removal and replacement of the wooden offshore pier with wooden piles and deck. The inner 180 m length of 320 m long wooden pier has deteriorated and is no longer safe for use. This section of pier was closed for public access in April 2020.

Parks Victoria proposes to remove the inner 180m of the pier to reduce the public safety risk. Works on the pier will require approval under the *Marine and Coastal Act 2018.*

1.1 Purpose of report

Parks Victoria commissioned CEE Pty Ltd Environmental Scientists and Engineers to inspect and describe the marine life under Flinders Pier and provide an assessment of potential impacts on the marine community of removal of timber piles along the first 180 m of the pier, while the existing steel structure to 180 m offshore and wooden structures from the middle landing to the offshore end of the pier would remain in place.

1.2 Scope of Work

The scope of work for this project included:

1) Survey of the marine biological community associated with pier and pile habitat around the inner timber section of Flinders Pier and the adjacent seagrass and seabed communities likely to be impacted within the proposed works footprint.
2) Repeat transects the Marine Ecology Baseline Survey (2007), with additional transect the length of the pier.
3) A technical report
    a) Documenting marine species associated with pilings and adjacent seagrass areas, and their abundance and distribution, with attention to any Weedy Seadragons and other Syngnathid fauna,
    b) Providing an overview of marine growth on the piles on the new section of pier,
    c) Assessing and documenting marine pest distribution,
    d) Assessing potential changes in marine biodiversity with removal of old piles,
    e) Providing the location and photographs of any debris in underwater,
    f) Reviewing the previous Marine Ecology Baseline Survey (2007) and compare community on the new steel piles and
    g) Outline mitigation options to address any potential impact of the proposed works

1.3 Limitations and constraints

The 2020 Flinders Pier marine ecology documentation followed the general approach of a sea life survey in 2007 (Stewart et al 2007).

Both studies for Parks Victoria were qualitative descriptions of diverse communities based on one-day surveys of the pier and nearby seabed habitat.

The description of the marine ecological community at Flinders Pier in December 2020 and interpretation of change since June 2007 is based on quality of the observations and recorded conditions of the marine community and representative species at the time of each survey (different seasons, 13 years apart) and the different teams of marine scientists responsible for the surveys.

2 Flinders Pier

The present 320 m long Flinders Pier structure is the product of episodes of construction, maintenance and removal activities by various pier managers over the 150 years since the pier was first built in about 1870 (URS 2008).

The pier structure comprised pairs of wooden piles that supported a wooden deck, hand rails, steps and loading landings located approximately midway along the pier and at the end of the pier. A wooden wave screen extended approximately 100 m northeast from the end of the pier. The wave screen was removed in 1999 due to storm damage and general deterioration (Figure 2).

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Figure 2. Flinders Pier with breakwater 1999
Source from resident during Flinders Pier Master Plan consultation, URS 2008

A masterplan was developed in the early 2000s in recognition that the condition of the wooden pier was deteriorating and would require replacement. The 2008 Masterplan for Flinders Pier (Figure 3) shows the plan for extending and replacing parts of Flinders Pier at that time.

Components of the Masterplan were implemented in 2013 with:

1) replacement of the deteriorating 140 m outer length of the wooden pier from the middle landing to the end of the pier (approximately) similar timber materials and
2) installation of a steel pile and concrete deck pier, loading pad and landing platform from the shore to the middle landing of the pier to cater for loading and unloading commercial vessels particularly those associated with the Flinders aquaculture zone and pilot vessel.

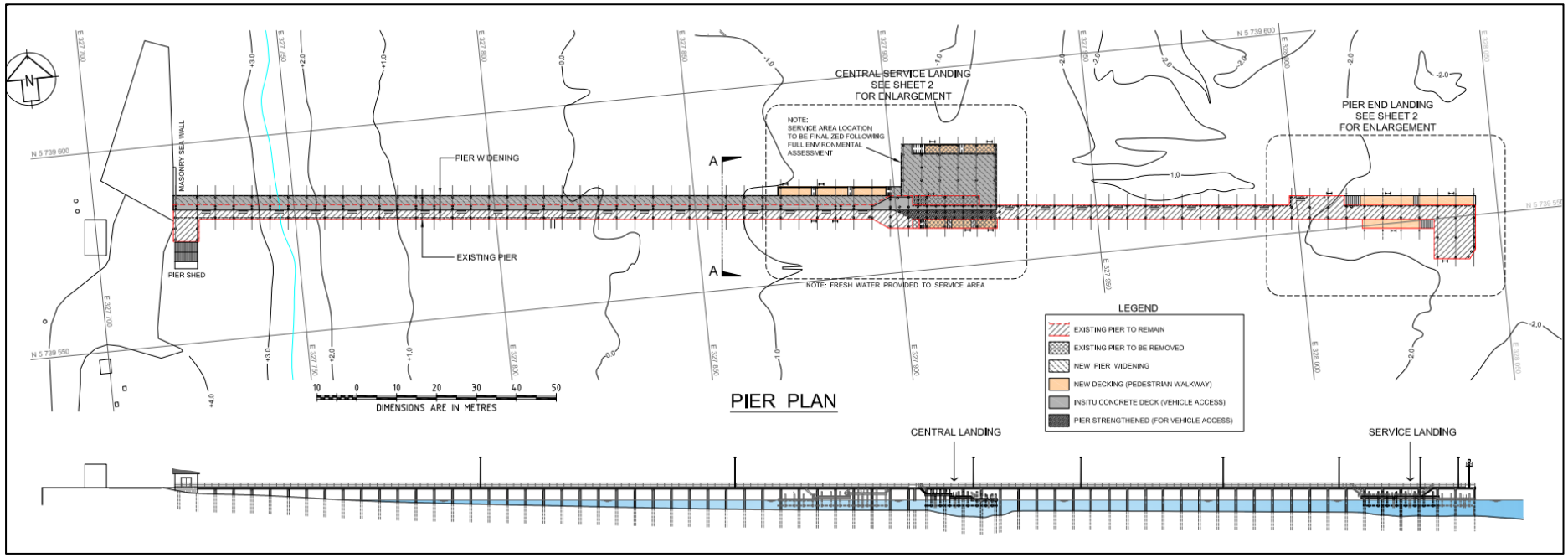

Figure 3. Planned Pier modification 2008
(URS 2008)

The new steel and concrete structures were installed parallel to north side of the existing older wooden pier structure (Figure 4). The two pier decks abut so that pedestrians can cross from one side to the other for the full length of the concrete and wooden decks, but the piers are structurally independent. As discussed previously, the wooden pier structures along the south side of the steel pier have deteriorated further since 2013, have become unsafe and were closed to public access in April 2020.

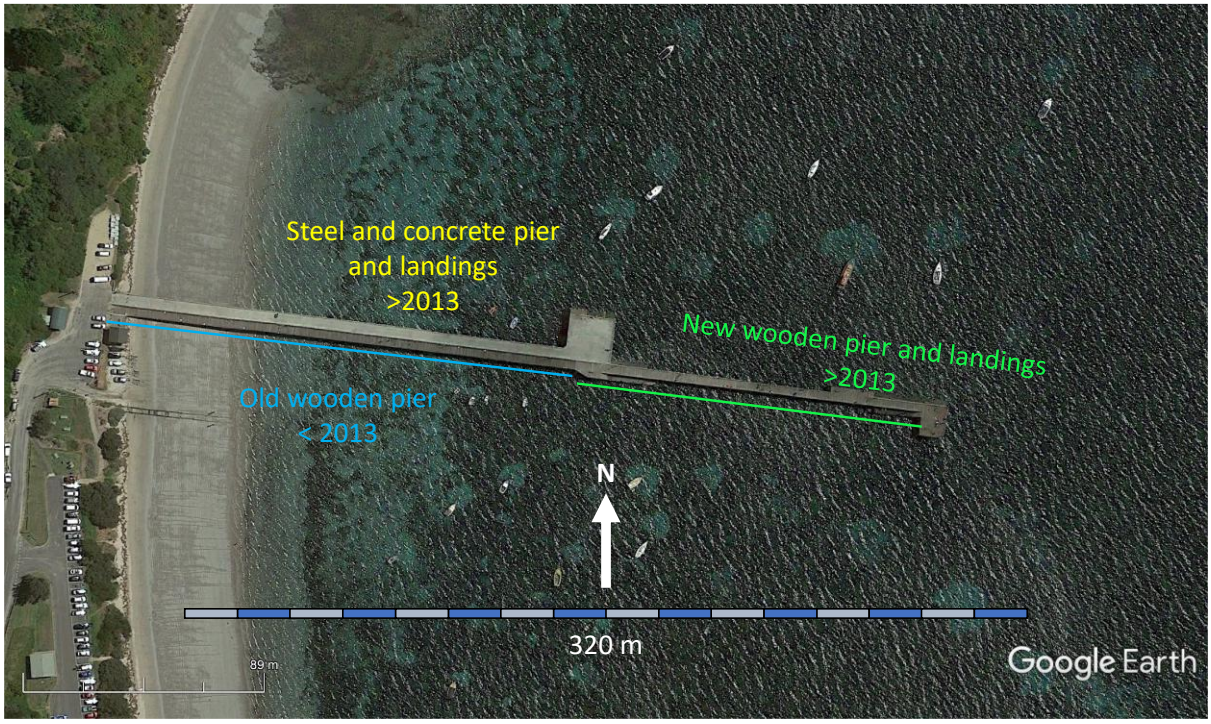

Figure 4. Flinders Pier 2018

2.1 Flinders Pier usage

The primary purpose of the Flinders Pier from the 1870s was to service commercial fishing vessels that moored at Flinders and traded to and from Flinders. In recent decades, the Pier has become an increasingly popular focus for:

- recreational mariners with moorings at Flinders;
- pilot vessel operations;
- recreational anglers and divers who launch from the beach next to the pier;
- aquaculturists who grow shellfish and macroalgae in the Flinders Aquaculture Zone;
- recreational anglers who fish from the Pier;
- visitors and residents who enjoy walking on the pier;
- young and older who enjoy jumping from the pier into the deeper water and;
- snorkellers and SCUBA divers who dive under the pier for lessons, training or to enjoy the artificial habitat and ambiance created by the pier and the diverse marine life in the protected waters under the pier (Figure 6)
- photography and appreciation of the wooden structures above (cover) and below the water.

2.2 Pier and Moorings

Flinders pier is the focal point for moored vessels in southwestern Western Port as it is the most sheltered position in from ocean swell, and northwesterly to southerly winds in the Western Entrance segment of the Bay. Fishing vessels have moored in this location at Flinders since the mid-1800s.

Moorings locations are managed and licensed by Parks Victoria at cost to boat owners. Mooring designs must comply with Parks Victoria requirements. Moorings must be inspected annually by licensed contractors and compliance reports must be submitted by boat owners to Parks Victoria annually. All costs are paid directly by boat owners. Vessels may be permanently moored at Flinders, but most moorings are only occupied during for the warmer months.

As discussed later, the location of spring mooring positions can be seen as circular sand patches in the seagrass habitat, where the riding chains of the moorings sweep the seabed as moored vessels move with changes in wind direction. These patches can be seen in Figure 4.

Figure 5. Boating anglers' refuse at Finders pier, 2007 and 2021
Under pier June 2007 (left), beside pier April 2021(right)

Figure 6. SCUBA diving school emerge after dive at Flinders Pier

3 Marine ecological setting at Flinders Pier

Western Port comprises a system of joined segments and arms that were recognised for their different physical, water quality and ecological characteristics during the Western Port Bay Study of the 1970s (Figure 7).

Flinders Pier is located at the Western Entrance of Western Port. The waters around Flinders Pier are flushed with Bass Strait waters on a daily basis by twice-daily tides, that range up to 3 m. Ocean swell from Bass Strait refracts into Flinders Pier and there is often strong wave surge on the seabed around the pier piles. The fine sands of the seabed are frequently mobilised by wave surge.

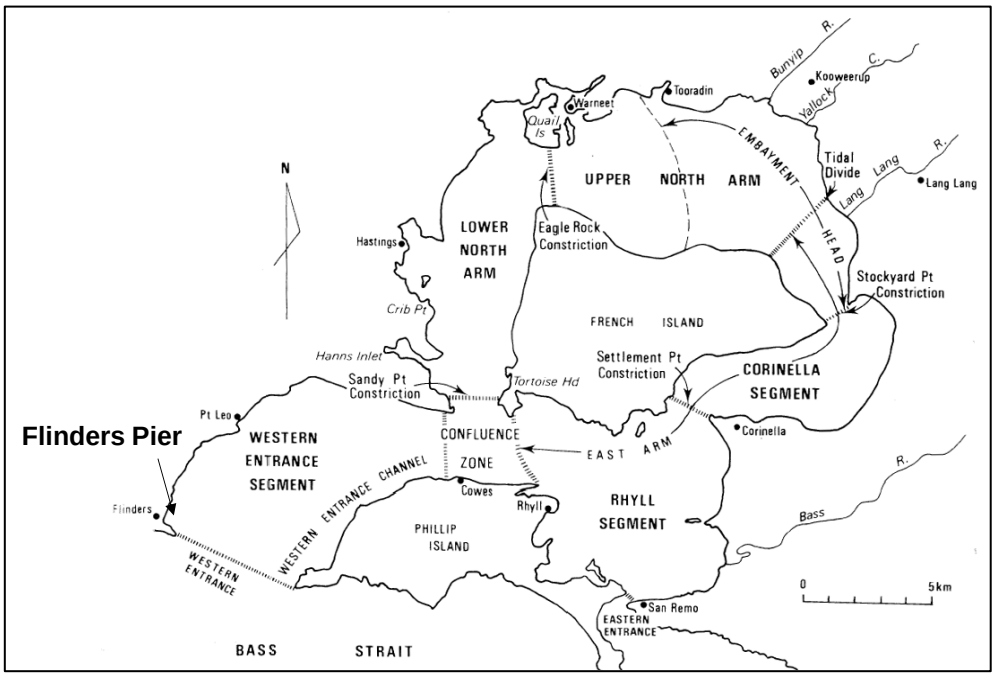

Figure 7. Environmental zone and features of Western Port
(Harris et al 1979, Marsden 1979)

These near-ocean conditions and exchange of waters with Bass Strait create an ecosystem environment very similar to ocean coast environments along the central Victorian coast. The ecosystem at Flinders is therefore more similar to those of the semi-oceanic IMCRA Central Victoria Marine Bioregion, which extends from Cape Liptrap to Apollo Bay, than the relatively sheltered and enclosed waters of Victorian Embayment bioregion, which includes Western Port (Figure 8).

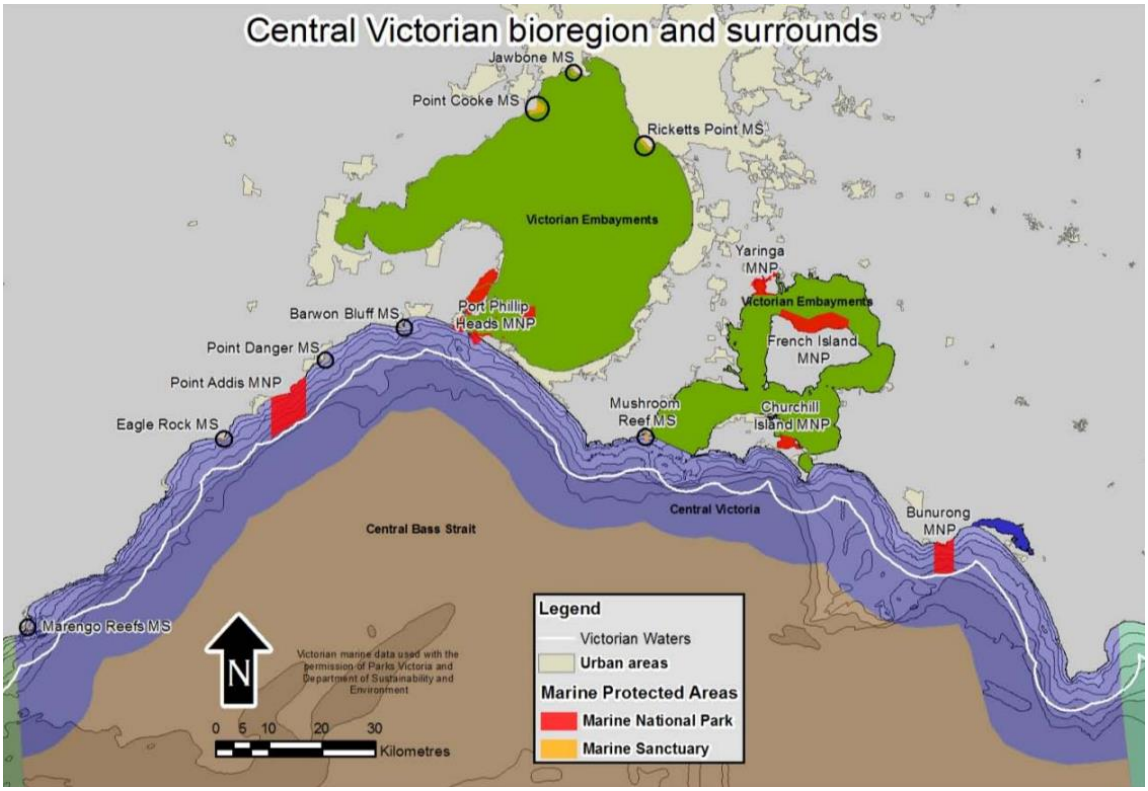

Figure 8. Central Victorian Bioregion
(Source, Barton et al 2012)

Flinders Pier extends seaward from a sandy shoreline across a very gently sloping beach to a maximum depth just over 2 m at the end of the pier. The nearshore habitats are clearly visible from the blufftop above Flinders Pier (Figure 9).

Figure 9. View from above Flinders Pier, January 2021

Figure 10. Seabed habits near Flinders Pier 2018

Seabed habitats can be interpreted from aerial images by marine scientists with appropriate experience in the area. Figure 10 shows seabed habitats on a Google Earth images interpreted by CEE. Figure 11 show shows the same area with habitats and biotopes mapped on DELWPs Coast Kit management App.

Both figures show that the natural seabed habitats within about 700 m from the pier include:

- a sandy shoreline close the pier;
- patches of rock reef along the shoreline and close to shore to the south and north of the pier; and
- extensive meadows seagrass with sand patches offshore of the sandy shoreline and rocky reef.

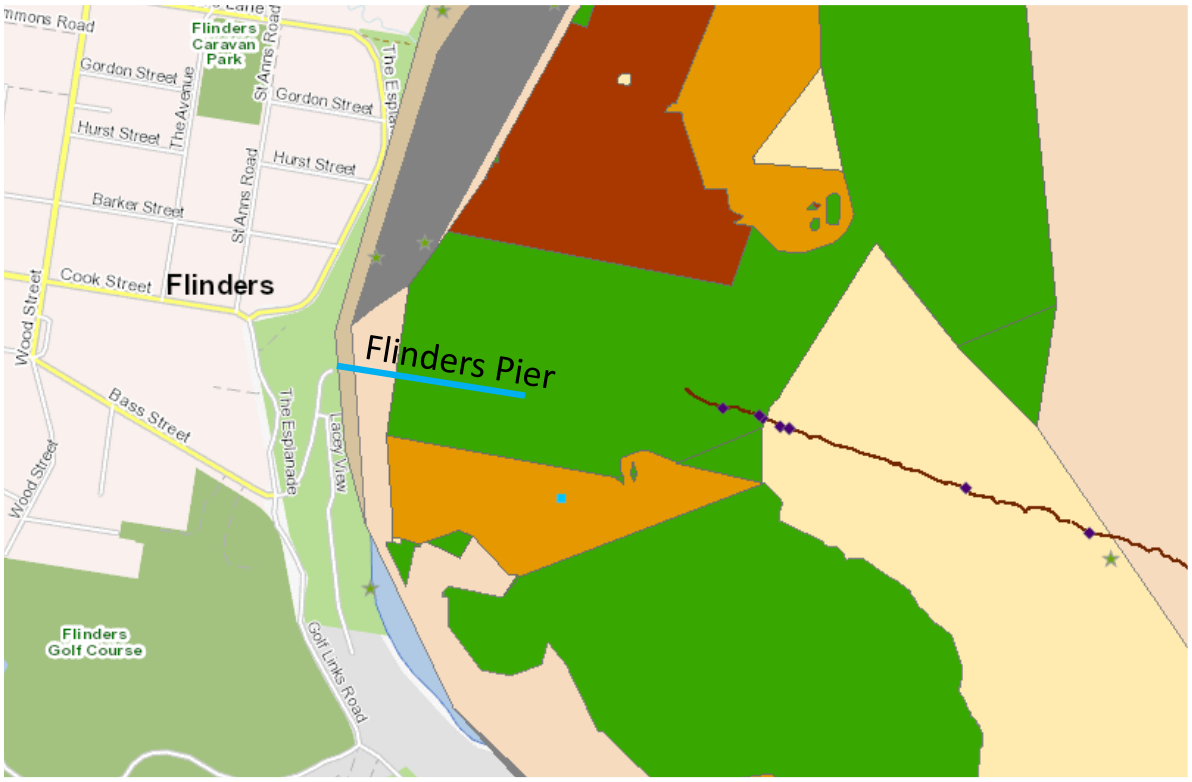

Figure 11. Seabed habits near Flinders Pier, Coast Kit
(https://mapshare.vic.gov.au/coastkit/) Pier added by CEE

3.1 Previous marine biological studies in Flinders area

Flinders Pier has provided a safe and sheltered habitat for student projects and marine naturalists for decades. A range of taxonomic and ecological student project reports have been prepared and herbarium records lodged (MJ Keough, GT Kraft University of Melbourne pers comm).

Flinders Pier is located among extensive *Amphibolis antarctica* seagrass beds that characterise most of the subtidal habitat along the western coast of Western Port's Western Entrance (Figure 12).

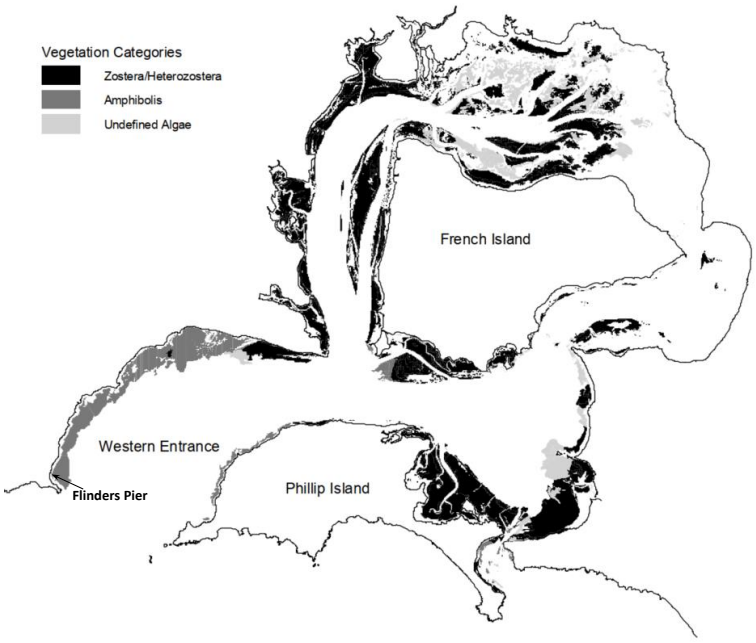

Figure 12, Seagrass habitat in Western Port
(Blake and Ball 2001)

3.1.1 Seagrass

Seagrass distribution in Western Port was last mapped in 2000 by the State's Marine and Freshwater Resources Institute (Blake and Ball 2001). Local-scale seagrass investigations have shown the distribution of seagrasses at particular sites (e.g., Blake et al 2013, CEE 2014, CEE 2020, Coast Kit). *Amphibolis* seagrass habitat and its associated ecological community in Western Port extended over a considerable distance along the western shore of the Western Entrance from West Head to Balnarring and the eastern shore from Sealers Cove (Cat Bay) to Cowes, as shown in Figure 12 and Figure 13. Areas of patchy reef were mapped along the shoreline and within the *Amphibolis* habitat (Figure 18, Figure 13).

The Port Phillip and Westernport Catchment Management Authority (PPWCMA) in June 2020 commissioned a program to map the spatial extent of littoral zone seagrass communities within the Western Port Ramsar site, which will update the benchmark distributions established by Blake and Ball in 2021.

The seagrass meadows of the Western Entrance are quite different from those of the more sheltered segments of Western Port, and are not within the Western Port Ramsar area. The subtidal meadows of the Western Entrance are characterised by the seagrass *Amphibolis antarctica,* whereas the subtidal meadows of the North Arm of Western Port are characterised by *Zostera nigricaulis.* The intertidal seagrass species *Zostera muelleri* is found in all parts of Western Port.

Historically, the subtidal seagrass *Zostera nigricaulis* (then known as *Heterozostera tasmanica*) was found in abundance on the intertidal flats of the northern and eastern Segments of Western Port. The historical losses of *Zostera nigricaulis* seagrass from the intertidal mudflats in northern and eastern Western Port in the late 1970s and early 1980s did not occur in relation to the subtidal *Amphibolis* beds in the Western Entrance. As shown in Section 4.2.2, the abundance of intertidal *Zostera muelleri* in the Western Entrance is more temporally variable in the short-term than *Amphibolis*.

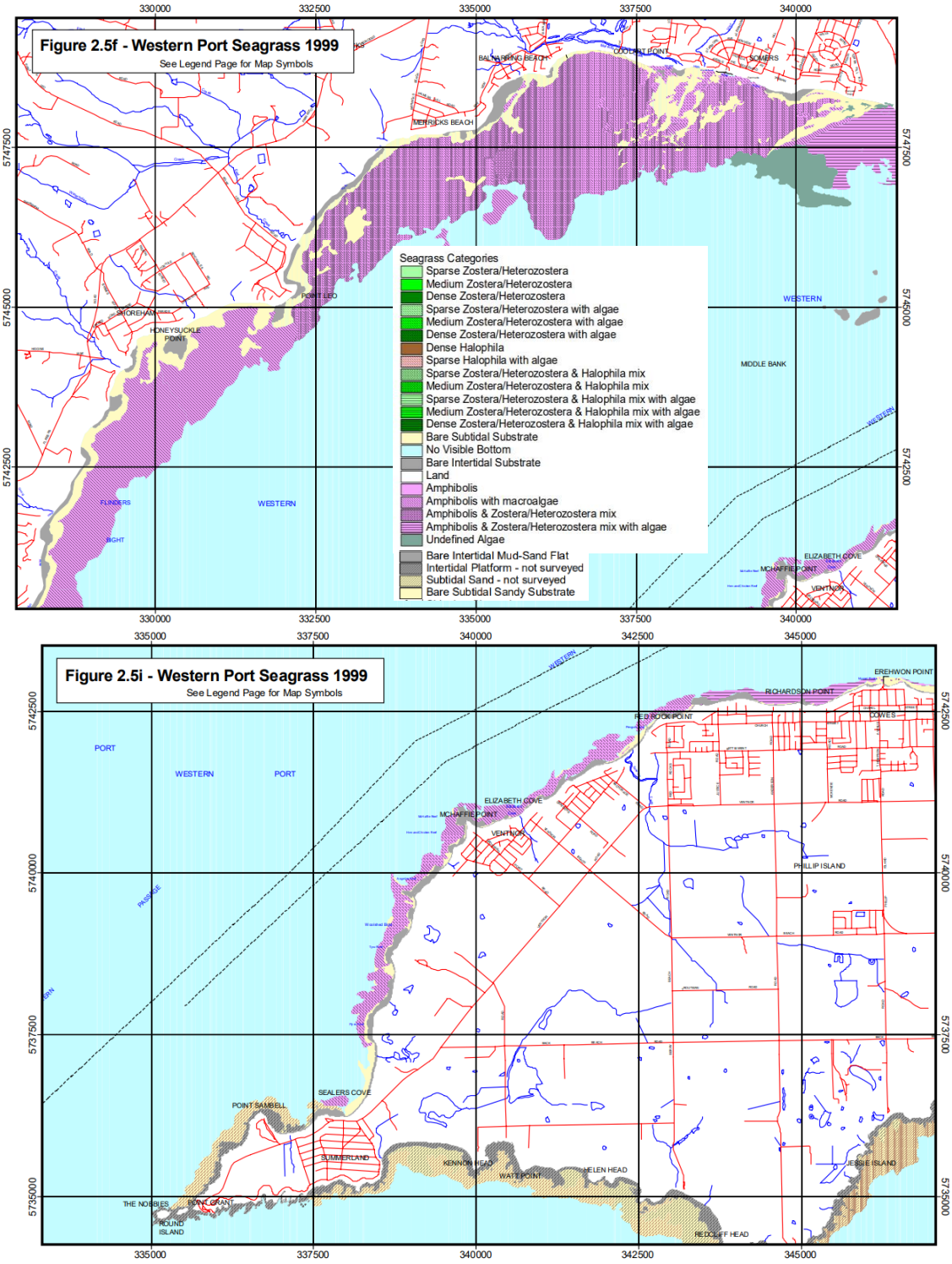

Figure 13. Seabed landscape maps in Western Entrance, Western Port
(Blake and Ball 2001)

Whereas Blake and Ball 2001's general map (Figure 12) shows seagrass distributions to West Head, their detailed maps do not include West Head and Flinders Pier

CoastKit 2021 provides a similar pattern of distribution based on Blake and Ball with more recent groundtruthing in some locations with lower granularity polygons (eg, Figure 11)

3.1.2 Fish communities

The nature of fish communities associated with different habitats in Western Port was investigated in 2013, including seagrass habitat at Flinders (Jenkins et al 2013). The study identified differences in fish communities in two seagrass species beds (*Zostera* and *Amphibolis*), soft seabed macroalgae (*Caulerpa*), rocky reef macroalgae and biogenic reef (rhodolith) habitats in the Western Entrance of Western Port (Figure 14).

Figure 14. Fish habitats surveyed by University of Melbourne

★ Seagrass (*Amphibolis*) ● Invertebrate reef ✚Rocky reef ▲ Macroalgae (*Caulerpa*)♦ Biogenic reef (Rhodolith)

(Jenkins et al 2013)

Among many interesting findings, the study found differences in the fish communities between *Zostera* and *Amphibolis* seagrass habitats. For example, the weedy seadragon was only found in *Amphibolis* seagrass beds and not in *Zostera* beds or any of the other habitats during the study. On the other hand, pipefish were only found in the *Zostera* beds and no other habitat.

All survey sites were randomly located within each habitat location. Six sites were surveyed at each location using static stereo camera and mini trawl nets. Three *Amphibolis* bed locations were surveyed: Balnarring, Point Leo and Flinders. Weedy seadragons were only recorded in the camera results, with none in the trawls. Significantly more weedy seadragons were found at the Flinders location. It is interesting to note that the survey did not target particular habitat within the *Amphibolis* beds, so the total number of weedy seadragons recorded (8 for the survey at all sites) appears low compared to the number of seadragons observed by divers focussing on sand patches with *Amphibolis* beds such as occurs at Flinders Pier. Nevertheless, the results of the seadragon component of the Jenkins et al (2013) study were statistically significant.

3.1.3 Weedy Sea Dragons

Flinders pier has been a popular destination for snorkelling and scuba diving enthusiasts at least since the 1970s. Over the past two or three decades, the main attraction is the resident population of weedy seadragons (*Phyllopteryx taeniolatus*). The weedy or common seadragon has been the Victorian state marine emblem since 2002.

This 'emblematic' species is a member of the Syngnathidae family which includes pipefish and seahorses. The main feature of syngnathid fish is their reversed sex roles during breeding where the male incubates the eggs received from the female. Seadragons can be differentiated from seahorses by their elongated non-prehensile tail and the males carry the eggs under the tail instead of a brood pouch. Syngnathids produce relatively few offspring resulting in low population densities (Foster and Vincent, 2004). Seadragon males can be differentiated from females by the broader tail of the male, where the male carries eggs in specialised folds.

The weedy seadragon is native to Australian temperate waters. Its geographical distribution range spans from south from Port Stephens (NSW), around Tasmania and westward to Geraldton (WA). There is some evidence that the eastern population of New South Wales and Tasmania may be genetically distinct from the 'western' population of Victoria, South Australia and Western Australia. They are reportedly commonly found associated with macroalgae, particularly kelps on reefs, often at the edge of sand patches (Edgar 2008, Klanten et al 2020, Sanchez-Camaro et al 2011). The seadragons in Western Port are mostly found among *Amphibolis* seagrass beds, as well as the edge of reefs within the *Amphibolis* beds.

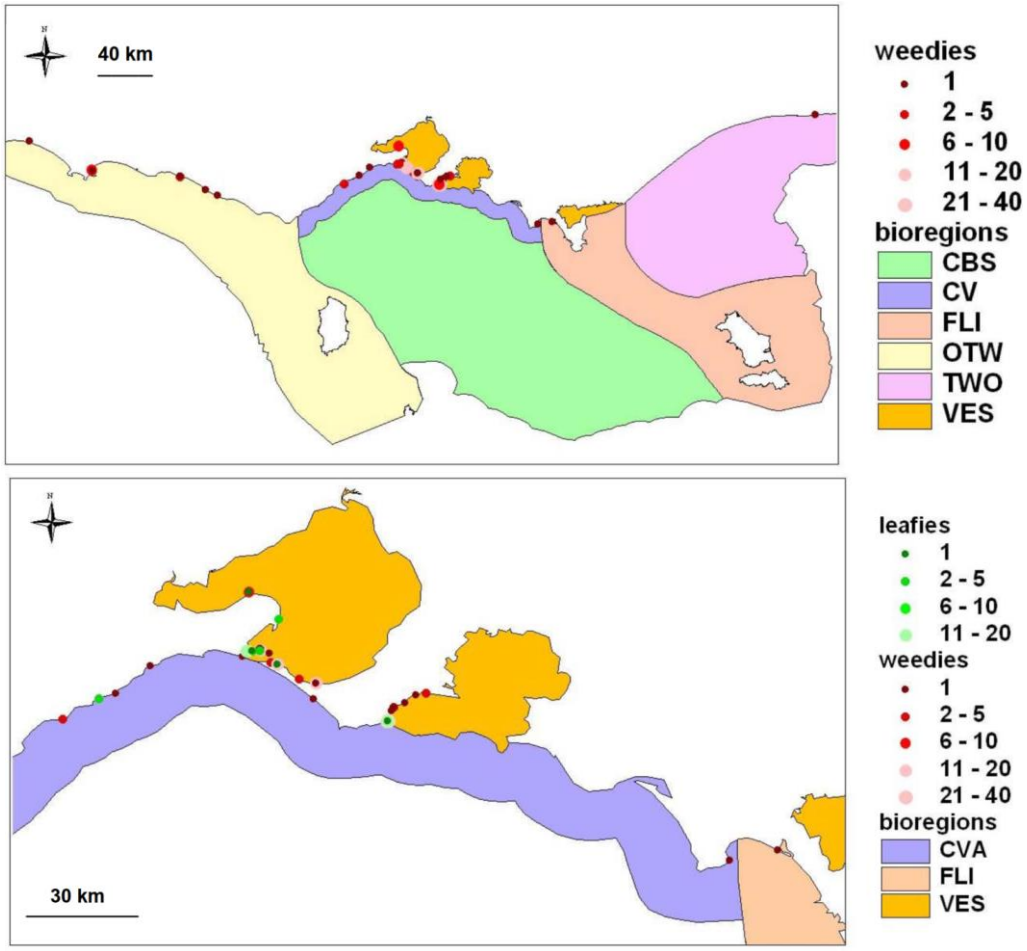

Figure 15. Seadragon distribution in Victoria, Dragon Search 2005 (Source Baker 2005)

Research by Dragon Search and the Great Victorian Fish Count (Figure 17) provides substantial Victorian context on the distribution and habits of leafy and weedy seadragons, including those at Flinders Pier and Portsea Pier (https://seadragonsearch.org/).

Published Dragon Search data (eg, Baker 2005) and recent unpublished data compiled by Victorian National Parks Association (Kade Mills VNPA *pers comm*) show that seadragons are widely distributed along the Victorian coast and along the western shore of Western Entrance in Western Port and inside Port Phillip Heads at Portsea. Historic records indicate that breeding appears to progress over 9 months of the year (Figure 16), with a seasonal peak from October to December.

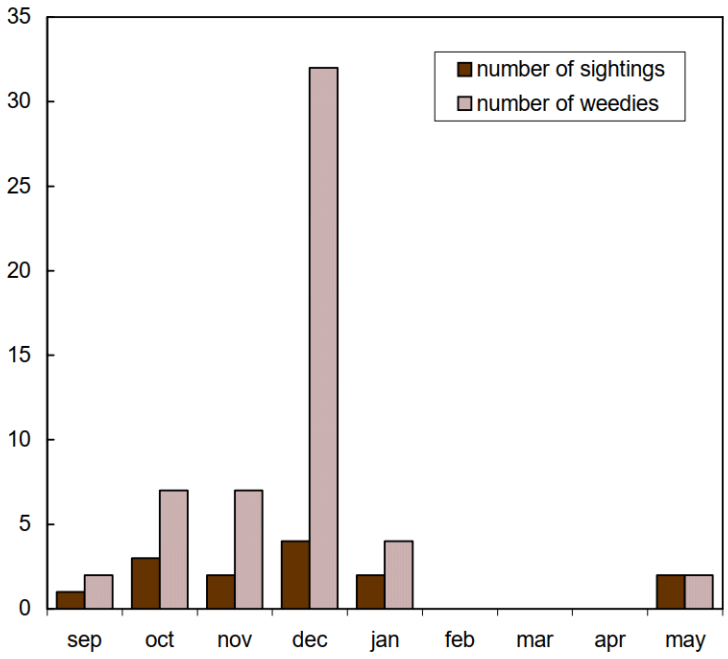

Figure 16. Monthly summary of brooding male seadragons in Victoria
(Dragon Search data, Baker 2005)

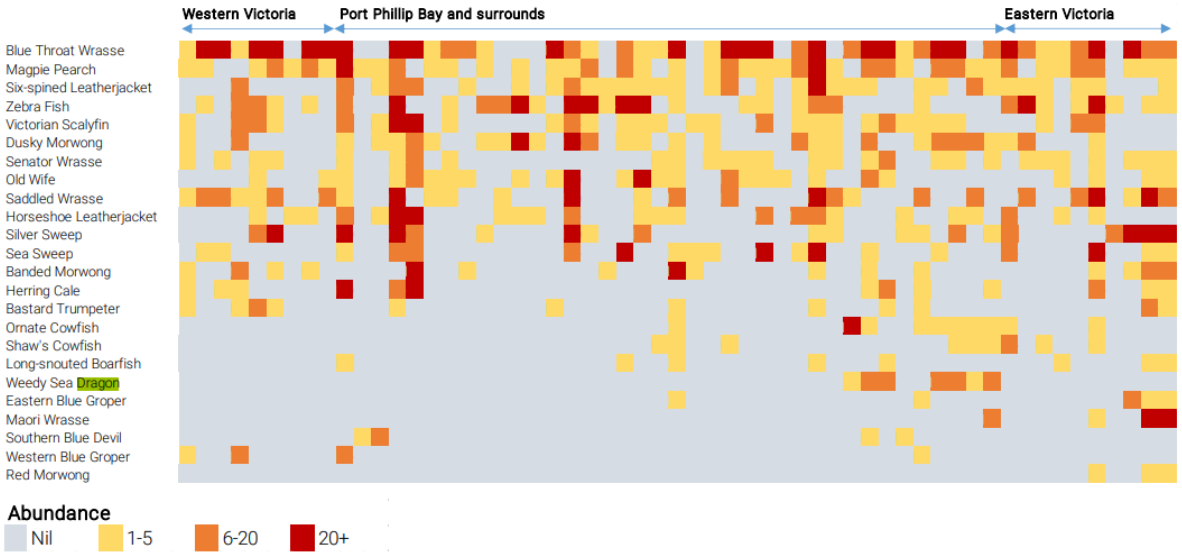

Figure 17. Great Victorian Fish Count 2018

Scripps Institution of Oceanography in San Diego and Western Australian Museum in Perth are coordinating the Seadragon Search community-driven research project on seadragons at an international level. The program, with assistance of local partners such as the Victorian National Parks Association, are compiling photographs of seadragons taken by citizen scientists from around Australia. The photographs are being analysed for unique markers of individual seadragons to develop further understanding of the ecology of seadragons at local and broad spatial scales and seasonal and interannual temporal scales

The canopy of *Amphibolis* meadows is dense, and fish such as wrasse and grass whiting disappear from view when they dive from above the canopy into the meadow. Sanchez-Camaro et al (2006) report weedy seadragons may spend substantial periods within or over kelp or algal beds where they are well-camouflaged when not feeding. These habits may explain why relatively low numbers of seadragons were observed in the habitat comparison described in Section 3.1 (Jenkins et al 2013), where sample sites in seagrass were randomly located compared to diver observations that target the seadragon preferred boundary habitat between bare sand and seagrass. Weedy seadragons are poor swimmers and it is possible that they may seek refuge from turbulence by moving under the seagrass canopy when large waves entering Western Port.

3.1.4 Marine life at Flinders Pier 2007

The marine community at Flinders Pier was investigated as part of the Parks Victoria's Flinders Master Plan to rebuild the pier (URS 2008). The marine life investigation (Stewart et al 2007) mapped the nature of habitats in the vicinity of the Pier (Figure 18), plotted habitats along transects radiating from the pier and qualitatively described the nature of the marine biological communities under the wooden pier and on its piles. The survey in 2007 provides a baseline for comparison with conditions after installation of the present nearshore steel and concrete pier and landing structures and replacement of the offshore wooden pier with similar wooden piles and deck materials. Results of the 2007 survey are presented for comparison with 2020 condition in Section 4.

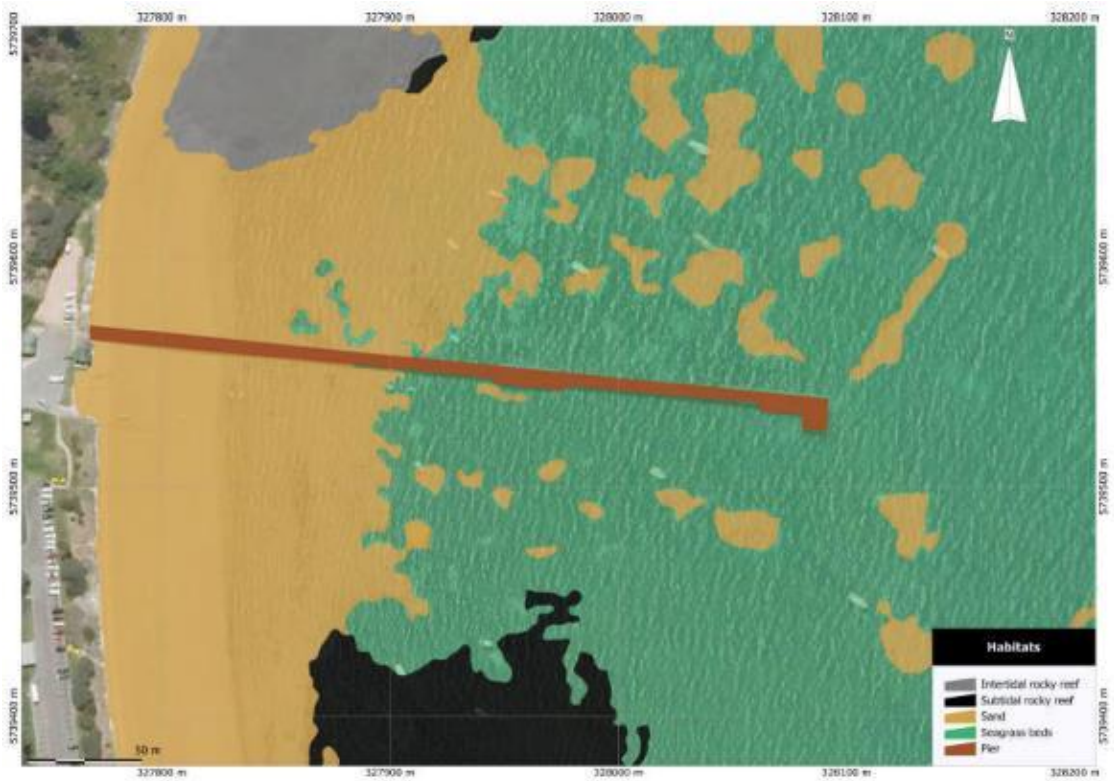

Figure 18. Seabed habitats near Flinders Pier 2007
(Stewart et al 2007)

4 Marine benthic habitats around Flinders Pier, 2020

Flinders Pier traverses 80 m of bare, sandy shoreline to near the lowest low water mark (Figure 19). This habitat is regularly exposed to the atmosphere and is characterised by the burrowing invertebrates and microalgae that are adapted to these conditions and the mobile fish and invertebrates that follow the tide in and out over the sandy seabed. The most numerous fish found in this zone is the smooth toadfish (*Tetractenos glaber*), but yellow eye mullet (*Aldrichetta forsteri*) may be found and the huge black smooth stingray may also wander over this area in search of food such as fish scraps left behind by anglers (Figure 5).

A patchy band of *Zostera muelleri* seagrasses extends from just above the low water mark to approximately 1 m depth (Figure 19). The pier then extends another 240 m over sandy seabed that is naturally covered with dense *Amphibolis* seagrass meadow, which continues to cover the seabed offshore to depths of 6 m to 8 m (estimated from aerial images).

The permanently submerged leaves and stems of *Amphibolis* plants create a significant 3-dimensional structural habitat for other plants (microalgae and macroalgae), invertebrates and fish. The natural seabed habitat occupied by *Amphibolis* meadow is therefore characterised as biogenic habitat over sand substrate. The *Amphibolis* meadow habitat, is the predominant natural subtidal habitat around Flinders Pier.

The steel and wooden piles of Flinders pier provide artificial surfaces for attachment of marine algae (seaweeds) and encrusting invertebrates and 3-dimensional structure that provides shelter for a range of small, juvenile and larger fish and mobile invertebrates.

The deck of the pier shades the marine environment and creates a haven for small fish and invertebrates that shelter from seabirds and visual predators. The lower light levels beneath the jetty also affect the growth of marine plants on the piles and seabed. Plant growth is particularly reduced in areas where the water is shallow or where the deck is wide. These conditions exclude seagrass and the shaded seabed is characterised by bare sand, shell and debris.

The boundary between the bare sand beneath the shaded pier (or around the base of some piles) and the adjacent seabed seagrass provide a habitat known as an edge or boundary habitat where concentrations of some biota, such as crustaceans, are higher than within the adjacent habitats (Tanner 2009). Schools of small mysids are often observed in these areas under Flinders pier.

4.1 Biodiversity

The range of species observed during the 2020 survey are listed below in Table 4-1. All species observed are relatively common to the Central Victorian Marine Bioregion and the nearby Western Entrance and Bass Strait marine habitats. The species are consistent with the observations and photographs recorded at Flinders Pier in 2007 (Stewart et al 2007).

Table 4-1. List of marine species recorded in thjis survey (December 2020)

Seagrass	**Echinoderms**
Amphibolis antarctica	*Tosia australis*
Zostera nigricaulis	*Coscinasterias muricata*
Zostera muelleri	*Uniophora granifera*
	Patiriella brevispina
Seaweed	*Heliocidaris erythrogramma*
Ecklonia radiata	
Sargassum sp.	**Mollusca**
Acrocarpia paniculata	*Phasianella australis*
Cystophora sp.	*Dicathais orbita*
Carpoglossum confluens	*Pleuroploca australasia*
Zonaria sp.	*Sepioteuthis australis*
Sporochnaceae	*Mytilus edulis*
Bellotia eriophorum	*Haliotis rubra*
Caulerpa obscura	**Crustacea**
Caulerpa brownii	*Carcinus maenas*
Caulerpa flexilis	*Palaemon serenus*
Caulerpa scalpelliformis	*Plagusia chabris*
	Paguristes frontalis
Dictymenia harveyana	
Gelidium australe	**Fish**
Plocamium leptophyllum	*Parablennius tasmanianus*
	Bovichtus angustifrons
Encrusting red algae	*Aracana ornata*
Spongites sp.	*Notolabrus tetricus*
Branched coralline	*Haletta semifasciata*
Encrusting coralline	*Phyllopteryx taeniolatus*
	Brachaluteres jacksonianus
Ascidia	*Enoplosus armatus*
Herdmania grandis	*Cheliodactylus nigripes*
Pyura sp.	*Upeneichthys lineatus*
Clavelina pseudobaudinensis	*Pempheris* sp.
Sycozoa cerebriformis	*Scorpis lineolta*
Didemnum spp	*Sphyraena novaehollandiae*
	Pseudocaranx georgiaus
Bryozoa	*Dasyatis brevicaudata*
Bugula dentata	
Celleporaria sp.	
Cnidaria	
Anthothoe albocincta	

Further information on the biological assemblages associated with these habitats follows in Sections 4.2 to 4.6.

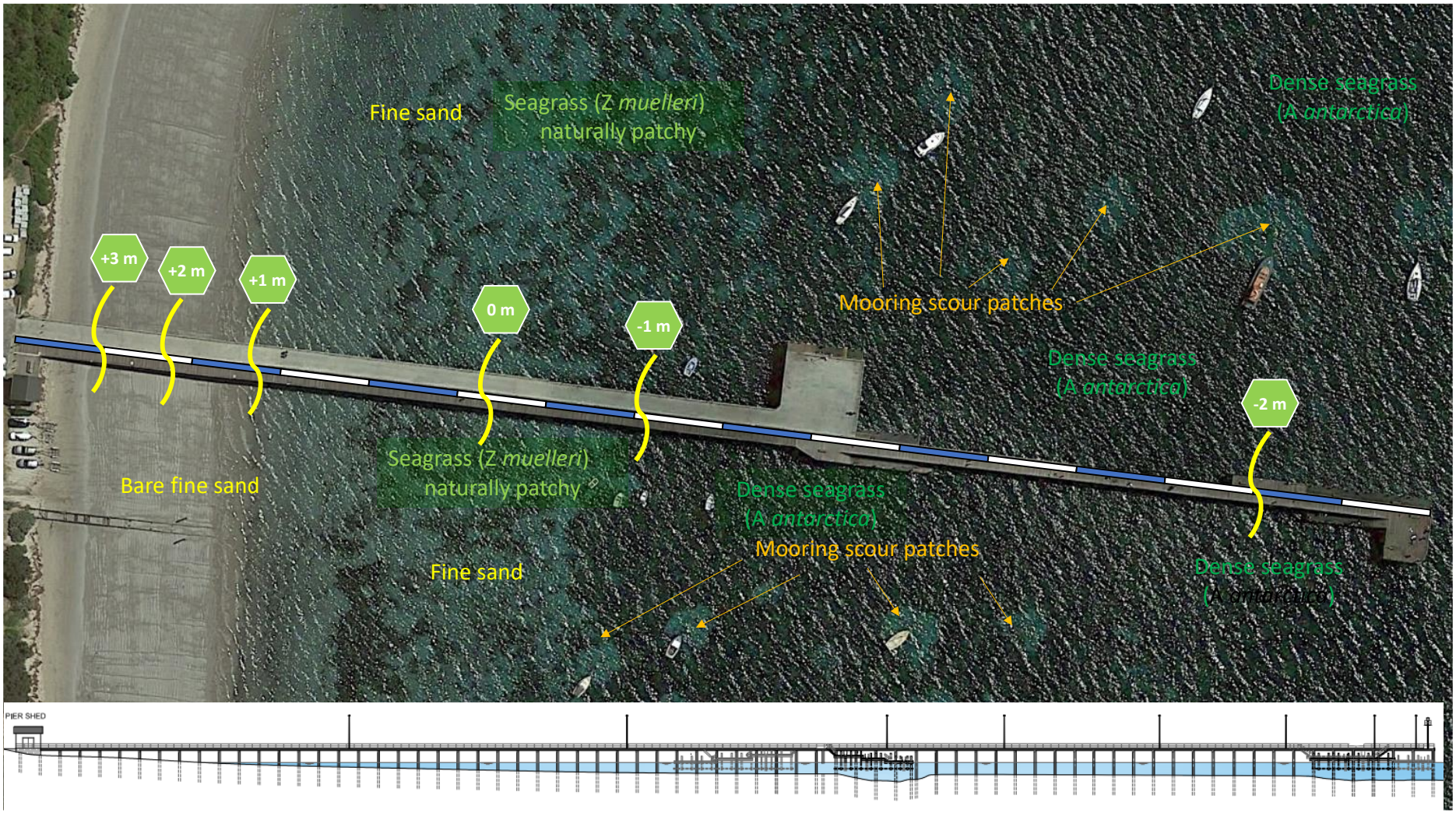

Figure 19. Flinders Pier natural seabed habitats and approximate depth
Depth to Chart Datum and profile (URS 2008); Scale bar approx 20 m intervals; Google image Dec 2018

4.2 Seagrasses

Seagrasses, such as *Amphibolis antarctica*, are flowering plants that evolved from terrestrial plants and re-adapted to marine conditions. There are 82 species of seagrasses described worldwide (Guiry and Guiry, 2021). *Amphibolis antarctica* is distributed along the southern Australian coast from Wilsons Promontory to Carnarvon in Western Australia including the north coast of Tasmania in waters from the below low tide to 23 m deep (Womersley 1984). Unlike other seagrasses that prefer sand and muddy sand seabed, *Amphibolis* typically grows on seabeds comprising sand and rubble or broken reef.

The *Amphibolis* meadow provides a structural habitat for other biota. A diversity of sponges, ascidians, bryozoans, molluscs and polychaetes as well as the epiphytic seaweeds attach to the stems and leaves, while a diversity of fish and mobile invertebrates (molluscs, crustaceans, echinoderms and polychaetes are resident under, above or on the boundaries of the leafy seagrass canopy (Edgar 1990, Edgar and Robertson 1992). Seagrass beds including *Amphibolis* are recognised for their high biodiversity, productivity and provision of a nursery sheltered habitat for fish and invertebrate larvae and juveniles. (Connell and Gillanders 2007, Larkum et al 2006, Keough and Jenkins 1995). The ecological association of the seagrass and the associated algae, invertebrates and fish can be termed a seagrass community. In the Flinders case, the main natural nearshore subtidal community is an *Amphibolis* seagrass community.

4.2.1 Seagrass transects at Flinders Pier

Seagrass habitat was surveyed along transects radiating from Flinders Pier in 2007 (Stewart et al 2007) and again by CEE in December 2020 along the same transect alignments for this study. The 2020 study mapped the same biological species and abundance categories as those described for the 2007 survey.

The mapped results for the 2007 and 2020 surveys are shown in Figure 20 and Figure 21, respectively. Examination of historical aerial images (Figure 26) indicates that the 2007 survey results appear to be overlaid on an aerial image of 2006 or earlier. The 2020 image is overlaid on a 2018 aerial image.

Two seagrass species were recorded along the transects in both June 2007 and December 2020: *Amphibolis antarctica*, *Zostera nigricaulis*. The transects were located on subtidal seabed at depths of around 1.5 m to 2 m below lowest low tide. A third species, *Z muelleri* is found on the shallower seabed. Each species is native and common to the Southern coast of Australia and occupy slightly different ecological niches.

Amphibolis usually forms extensive meadows in moderately waved exposed shallow sandy or rock rubble areas such as Flinders and it is easily differentiated from *Zostera muelleri* and *Z nigricaulis*. *Amphibolis* is recognised by its woody stems and proportionally short, broadish leaves that are twisted 180° (Figure 22). *Zostera* species have long, narrow leaves and are common in sheltered Victorian waters. The distinctive dark stem *of Z. nigricaulis* readily differentiates it from Z *muelleri* (Figure 23).

Amphibolis sheds a proportion of its leaves in autumn and winter after a period of growth in spring and summer. The shed leaves float and drift with wind and currents. Large quantities of leaves accumulate in the nearshore waters and on the Western Port shoreline from Flinders to Point Leo (Figure 24).

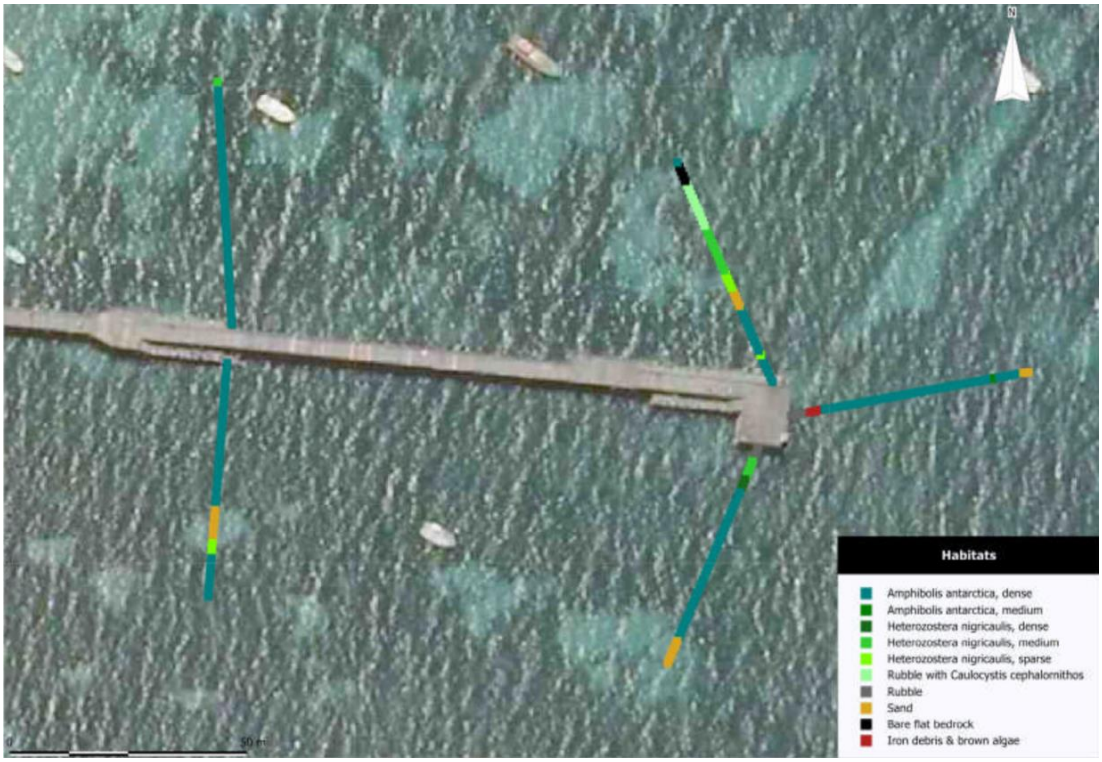

Figure 20. Transect mapped biological categories at Flinders Pier, 2007
(Stewart et al 2007)\

Figure 21. Transect mapped biological categories at Flinders Pier, 2020
(Biological distributions from CEE December 2020 survey Base overlaid on 2018 Google Earth photo)

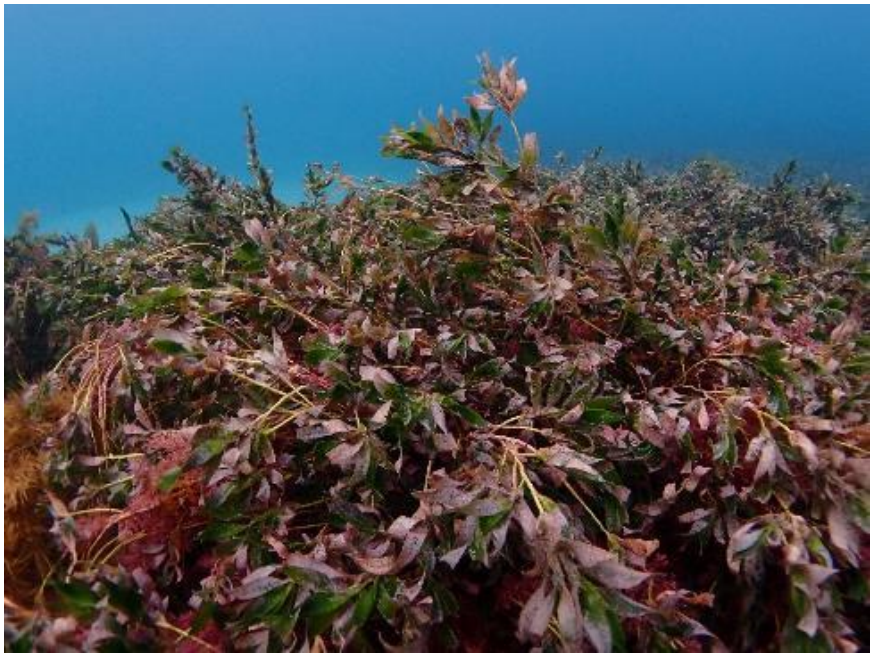

Figure 22. Sea nymph seagrass (*Amphibolis antarctica*)
Characterised by a woody stem and relatively short leaves at the top of the plant that are arranged in 180° (Flinders, December 2020)

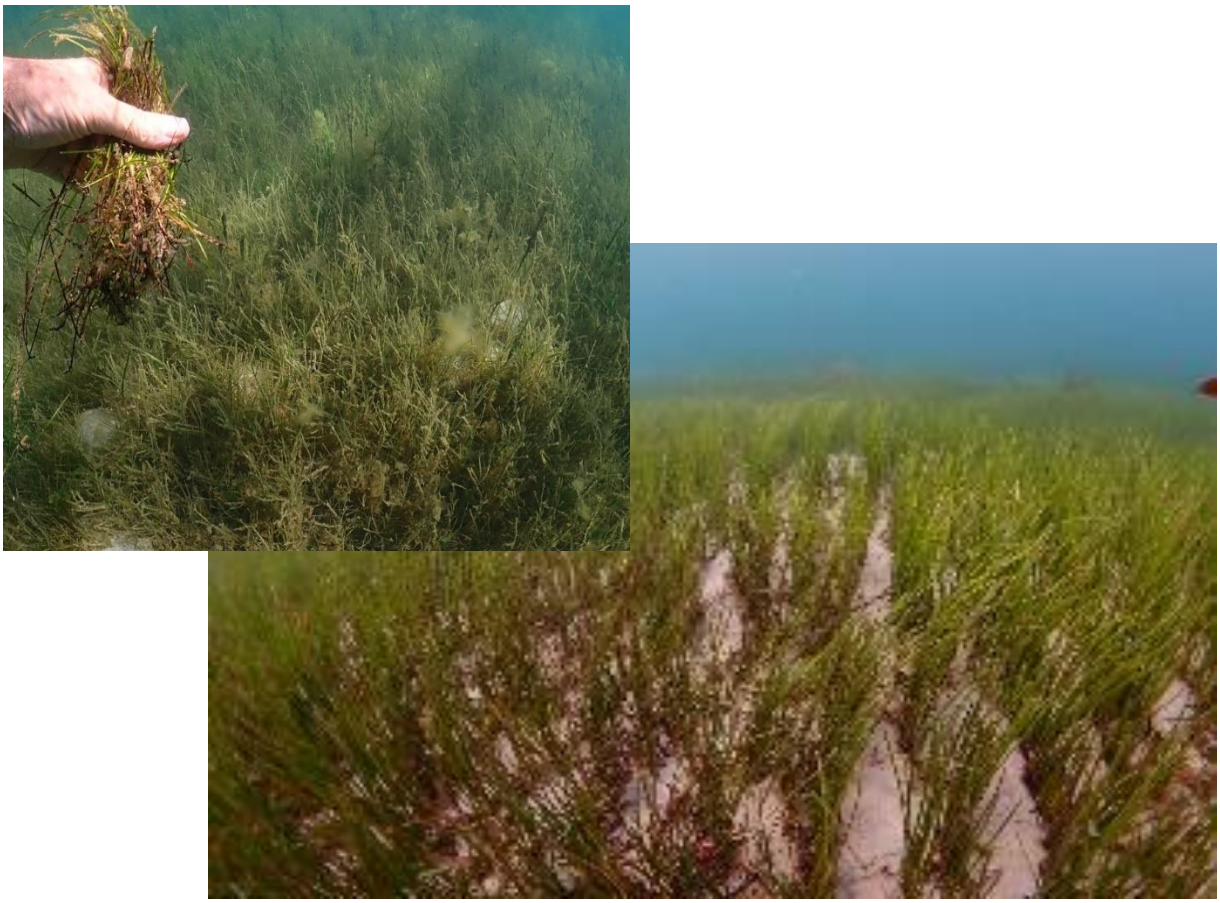

Figure 23. *Zostera nigricaulis* at Blairgowrie (top) *and Z muelleri* at Flinders (bottom)
The distinctive dark stem of Z nigricaulis distinguishes this species from Z. muelleri which lacks the dark stem. Both species may reach similar lengths and be indistinguishable from the surface of the canopy

Figure 24. *Amphibolis* leaves and macroalgae on shoreline north of Flinders Pier, August 2014

A considerable number of macroalgae epiphytes were observed growing on *Amphibolis* stems. This is a common observation in seagrass meadows. The woody nature of the seagrass stems provides substrate for the establishment of seaweeds (Figure 25).

Patches of a mix of large brown seaweed (e.g. *Cystophora* sp., *Caulocystis* sp., *Sargassum* sp.) were observed in deeper waters both south and north of the pier. These are all species commonly found amongst the diverse marine flora of Southern Australia.

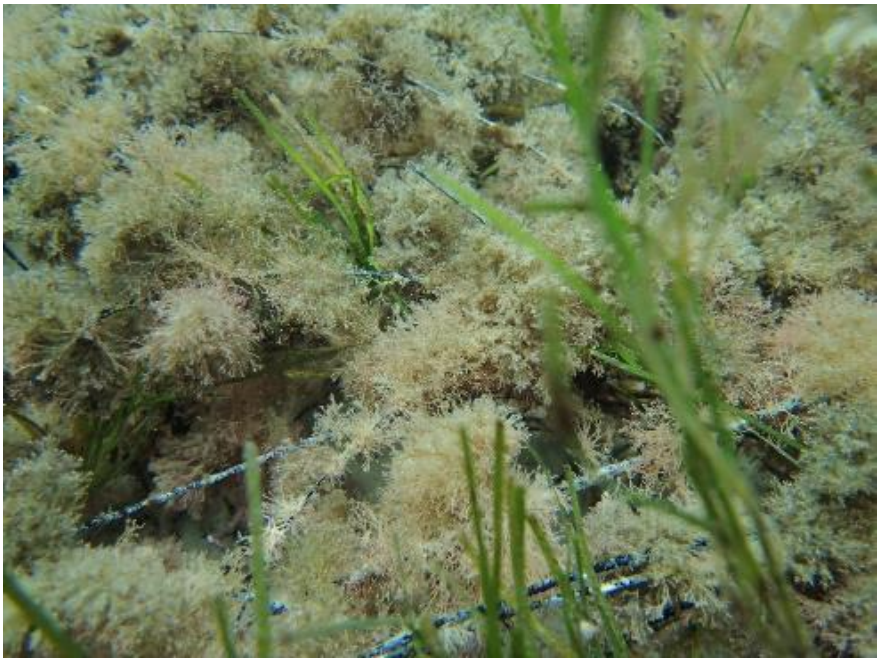

Figure 25. Branched coralline red algae epiphytes growing on seagrass stems

4.2.2 Seagrass habitat variation over time at Flinders 2006 to 2018

Seagrass beds can be stable or dynamic habitats. Figure 26 shows aerial photographs of Flinders Pier from 2006 to 2018. The darker areas and patches on the sandy seabed around the Pier area (mostly) seagrasses. A patch of intertidal reef can be seen in the top left corner of each photo. The series of photographs show:

- The bare sandy beach shoreline and intertidal area;
- The patchy pattern of the *Zostera muelleri* seagrass growing in the lower intertidal area and *Zostera nigricaulis* which grows below the low tide mark;
- The changes in density of the intertidal Zostera seagrasses between years is readily apparent in the photograph series;
- The dense dark area of the seagrass *Amphibolis antarctica* extending seaward from about 1 m below the low water mark;
- Bare, circular patches of sand created within the *Amphibolis* meadow by the chains of swing-moorings in the relatively sheltered waters of Kennon Cove;
- Relatively consistent seabed cover of the offshore *Amphibolis* beds between years compared to the variation in the density and extent of the nearshore *Zostera* beds.

A bare patch extending north west from the end of the pier is visible in the 2006 photo. This bare area remained when the breakwater was removed in 1990. The area has slowly been recolonised by *Amphibolis*, although small bare patches appear to remain in 2018.

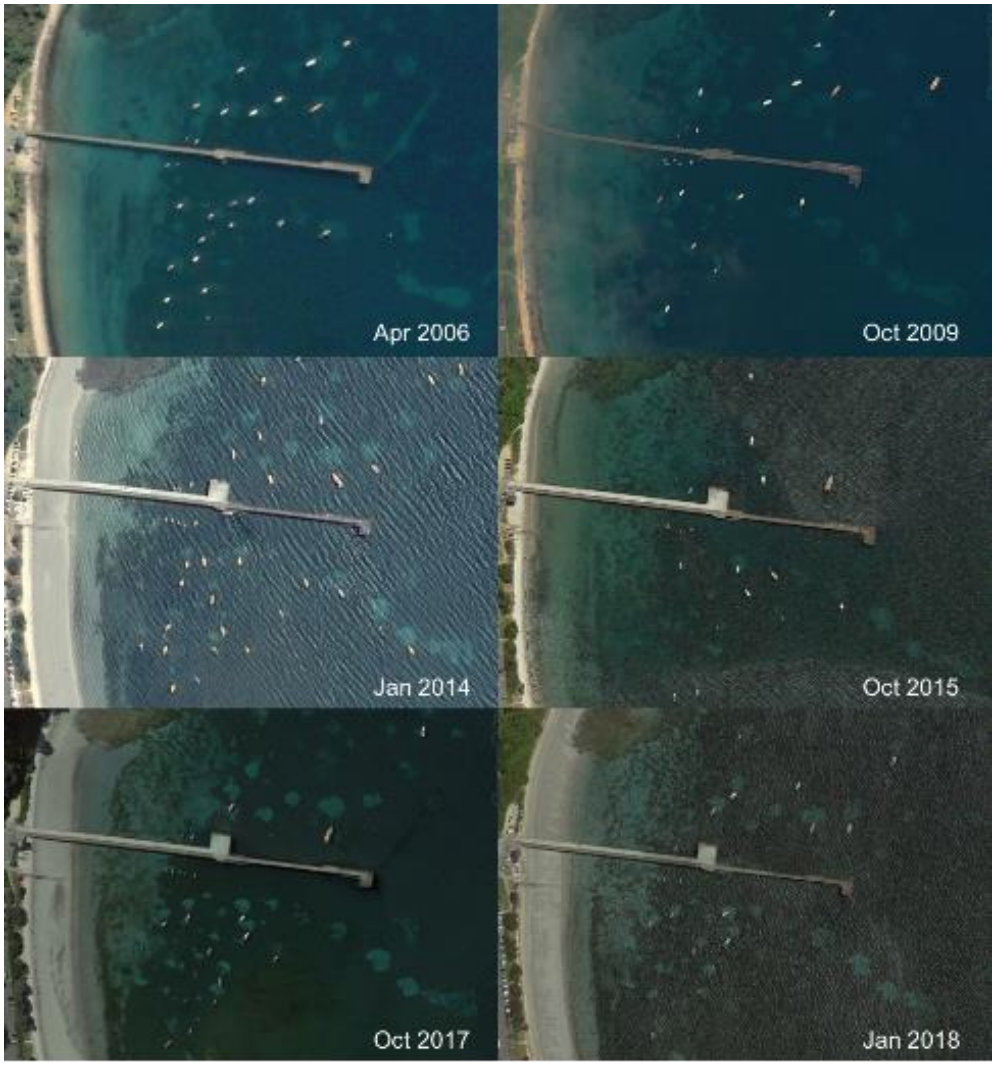

Figure 26. Seagrass meadows around Flinders Pier (2006-2018)

Comparison of seagrass transects 2007 and 2020

Comparison of the distribution of habitats and biota from the 2007 and 2020 surveys transect shows similar patterns in seabed vegetation along the transects (Figure 20 and Figure 21).

The seabed along the transects showed is similar patterns of predominantly dense *Amphibolis antarctica* meadows along all transects in both years, with minor variations resulting from mooring chain scour of the seabed and seagrass, the exposure of rock rubble beneath the *Amphibolis* canopy and growth of filamentous brown algae on seagrass stems (Figure 27).

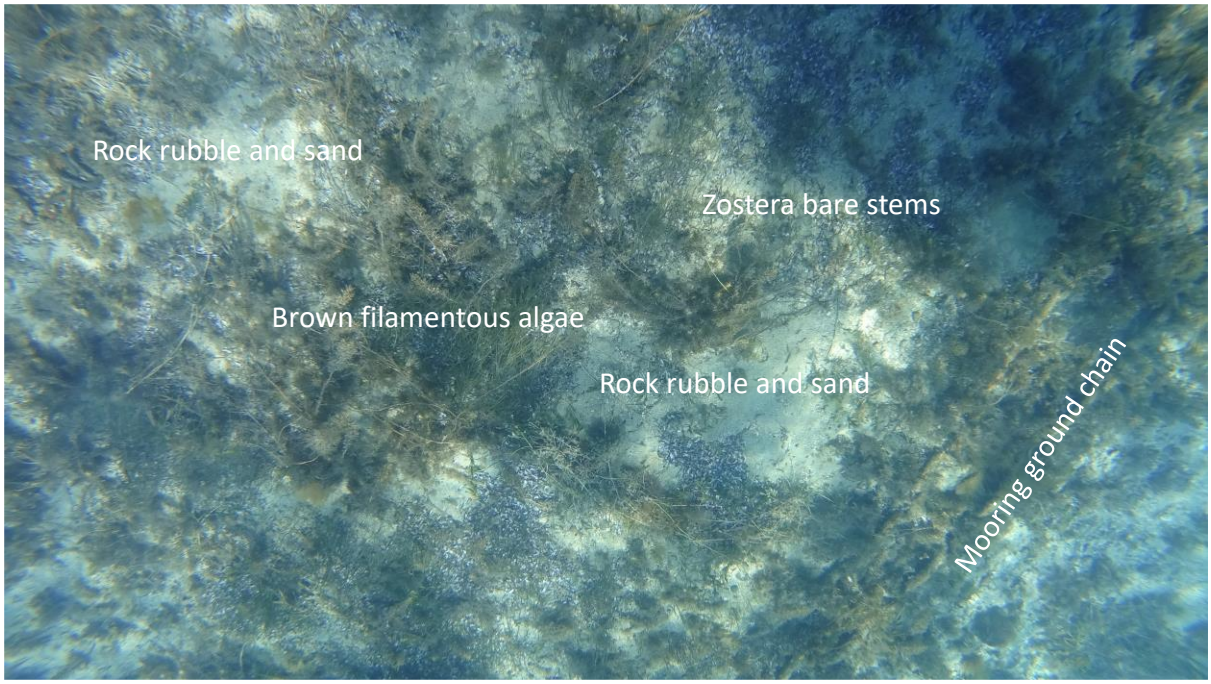

Figure 27. Area of chain scour at end of southeast transect Devember 2020

Figure 20, Figure 21 and Figure 26 all show visible sandy patches amongst the seagrass meadows on either of the pier. These result from vessel mooring chains that scour the seagrasses as vessels shift position with prevailing winds.

This pattern if circular bare patches in seagrass beds is common to other boat mooring areas managed by Parks Victoria such as Portsea to Blairgowrie in Port Phillip Bay. Parks Victoria advise that "environmentally-friendly" moorings can be used in some areas to minimise effects on seagrass beds (https://www.parks.vic.gov.au/water-management/moorings-and-berths/destination-moorings). The mooring design includes an auger-style pin that can be screwed into the soft seabeds by commercial divers. A swivel connection is attached to the pin embedded pin, with a floating rope leading to the top float buoy. This arrangement is suitable for seabeds with a thick layer of soft sediment and sand where *Zostera* seagrasses may be found. However, *Amphibolis* is usually found on rubbly or low reef seabed, where the auger-pin cannot easily penetrate. This is the case at Flinders, where much of the seabed comprises sand over rock rubble (Figure 27). Pier piles may be driven into this seabed, but auger pins that must be screwed into the seabed by divers are impractical for moorings.

Overall the comparison shows that the density of *Amphibolis* seagrass along the same transect alignments directly observed *insitu* by biologists 13 years apart was remarkably similar. This confirms that significant interannual variability in intertidal *Zostera* habitat compared to the relatively constant *Amphibolis* density around Flinders Piers interpreted from Figure 26 is reasonable.

4.3 Seabed beneath wooden pier (Transect)

The wooden pier at Flinders extends for 320 m in a west-east direction. A video transect was recorded by CEE along the subtidal length of the pier (from wooden pile pair 24) to document the benthic habitat beneath the pier and any other features along the seabed. The benthic habitat characteristics of seabed between the wooden piles interpreted from the video and diver observations at Flinders pier is shown in Figure 28.

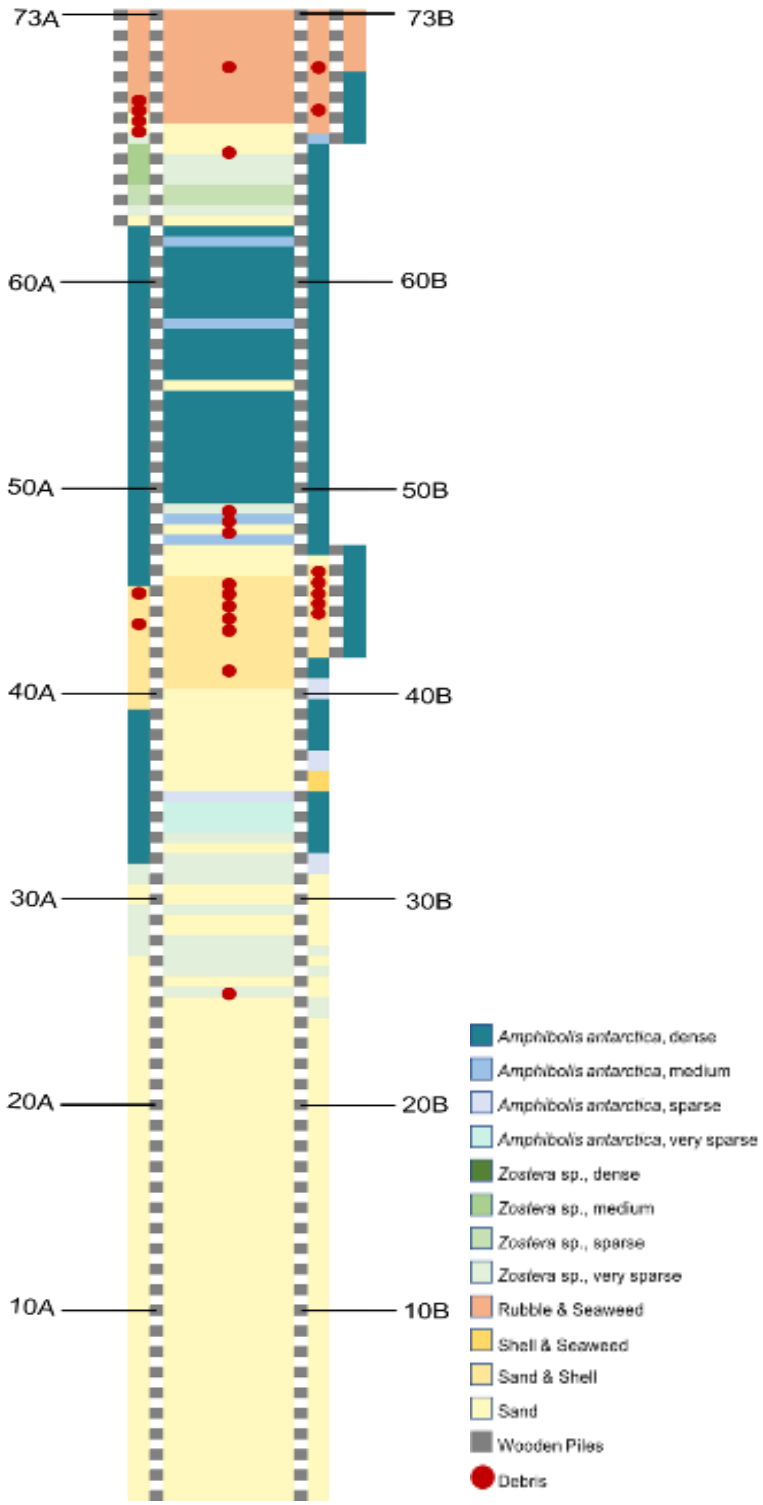

Figure 28. Seabed beneath wooden pier at Flinders

The wide angle of the video recorded each pair of piles to serve as distance reference points along the transect. The wooden piles are represented by grey squares numbered as marked by Parks Victoria tags on the pier piles. The habitat on the seabed adjacent to the pier was also in the field of view. The video was reviewed, and the seabed character and marine species occurrence documented. A copy of the video transect record has been provided to Parks Victoria.

4.3.1 Seabed habitat

Figure 28 shows that the seabed to the commencement of intertidal seagrass at approximately piles 24 comprises bare sand and corresponds to approximately 80 m from the start of the pier (Figure 19). The commencement of *Amphibolis* at pile 32 corresponds to approximately 130 m from the start of the pier and represents at depth of approximately 1 m below the low water mark (LAT). Until this point, there is little biological growth on the pier piles and sparse *Zostera* seagrass beneath the pier.

From around pile 32 until the low landing (~2m depth) *Amphibolis* dense beds are present on both south and north outer sides of the piles but not in the shaded areas underneath the pier. The seabed up to the first lower landing (pile 42) is mostly characterised by bare fine sandy sediment with very sparse seagrass patches. Brown (e.g. *Cystophora* sp.) and red macroalgae (e.g. *Thuretia* sp.) can be seen associated with the seagrass bed.

At the low landing (piles 42 to 47), the sandy seabed is covered in empty shells, mostly abalone (Figure 29). The concentration of shell material has been present on the seabed here for many years (pers obs and see Parry and Cohen 2001) demonstrating the low disturbance of the seabed by waves under the landing. A considerable amount of wood and iron debris was also found in this area. The established sessile community growing on both debris types suggests that they have been on the seabed for some time (Figure 34).

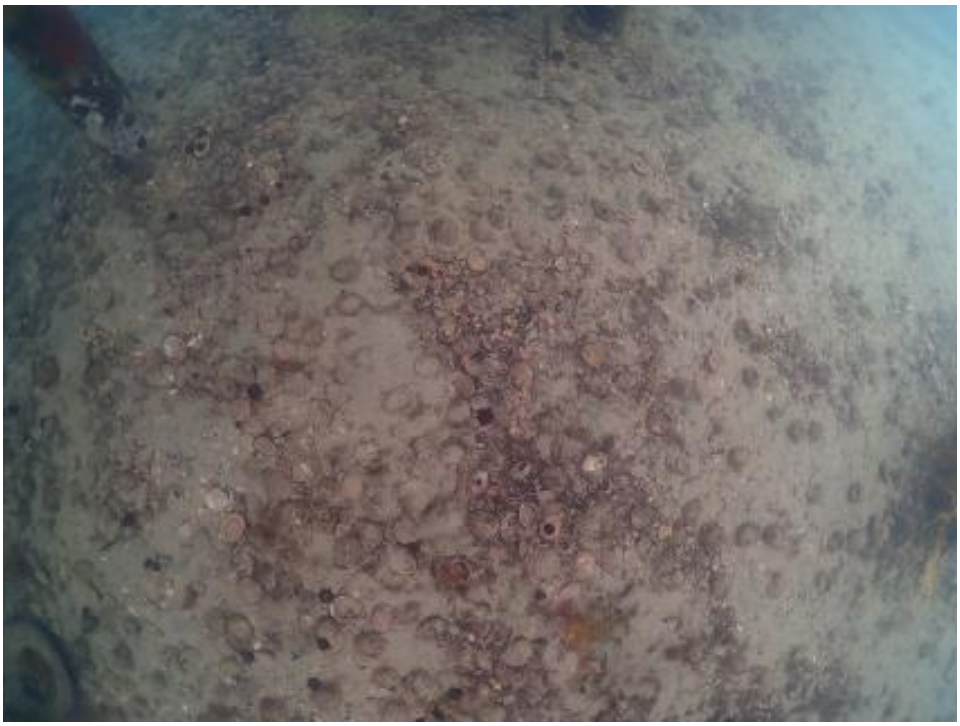

Figure 29. Discarded abalone shell on seabed close to the low landing under the wooden pier at Flinders, December 2020

Figure 30. Dense *Amphibolis antarctica* seagrass meadow under and around Flinders pier offshore section, December 2020

East (offshore) of the first lower landing, as water depth slowly increases, dense *Amphibolis* beds are found underneath the pier (Figure 30) until at around pile 63. The deck of the pier expands to the lower landing at pile 63 and *Zostera* patches replace the *Amphibolis* beds (Figure 31) until the expanse of the service deck area results in sufficient shade to exclude seagrasses.

Figure 31. *Zostera* sp. under the eastern end of Flinders pier, December 2020

A combination of depth and shading by the large deck at the end of the pier create a relatively low-light environment in the benthic habitats under the wooden pier. The seabed beneath the service deck is mostly rubble on sand (Figure 32). Higher abundances of brown and red macroalgae were seen in this area as the rubble provides the hard substrate habitat needed for the establishment of these species.

Figure 32. Seabed beneath service deck at end of the Finders Pier, December 2020

4.3.2 Debris

A large engine block was a notable item on the seabed beneath the service deck at the end of the pier. The block provided habitat for a variety of fish including juvenile magpie perch, blue throat wrasse, cardinal fish and juvenile sweep.

Figure 33. Engine block beneath service deck at end of the Finders Pier, December 2020

Scattered debris (timber, iron, tyres and other litter) was observed along the pier and it is generally covered in marine growth including algae and invertebrates (Figure 34).

Figure 34. Debris under the Flinders Pier, December 2020.
a. Iron ladder between piles 25 and 26; **b.** Wood debris covered with red and brown macroalgae; **c.** Iron debris under the middle lower landing; **d.** Engine block at the offshore end of the Flinders Pier (pile 70-71)

4.3.3 Associated biota

Diversity of marine life seems to increase along the pier with less species associated with the bare sandy seabed of the intertidal and shallow subtidal areas nearshore.

Species belonging to all three groups of macroalgae (brown, red and green) are found growing on the seabed under Flinders Pier (Figure 35 to Figure 38). All species are common to the temperate southern coast of Australia. No introduced species were observed. Macroalgae abundance was generally proportional with depth and access to hard substratum. Some examples are several species of the brown seaweed family Dictyotaceae, *Carpoglossum confluens* and *Bellotia eriophorum*. These species were found growing on shells, rock, rubble and debris. Encrusting corallines and filamentous red algae were found thriving on hard surfaces such as shell and debris. Another red algae that is abundant under the Flinders pier is *Thuretia* sp., a species common to flat reefs associated with seagrass beds. Unlike most macroalgae the green and serrated *Caulerpa scallpelliformis* grows sand thanks to its horizontal rhizome system.

Figure 35. Succulent seaweed (*Carpoglossum confluens*)

Figure 36. Chimney-brush seaweed (*Bellotia eriophorum*)

Figure 37. Red algae *Thuretia* sp.

Figure 38. The green seaweed *Caulerpa scalpelliformisi* growing on sand

Schools of juvenile fish were observed in the water column at the inshore end of the pier (Figure 53, Figure 39), most fish diversity can be seen under the landings at the deeper end of the pier. Nevertheless, species native to shallow waters such as the smooth toadfish (*Tetractenos glaber*) are common at the nearshore at the Flinders Pier often burying itself in the sandy seabed. This pufferfish species is native to the coastal shallow waters of southeastern Australia and is highly abundant around Western Port.

Figure 39. Flinders pier as a nursery. Juvenile fish school, December 2020

Small fish such as the Tasmanian blenny (*Parablennius tasmanianus*) and the dragonet (*Bovichtus angustifrons*) that are abundant in sheltered and shallow habitats of the southeastern coast are common at the Flinders pier (Figure 40). Here they are usually found near the bottom close to the pier piles using small crevices in the wood, shells or even debris. Other small fish usually found associated with shallow seagrass habitats that are also common at Flinders include the pygmy leatherjacket (*Brachaluteres jacksonianus*) and the ornate cowfish (*Aracana ornata*).

Species of goatfish, sweeps and bullseye (Figure 44) are also seen using the Flinders Pier habitat. Goatfish are easily recognised by the presence of two long barbles used to search the seabed for food and the red mullet is a common species in the area (Figure 43). The omnivorous sweep *Scorpis lineolata* (Figure 45) although more abundant in more wave-exposed reef habitats is also present at Flinders pier.

Colourful species such as magpie perch (*Cheliodactylus nigripes*) (Figure 42) and old wife (*Enoplosus armatus*) are common in reef habitats. At Flinders they are found mid-pier at the boundary between seagrass and sand.

The shortfin pike (*Sphyraena novaehollandiae*) was observed under Flinders pier. Shortfin pike belong to the barracuda family, characterised by protruding lower jaws. This slender, fast-moving predator is often found hovering over seagrass, camouflaged from above as they wait for prey to pass overhead (Figure 46).

Figure 40. Dragonet (*Bovichtus angustifrons*)

Figure 41. An old wife (*Enoplosus armatus*) adult in a sparse patch of *Zostera muelleri*

Figure 42. Magpie perch (centre) and bluethroat wrasse (top right)

Figure 43. The goatfish red mullet (*Upeneichthys lineatus)*

Figure 44. Bullseye (*Pempheris* sp.)

Figure 45. Sweep (*Scorpis lineolata*) using the habitat provided by debris

Figure 46. Shortfin pike (*Sphyraena novaehollandiae*) swimming through Flinders pier over an *Amphibolis* seagrass bed

Figure 47. Smooth stingray and silver trevally at eastern end of Flinders Pier December 2020

The occurrence of economically important fish such as the silver trevally (*Pseudocaranx georgiaus*), grass whiting (*Haletta semigasciata*), bluethroat wrasse (*Notolabrus terticus*) and southern calamary squid (*Sepioteuthis australis*) makes Flinders an attractive fishing destination. All these species are common to Victorian waters.

The weedy seadragon population (see Section 3.1.3 for details on the weedy seadragon) and the recurrent presence of smooth stingray (*Dasyatis brevicaudata*) are probably the most iconic occurrences at Flinders. Although one of the largest stingrays, the smooth stingray is commonly found in shallow waters feeding on invertebrates and fish. Despite not being aggressive the smooth stingray tail spine is venomous. In 2017 new regulations were introduced in response to an increase in community concern about the cruel treatment towards large rays such as smooth and fiddler rays. Malpractices include flap and/or tail cutting. An illustration of a smooth stingray with its tail cut at Flinders Pier can be seen in Figure 52. Current regulations by the Victorian Fisheries Authority prohibit the take of stingrays smaller than 1.5m wide or from within 400m of any pier, pier, wharf or breakwater. The limit bag has been reduced to 1 individual per day and it is required that the whole individual is landed. These recently introduced regulations not only reduce cruel behaviour such as tail cutting but they also recognise the stingray ecological importance, community appreciation and artificial structures as a relevant habitat.

Table 4-2. Species of fish found at Flinders Pier (December 2020)

Species	Common name
Bovichtus angustifrons	Dragonet
Parablennius tasmanianus	Tasmanian blenny
Brachaluteres jacksonianus	Southern pygmy leatherjacket
Aracana ornata	Ornate cowfish
Pseudocaranx georgiaus	Silver trevally
Upeneichthys lineatus	Red mullet
Pempheris sp.	Bullseye
Scorpis lineolata	Sweep
Enoplosus armatus	Old wife
Cheliodactylus nigripes	Magpie perch
Sphyraena novaehollandiae	Shortfin pike
Notolabrus tetricus	Bluethroat wrasse
Haletta semifasciata	Grass whiting
Dasyatis brevicaudata	Smooth stingray
Phyllopteryx taeniolatus	Weedy seadragon
Undetermined	Schools of fish larvae/juveniles

Figure 48. Tulip shell (*Pleuroploca australasia*) surrounded by brown algae and seagrass debris

Figure 49. Blue mussel (*Mytilus edulis*) shell, probably fallen from mussel aquaculture vessel

Figure 50. Senescent lion's mane jellyfish, *Cyanea annaskala*

Figure 51. Crab at the bottom of a wooden pile
Red swimmer crab, *Nectocarcinus tuberculosus*

Figure 52. Smooth stingray (*Dasyatis brevicaudata*) swimming above an *Amphibolis antarctica* bed

Figure 53. School of mysid shrimp on which seadragon feed

4.3.4 Seadragons

Weedy seadragons are commonly sighted at Flinders under the pier and in the adjacent seagrass habitat feeding on mysid shrimp, other small crustaceans and fish larvae. Five weedy sea dragons were observed along the pier during the December 2020 survey. All individuals were observed at or beyond the central landing.

Three of five sighted in under Flinders Pier December 2020 are shown in Figure 54. The top individual among brown macroalgae and seagrass alongside the pier is possibly a female due to her narrow tail and is not carrying any eggs. The middle individual is a male among red algae and seagrass under the outer jetty and appears to be carrying a few eggs the base of his tail, algae seems to be growing from upper brooding patch. The bottom individual is a male next to a pier pile carrying a large number of eggs.

Weedy seadragons are very well camouflaged in macroalgal and *Amphibolis* beds. Consequently, they are usually seen close to sand patches under and along the pier or at the base of piles. It is not uncommon for four or more seadragons to be observed during a single dive at Flinders Pier. They are also frequently seen on natural sand patches in the *Amphibolis* beds elsewhere in Kennon Cove but are not usually seen in the sand patches created an occupied by swing moorings. Figure 55 shows three of four seadragons observed during snorkelling inspection of seagrass/reef/sand habitat near shore approximately 500 m north of the pier in 2021. Figure 54 and Figure 55 demonstrate the range of colours and patterns that distinguish individual seadragons.

Figure 54. Weedy seadragons *Phyllopteryx taeniolatus* at the Flinders pier December 2020.

- *Top seadragon is possibly a female due to her narrow tail and is not carrying any eggs.*
- *Middle individual is a male among red algae and seagrass under the outer jetty and appears to be carrying a few eggs the base of his tail, algae seems to be growing from upper brooding patch.*
- *The bottom individual is a male next to a pier pile carrying a large number of eggs.*

Figure 55. Weedy seadragons 500 m north of Flinders Pier, December 2020
Three of four sighted in seagrass and nearshore reef habitat, none is carrying eggs

Seadragon numbers 2007, 2018 and 2020

As discussed above five weedy seadragons were observed on the offshore length of the pier area during the 2020 pier survey. None were observed along the length of pier proposed for removal.

The 2007 survey did not record numbers of seadragons observed during the survey, but characterised the number of seadragons as a "considerably large colony of seadragons … associated with the pier and adjacent benthic habitat".

The 2018 Great Victorian Fish Count recorded between one and 20 weedy seadragons at Flinders Pier during the 2018 count, and similar numbers (1 to 20) at Portsea Pier. VNPA (Kade Mills *pers comm*) advised that young seadragons (10 to 20 cm) may aggregate in shallow protected areas before dispersing over suitable habitat and into deeper water.

Flinders and Portsea Piers are convenient and accessible locations with permanent artificial habitat structures for divers to visit and revisit. While weedy seadragons are widely distributed, the Piers provide locations for repeat surveys over time to document seasonal and interannual patterns in sea dragon numbers. The Great Victorian Fish Count provides a useful long-term record and involves keen observers in a valuable exercise, however the variability in numbers of recorded by individual observer groups on the same day (one to 20) indicates the granularity of these observations.

4.4 Flinders pier piles

The marine biota on the Flinders Pier piles were qualitatively examined in December 2020 following the same general approach as the 2007 survey. Most of the subtidal portions of the timber piles at Flinders pier had 100 per cent cover of marine growth, comprising a diverse range of algae and invertebrates. The more recent installed steel piles appeared to have a higher proportion of large brown seaweeds and fleshy frondose red algae than the wooden piles and a correspondingly lower proportion and diversity of other sessile biota (Figure 56). This may be the result of a combination of factors: the composition of the piles; the age of the piles and the amount of sunlight reaching the piles. The wooden piles were older, more weathered and more shaded than the steel piles, which would result in more diversity of encrusting invertebrates.

The few exceptions on wooden piles showing a lower percent cover of growth were the piles supporting the lower landing. The lower deck of the landing and the additional piles obstruct the availability of light. Invertebrates such as sponges, ascidians, bryozoans and echinoderms were clearly visible on these piles (Figure 59).

There were distinct differences in the dominant marine growth between wooden and steel piles. At the shallow end of the pier, the timber piles were dominated by *Caulerpa brownii* (Figure 57), a green seaweed that although common to Victorian waters was only observed growing in three steel piles. A variety of sponges was observed at all wooden piles along the Flinders Pier and frondose red algae become increasingly abundant as depth increases (Figure 56 to Figure 59). Large brown algae were less abundant, although the kelp *Ecklonia radiata* was recorded attached to at least three wooden piles in the mid-section of the pier (Figure 58). At the offshore end *Caulerpa obscura* becomes highly dominant on the wooden piles (Figure 60).

The marine life on the steel pilings was dominated by large brown macroalgae (*Sargassum* sp., *Cystophora* sp., *Dictyopteris muelleri*). Red algae (encrusting, filamentous and frondose forms) were the next most abundant sessile biota and sponges (Figure 56 to Figure 59).

Other sessile invertebrates such as ascidians (sea squirts), both colonial (*Sycozoa cerebriformis, Didemum* spp.) and solitary (*Herdmania grandis*) and bryozoans (*Bugula dentata*, *Celleporaria* sp.) were distributed on both pile types. The same was observed for mobile invertebrates such as, gastropods (e.g. *Dicathais orbita*) and the seastars *Tosia australis (*Figure 65) and *Patiriella brevispina* (Figure 66). The nudibranch *Tambja verconis* (Figure 63)

A pattern in the abundance of the piles marine life is apparent in both pile types. Probably more pronounced on the steel piles, it seems that the side of the pile facing inwards to the pier shows lower abundance of marine growth than the side of the pile facing outwards (Figure 61).

No pipefish or seahorses were observed on any of the piles during the survey or snorkelling visits to Flinders Pier (Chidgey per obs). It is possible that small, cryptic pipefish are associated with the biological growth on the wooden piles to be removed, as well as the steel and wooden piles that will remain. Sea horses can be found on piles in sheltered waters or on deeper sheltered to moderately exposed reefs (Edgar 2008, Kuiter 2006), but may be less likely in this shallow, strong-wave characterised environment.

Figure 56. Marine growth on a wooden pile at Flinders (left) and on a steel pile (right)

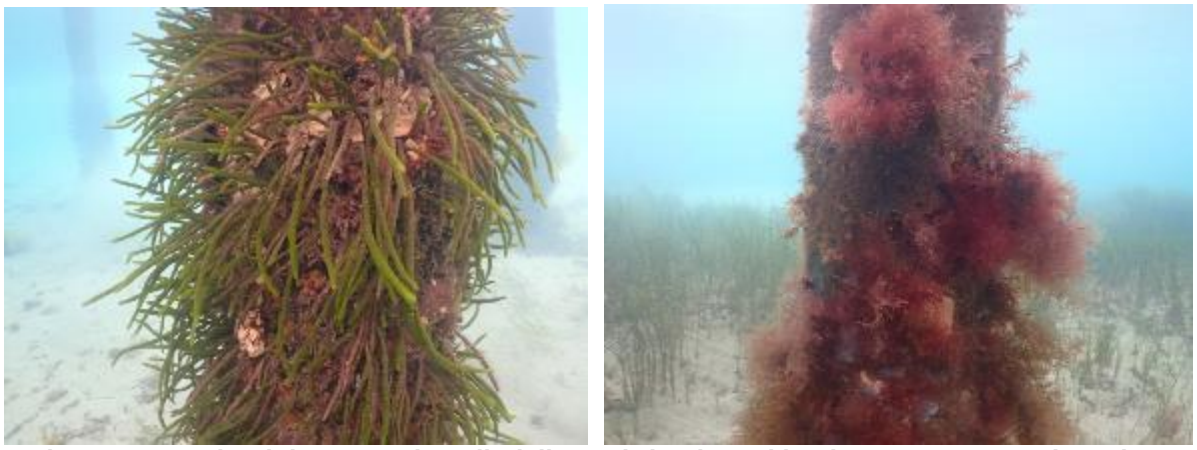

Figure 57. On the right, a wooden pile (pile 28B) dominated by the green seaweed *Caulerpa brownii* and on the left the parallel steel pile with brown and frondose red algae

Figure 58. On the left, assemblage of a mid-pier wooden pile (pile 38B, south facing side). On the right, the parallel steel pile (outer pile 38, south facing side)

Figure 59. Inward facing side of wooden pile under the lower landing (pile 42B) with the colourful colonial brain ascidian (*Sycozoa cerebriformis*)

Figure 60. Wooden pile at the offshore end of the Flinders pier.
Ascidians and hydroids can be seen amongst the dominating green seaweed *Caulerpa obscura*

Figure 61. Outer steel pile (pile 33) facing inward (left) and outward (right) Flinders pier, 2020

Figure 62. The ascidia *Herdmania grandis* surrounded by several species of sponges and green algae on a wooden pile

Figure 63. The nudibranch (sea slug) *Tambja verconis* on a wooden pile offshore end of pier

Figure 64. Top half of a wooden pile at Flinders with *Caulerpa* spp. solitary ascidian (*Herdmania grandis*, left) and the predatory gastropod *Dicathais orbita* (top centre)

Figure 65. The seastar *Tosia australis* surrounded by the green algae *Caulerpa brownii* on a wooden pile

Figure 66. The seastar *Patiriella brevispina* attached to a steel pile (outer pile 40, north facing side)

Figure 67. Native feather duster fan worm *Sabellastarte australiensis,* Flinders 2020

4.4.1 2020 comparison with 2007

The 2007 AME ecological survey (Stewart et al 2007) qualitatively described the flora and fauna of the wooden piles prior to the installation of the steel piles. A summary of their findings follows:

- North side piles (exposed to more light) - abundant thallose red algae and large browns (*Ecklonia radiata* and *Sargassum* sp.)
- Inshore and middle piles - mixed algae and sponges
- Mid-pier piles - dominated by *Caulerpa* sp
- Offshore (seaward) southside piles - abundant solitary ascidians providing substratum for colonial ascidians bryozoans and red algae, and less abundant, larger erect sponges
- South side piles (darker side) - predominantly sponges, colonial ascidians and bryozoans.

AME's description in 2007 shows a general increase in diversity of biota on the piles, particularly invertebrates, as distance from shore increased. This is consistent with increasing water depth, greater surface area of individual piles, a light gradient down the pile and decreasing sand scour at the base of the pile.

The December 2020 survey found that the north-facing outer pile surfaces received direct sunlight and were characterised by a variety of large seaweeds. Both the nearshore outer north-facing steel piles and the outer offshore wooden north-facing showed this characteristic at the top of the piles. The south sides of the same piles were characterised by smaller algae and encrusting invertebrates. The inner and outer southern piles, both steel and wooden, were shaded by the pier deck and characterised by encrusting invertebrates and few large macroalgae.

The steel piles are located in shallower depth than the offshore wooden piles. Consequently, the range of macroalgae and invertebrates observed over the depth profile on the longer, offshore piles was not present on the shallower, shorter, steel piles where the lower parts of the piles were scoured by sand.

The characteristics of the ecological community that establishes on pier piles depends on a range of factors other than the composition of the piles. A quantitative survey would be required to determine any difference between marine communities on wooden compared with steel or concrete piles. Factors in the comparison would include water depth, degree of shading, diameter of pile, age of community, age of surfaces, smoothness of surfaces.

Ultimately the community on the artificial surface will comprise species that occur on reefs and seagrass meadows of the Central Victorian Marine Bioregion and are suited to the particular environment at the Flinders Pier. Examples of marine communities growing piles in at Blairgowrie Harbour and North Arm of Western Port are shown in Figure 68 and Figure 69.

Figure 68. Outer steel pile and concrete wave screen at Blairgowrie, 2021

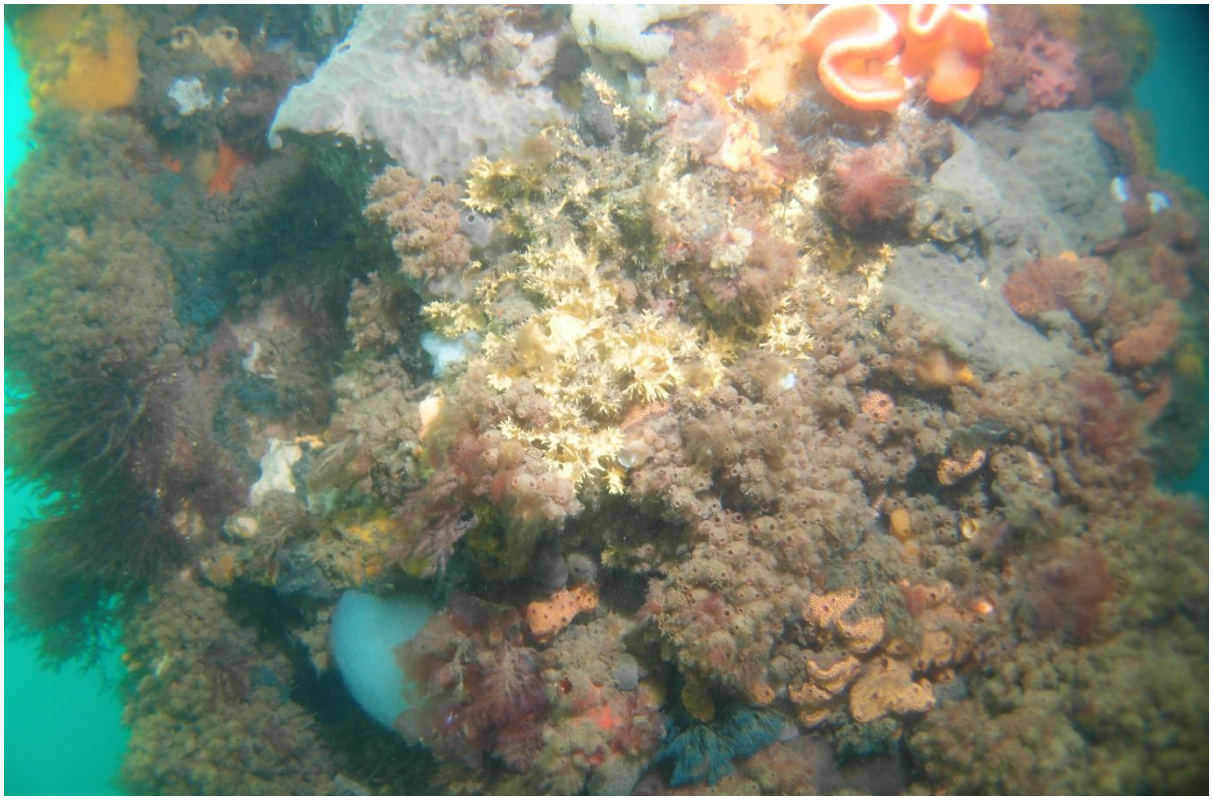

Figure 69. Encrusting invertebrates on steel jetty pile, North Arm Western Port

4.5 Protected species

The Flora and Fauna Guarantee Act 1988 (FFG Act) protected species list (November 2019 appended) and Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) marine species lists Protected Matters Search at Flinders Pier 23 Dec 2020, 10 Feb 2021 appended) were examined for likelihood of occurrence of protected species in the project area. Many of the marine species listed in the EPBC Act are oceanic species that have negligible likelihood of occurring in the neighbourhood of Flinders pier.

Comparison of the FFG and EPBC Acts lists revealed that there were threatened or migratory EPBC Act listed species that might occur in Western Port that were not on the FFG Act list of threatened species. All species are listed together with the species status from the corresponding Act in Table 4-3.

Table 4-3. FFG and EPBC Act protected species

Species	Common name	FFG	EPBC	LoO
Mammals				
Balaenoptera musculus	Blue Whale	Threatened	EN	R
Eubalaena australis	Southern Right Whale	Threatened	EN	R
Megaptera novaeangliae	Humpback Whale	Threatened	VU	R
Tursiops australis	Burrunan Dolphin	Threatened		P
Coastal Birds		Threatened		
Ardea alba	Great Egret	Threatened		P
Calidris canutus	Red Knot		EN	R
Calidris ferruginea	Curlew Sandpiper	Threatened	CR	P
Diomedea antipodensis	Antipodean Albatross		VU	R
Diomedea epomophora	Southern Royal Albatross	Threatened	VU	R
Diomedea exulans	Wandering Albatross	Threatened	VU	R
Diomedea sanfordi	Northern Royal Albatross		EN	R
Haliaeetus leucogaster	White-bellied Sea-Eagle	Threatened		P
Hirundapus caudacutus	White-throated Needletail	Threatened	VU	R
Lathamus discolor	Swift Parrot	Threatened	CR	R
Limosa lapponica baueri	Bar-tailed Godwit		VU	R
Limosa lapponica menzbieri	Northern Siberia Bar-tailed Godwit		CR	R
Macronectes giganteus	Southern Giant-Petrel	Threatened	EN	R
Macronectes halli	Northern Giant-Petrel	Threatened	VU	R
Neophema chrysogaster	Orange-billed Parrot	Threatened	CR	R
Numenius madagascariensis	Eastern Curlew	Threatened	CR	R
Pachyptila turtur subantarctica	Fairy Prion		VU	U
Phoebetria fusca	Sooty Albatross	Threatened	VU	R
Phoebetria palpebrata	Light-mantled Sooty Albatross	Threatened		R
Rostratula australis	Australian Painted Snipe		EN	
Sterna albifrons	Little Tern	Threatened		P
Sterna caspia	Caspian Tern	Threatened		P
Sterna nereis nereis	Fairy Tern	Threatened	VU	P
Thalassarche bulleri	Buller's Albatross	Threatened	VU	R
Thalassarche cauta	Shy Albatross	Threatened	VU	R
Thalassarche steadi	White-capped Albatross		VU	R
Thalassarche impavida	Campbell Albatross		VU	R
Thalassarche melanophris	Black-browed Albatross		VU	R
Thalassarche salvini	Salvin's Albatross		VU	R
Thinornis rubricollis	Hooded Plover	Threatened	VU	P

(Table continued below)

Table 3 2. FFG and EPBC Act protected species (cont)

Species	Common name	FFG	EPBC	LoO
Terrestrial Birds				
Anthochaera phrygia	Regent Honeyeater	Threatened	CR	R
Botaurus poiciloptilus	Australasian Bittern	Threatened	EN	R
Gelochelidon nilotica	Gull-billed Tern	Threatened	R	
Pedionomus torquatus	Plains-wanderer	Threatened	CR	U
Pterodroma leucoptera	Plains-wanderer		CR	
Reptiles				
Dermochelys coriacea	Leathery Turtle	Threatened	EN	R
Caretta caretta	Loggerhead Turtle		EN	R
Chelonia midas	Green Turtle		EN	R
Fish				
Carcharias taurus	Grey Nurse Shark	Threatened		N
Carcharodon carcharias	Great White Shark	Threatened	VU	R
Lovettia sealii	Australian Whitebait	Threatened		N
Mugilogobius paludis	Pale Mangrove Goby	Threatened		N
Neochanna cleaveri	Australian Mudfish	Threatened		N
Prototroctes maraena	Australian Grayling	Threatened	VU	R
Thunnus maccoyii	Southern Bluefin Tuna	Threatened		N
Crustaceans				
Athanopsis australis	Southern Hooded Shrimp	Threatened		N
Eucalliax tooradin	ghost shrimp species	Threatened		U
Michelea microphylla	ghost shrimp species	Threatened		U
Echinoderms				
Amphiura triscacantha	brittle star species	Threatened		R
Apsolidium densum	sea-cucumber species	Threatened		U
Apsolidium handrecki	sea-cucumber species	Threatened		U
Ophiocomina australis	brittle star species	Threatened		R
Pentocnus bursatus	sea-cucumber species	Threatened		R
Thyone nigra	sea-cucumber species	Threatened		R
Trochodota shepherdi	sea-cucumber species	Threatened		R
Cnidarians				
Ralpharia coccinea	stalked hydroid species	Threatened		U
Molluscs				
Bassethullia glypta	chiton species	Threatened		U
Platydoris galbana	marine opisthobranch	Threatened		U
Rhodope genus	marine opisthobranch	Threatened		U

N - Not possible due to required environmental requirements or known distribution limits
R - Rare likelihood due to preferred environmental requirements or known migratory path
U - Unlikely due to general environmental requirements or migratory paths
P - Within general range of occurrence and habitat
L - Within range of occurrence and habitat
E - Known to be present in area

Table 4-3 shows a total of 67 marine species and communities are listed in the FFG and EPBCA Acts for the Flinders pier area:

- Seven species may possibly occur around Flinders.
- Around 40 species of birds, invertebrates, whales, fish and turtles have rare likelihood of occurrence in the project area.
- The listed seabirds, including albatrosses and petrels, whales and turtles have migratory paths that are predominantly oceanic. They may stray into Western Port from time to time.
- A range of marine invertebrates are known from Western Port or similar environment but have habitat and environmental preferences that does not appear to match Flinders environment.
- Great white sharks may be found occasionally in low numbers in Western Port.
- Burrunan Dolphin have been sighted in Western Port Bay including at Flinders. The status of Burrunan Dolphin is discussed further below.
- Eight FFG Act listed species and two marine communities will not be found in Flinders due the unsuitability of the environment or the remoteness of the known distribution of the species.

Migratory paths of humpback and southern right whales pass through Bass Strait and individuals of these two species may wander into the deeper channel of Western Port close to Phillip Island. The likelihood of these large whales straying close to Flinders pier is remote. Dead individuals or their remains may wash ashore near Flinders from time to time.

The Burrunan Dolphin (*Tursiops australis*) was proposed as a separate species from the widespread common bottlenose dolphin (*Tursiops truncatus*) in 2011. There is a relatively small resident population of Burrunan Dolphins in Port Phillip Bay. They are regularly sighted in Western Port Bay and nearshore at Kilcunda. A young-sized individual dolphin was observed feeding on schooling fish in very shallow water inshore of moored boats between Flinders Pier and yacht club on 3 January 2021.

The International Society of Marine Mammalogy questions the separation of *T. australis* as a species and did not include it as a recognised species in its ‘List of Marine Mammal Species and Subspecies’ (June 2020). Regardless of its taxonomic status dolphins are highly mobile and the likelihood of works activities associated with the pier affecting the population is remote.

A range of listed seabirds, shorebirds and waterbirds occur in Western Port. Some may be seen in the Flinders area and close to Flinders Pier from time to time, such as various terns and the hooded plover. Oceanic species may be blown ashore at Flinders during strong southerly storms. However, there is considerable human activity at Flinders Pier including fishing, boating, swimming, dog walking. Consequently, the area around Flinders Pier is most unlikely to provide significant habitat for populations of protected bird species.

Listed turtle species are oceanic and do not breed in Victoria. Green and loggerhead turtles are most unlikely to be found in Victoria. Individual adult leatherback turtles are known to occasionally pass through Victorian ocean waters. Dead individuals are occasionally found washed ashore along the Victorian coast. A dead individual leatherback turtle was found washed ashore near Crib Point in recent times.

Great White Sharks are known in Western Port and adjacent Bass Strait. They may occur in deeper channels or close to deeper water in Western Port, around Seal Rocks on the open coast. Southern Blue fin tuna may pass offshore from Flinders but are unlikely to occur in the proximity of Flinders Pier. This species is listed as 'threatened' under the Victorian FFG Act list but may be caught by recreational anglers. Other protected fish species are unlikely to occur in the habitat or semi-oceanic conditions of Kennon Cove.

The FFG Act lists 14 marine invertebrates as threatened. O'Hara and Barmby (2000) describe 13 of these species. Each of the listed species is known from particular habitats (rock, mud, sand, shell, seagrass species), depth (intertidal, shallow, deep), exposure (quiescent, bay, channel, semi-exposed, exposed) or position along the Victorian coast.

The Flinders Pier environment may be considered as fine sand and *Amphibolis antarctica* seagrass, wooden and steel piles, intertidal and shallow subtidal, semi-exposed central coast region (Central Victorian Bioregion). These conditions are unlikely to suit most of the FFG Act listed species. Two listed species have been recorded at Flinders (*Apsolidium densum* and *Bassethulia glypta*) and one at Merricks (*Apsolidium handrecki*).

The two sea cucumbers *Apsolidium densum and A handrecki* are known from shallow rocky habitats. A *densum* (4 cm long) was found at Mushroom Reef which is more exposed than the Merricks location where *A handrecki* (2 cm) was recorded. O'Hara and Barmby (2000) state that only a few specimens of either species had been collected despite searches over a 10 year period. These requirement of these very small sea cucumbers for rocky habitat would preclude them from the close proximity of Flinders Pier where the seabed is predominantly sand and sand over rubble. There may be suitable habitat at the reefs to the north and south of the pier, but there seems no greater likelihood of these species occurring at these reefs compared to others in the state given the searches cited by O'Hara and Barmby (2000).

The small chiton *Bassethulia glypta* (3 cm) is mostly found under rocks in clean sand from the intertidal to 10 m water depth. A record in Tasmania was attached to a dead shell, rather than rock. Its distribution is South-eastern Australia, including central Victoria (O'Hara and Barmby 2000, Patulo 2011). There seems reason that this species should occur in greater numbers in the Flinders Pier proximity than any similar habitat elsewhere in its geographic range

4.5.1 Conservation significance of weedy seadragon

Phyllopteryx taeniolatus belongs to the taxonomic family Syngnathidae, which includes seahorses, sea dragons and pipefish. Members of this family are listed as Protected Aquatic Biota (PAB) under the *Victorian Fisheries Act 1995* (VFA), which states that "*A person must not take, injure, damage, destroy, possess, keep, display for reward, release into Victorian waters or sell any PAB unless otherwise authorised*." Hence a permit from DELWP is required if there is risk that a proposal will affect (injure or damage) a syngnathid, such as a seadragon.

Syngnathids are "Listed marine species" under the *Commonwealth Environment Protection and Biodiversity Conservation Act* (EPBC Act) 1999 but are not *protected* from marine the effect of marine works under this Act unless an *action* is proposed by a Commonwealth agency or is within or affects a Commonwealth area. *Export* of Syngnathids, however, is controlled under the EPBC Act.

Potential interference of seadragons or any other syngnathid is <u>not</u> a controlled action under the EPBC Act. However, application for Permit under the VFA should be included for works that risk injury or destruction of seadragons or any other syngnathids.

4.6 Introduced species

Previous studies reported the occurrence of at least 18 exotic species in Western Port Bay (Curry and Crookes 1997, Cohen et al 2000, Parry and Cohen 2001). The status of exotic species in Western Port was last systematically assessed in 2001 (Parry and Cohen 2001), with 12 of the exotic species listed to be self-sustaining populations within the bay (Table 4-4, Parry and Cohen 2001).

Table 4-4. Western Port Bay introduced marine species and current population status

	Status
Microalgae	
Alexandrium tamarense	Established
Alexandrium catenella	Probably established
Alexandrium minutum	Probably established
Green Macroalgae	
Codium fragile	Established
Ulva lactuca	Established
Brown Macroalgae	
Undaria pinnatifida	Not established
Ascidian	
Ascidiella aspersa	Established
Ciona intestinalis	Established
Styela clava	Established
Styela plicata	Established
Bryozoa	
Bugula neritina	Established
*Watersipora subtorquata**	Established
Crab	
Carcinus maenus	Established
Bivalve	
Musculista senhousia	Established
Theora lubrica	Established
Corbula gibba	Not established
Crassostrea gigas	Not established
Polychaeta	
Sabella spallanzanii	Not established

*species recorded to occur at Flinders Pier (2020)

Neighbouring Port Philip Bay contains more than 100 introduced marine species and more than 60 species with uncertain origin (cryptogenic species), including most of those found in Western Port. The Japanese native 'wakame' kelp *Undaria pinnatifida* was reported growing on abalone shells at the Flinders pier in 2000 (Parry and Cohen 2001). A prompt response program was launched and the species appears to have been eradicated from the area.

4.6.1 Flinders Pier 2007 and 2020

A small bryozoan colony resembling *Watersipora subtorquata* was recorded on a wooden pile in 2020, but no other introduced species were seen. No introduced pests were observed in the 2007 survey, although bore holes were noted in wooden pier piles and were likely attributed to the introduced ship-worm *Toredo navalis*. Bore holes were also observed in wooden piles during the 2020, but obviously not in the steel piles.

The distinctive Asian Shore crab *Hemigrapsis sanguineus*, which was recently recorded in Port Phillip bay (www.agriculture.vic.gov.au) was not observed during the Flinders survey. A survey specifically targeting introduced pest species at Flinders Pier may record species listed in (Table 4-4) that were not observed in the general surveys by AME in 2007 and CEE in 2020.

5 Impact Pathways, Receptors and Risk Assessment

Parks Victoria proposes to remove the inner 180m of the pier to reduce the risks to public safety risk associated with the degraded condition of the structure. The works will involve removal of the wooden deck and approximately 40 pairs of wooden piles along the inner 180m of the wooden pier. The works area is shown in Figure 70.

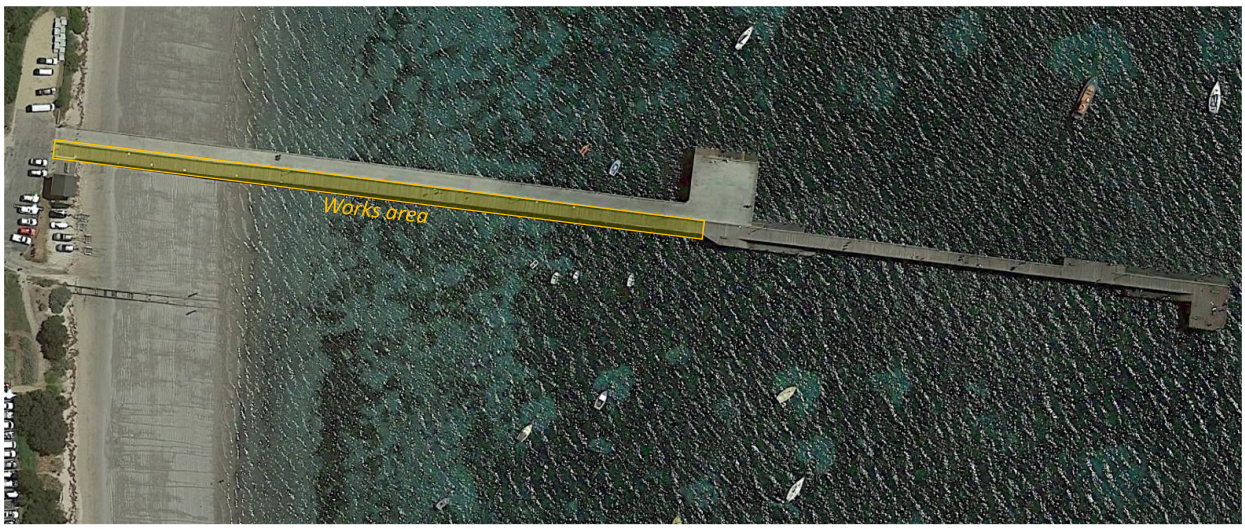

Figure 70. Pier removal works area

This section identifies the risk pathways of the proposed works to the marine ecosystem, provides local context for assessment of risk on key marine ecosystem components and categorises risks and mitigation measures at a level appropriate to the proposed works and the scope of this assessment.

5.1 Potential impact pathways

The deck would be removed by direct access for equipment and personnel along the wooden and concrete decks. Pier piles would be removed by either: pulling by cranes on the beach at low tide or cranes on the concrete pier, or; cutting piles at the seabed by land crews from the shore to low tide, and divers below low tide.

Potential impact pathways from these tasks include:

- Removal of pier elements: deck and piles
- Disturbance to seabed from works
- Underwater noise generated from works
- Oil and fuel spills associated with equipment used during works
- Demolished material jettisoned from works
- Litter
- Introduction of marine pests from works vessels and equipment

These pathways are addressed in the risk assessment table in Section 5.3.

5.2 Marine ecosystem receptors and potential impacts

This section provides context on the key ecosystem works effects receptors for the risk assessment that follows in Section 5.3.

5.2.1 Physical structures

The length of pier proposed for removal comprises approximately 40 pairs of wooden piles and the associated wooden deck from the shoreline to, but not including the landing and pier piles and decks. This represents approximately 170 m of the existing 320 m long wooden pier. Approximately 40 m of this 170 m length (approximately 10 pile pairs, Piles 32 to 41) is associated with *Amphibolis* seagrass seadragon habitat (Figure 19 and Figure 28), while the 150 m length of pier that will remain in place is all existing *Amphibolis* seagrass seadragon habitat that will be unaffected.

There have been no quantitative surveys of biota including seagrasses, seadragons or other biota at the Flinders Pier that inform comparison of the abundance at different distances or water depths along the pier either before or after the new steel and concrete structure was added to the wooden pier. There is no quantitative data to compare flora and fauna preferences for the north or south side of the pier and or steel versus wooden piles. However, the following summary may assist in assessing the implications of wooden pile removal on seagrass/pier habitat value for seadragons at Flinders.

- There are 73 rows of piles supporting deck structures along Flinders Pier. The construction of the steel and concrete pier parallel to the wooden pier replaced the 40 pairs of wooden piles that may be removed with a slightly lower number of piles. Hence after removal of the wooden piles, there would be a slightly lower number number of piles along the nearshore length of the pier than before the steel and concrete structure was added.
- There would have been a net replacement of the 10 pairs of wooden piles in the *Amphibolis* habitat with 8 or 9 pairs of steel piles in the *Amphibolis* habitat.
- The steel structure has added a considerably larger upper landing area to the existing timber deck. This has increased the shaded area the landing, which appears to have created a larger haven for juvenile fish and a range of species preferring overhead shelter and shaded conditions.

The key habitats and ecosystem components are discussed further in the following sections.

5.2.2 Pile Habitats

Both the wooden piles and steel piles provide artificial habitat for a range of marine flora and fauna. The length of pier proposed for removal comprises approximately 40 pairs of wooden piles and the associated wooden deck from the shoreline to, but not including the landing and pier piles and decks. This represents approximately 170 m of the existing 320 m long wooden pier. Approximately 40 m of this 170 m length (approximately 10 pile pairs, Piles 32 to 41) is associated with *Amphibolis* seagrass and potential seadragon habitat (Figure 19 and Figure 28), while the 150 m length of pier that will remain in place is all existing *Amphibolis* seagrass and seadragon habitat that will be unaffected.

The qualitative observations at Flinders in 2007 and 2020 recorded interesting distribution patterns in various flora and fauna in relation seabed depth and degree of shading. The 2020 observations indicated possibly greater invertebrate growth on interior wooden piles relative to steel piles. However, there have been no rigorous quantitative surveys of biota including seagrasses, seadragons or other biota at Flinders Pier that inform comparison of the abundance at different distances or water depths along the pier either before or after the new steel and concrete structure was added to the wooden pier.

While there is no quantitative data to compare flora and fauna preferences for the north or south side of the pier and or steel versus wooden piles, the qualitative observations, known characteristics of the physical habitats and environment and knowledge of the biological and ecological processes of the marine biota comprising the community at Flinders Pier inform assessment of the potential effects of wooden pile removal on general biodiversity values at Flinders.

1. It is likely to certain that that the all plant and animal species found on the wooden piles inshore of the central landing would be found on the wooden piles of the pier and service landing offshore from the central landing.
2. It is likely to certain that there are more plant and animal species associated with the wooden pier and service landing piles offshore from the central landing than the wooden piles inshore from the central landing
3. It is likely to certain that all plant and animal species found on the wooden piles inshore of the central landing would be found on natural habitats in the Flinders region.

5.2.3 Seagrass

The pier deck and piles create shade beneath pier and affects the amount of light available for plants to grow on the seabed and, in the case of macroalgae, on the pier piles. Seagrasses do not grow on wooden or steel pier piles.

The east west orientation of the pier means that shading is constant compared to piers orientated north-south, where the seabed receives direct sunlight at some time of the day as the sun moves from east to west ‘around’ the pier alignment. Shading of the seabed is greatest at Flinders at the nearshore end where the sun angle does not travel far under the deck in the shallow water.

This creates an area bare of seagrass from the natural beginning of the *Amphibolis* seagrass at about Pile 33 located 130 to 140 m along the pier from shore (Figure 19 and Figure 28) to the end of the middle landing. The sun’s varying angle and deeper seabed depth allows the seagrass bed to continue under the pier from the offshore end of the middle landing (Pile 49, 210 m) to the shoreward side of the offshore landings (Pile 65, 290 m, Figure 19 and Figure 28).

Shading from the addition of the concrete deck on the north side of the pier increased the size of this bare area, including the area under the vehicle turning and access area of the new concrete pad at the middle landing. Removal of the deck of the old wooden shoreward of the middle landing may result in some recolonisation along approximately 30 to 35 m of seabed on southward side of the pier between Pile 33 and about Pile 40.

The addition of the concrete deck on the north side of the wooden pier has further shaded the old wooden piles on the south side. It is apparent that the area of the wooden piles occupied by macroalgae is relatively small due to shading and the depth of water below low tide. The steel piles have provided habitat suitable for most macroalgal species that would have been found on the wooden piles. Removal of the old wooden piles would remove some of the macroalgae attached to subtidal piles representing an approximately 70 m length of the pier.

Seagrasses or macroalgae are not listed in Ecological Vegetation Classes for terrestrial bioregions. Seagrasses are not listed individually or as communities in the state FFGA or the Commonwealth EPBCA.

Seagrasses are, however, an important component of the marine ecosystem and should be considered in the assessment of any works where seagrasses along the Victorian coastline. The Victorian Planning Provisions (VPP) provide for inclusion of Native Vegetation regulations under the *Planning and Environment Act* 1987. Under the VPP, the "removal of seagrass" may be treated as removal of native vegetation where a local council's planning scheme extends over lakes, estuaries or the sea (DELWP 2018).

In addition, the MaCA guiding principle include "Ecosystem based management" and "Ecologically sustainable development". The MaCA does not include offsets for marine ecosystem components. The MaCA Guiding Principal of Ecologically Sustainable Development states:

> *"It is a guiding principle for the management of the marine and coastal environment that use and development that affects the marine and coastal environment should be focused on improving the total quality of life of Victorians, across current and future generations, in a way that maintains the ecological processes on which life depends."*

Potential impact on seagrasses

The existing nearshore length of the pier shades the seabed by the combined width of the concrete and wooden pier decks, which has resulted in a wider area of bare sand through the nearshore *Amphibolis* bed compared with the wooden deck alone.

Removal of the wooden pier would reduce the width of the shaded area by approximately 45% (the concrete deck is slightly wider than the wooden deck).

- There would be no reduction in seagrass habitat resulting from removal of the inshore wooden pier.
- *Amphibolis* and *Zostera spp* are likely to slowly recolonise the unshaded area resulting from the removal of the existing wooden deck in over the length of pier in the seagrass zone: approximately 60 m in the *Zostera muelleri* zone and 40 m in the *Amphibolis antarctica* zone.
- Removal of the wooden piles should be achievable with no removal and minimal disturbance to seagrasses using extraction or cutting methods.

Hence, there would be no removal of seagrass resulting from the removal of the wooden pier deck or piles.

5.2.4 Water column

The December 2020 survey observations showed that environment created by the pier piles and deck provided a refuge for a range of fish, particularly schools of unidentified juvenile and larval fish. Most of the schools of fish were associated with the larger deck cover provided by the central and offshore landings. Therefore, the removal of the nearshore section of the wooden pier would be unlikely to affect the value of the pier as a refuge for fish larvae or juveniles.

5.2.5 Matters of National Environmental Significance

The observations during the sea life survey 2020 and CEE's understanding of the distribution and habits of EPBC Act listed marine species indicate the likelihood of occurrence of most species protected from the works area at Flinders pier is remote. This is consistent with the 2007 survey conclusion and Parks Victoria's June 2008 referral submission that likelihood of the works associated with removal of the nearshore length of the wooden pier at Flinders having significant effect on any MNES is very low.

As discussed in Section 4.5.1, the EPBC Act lists various Syngnathids (pipefish, seahorses and seadragons) as "listed marine species". "Listed marine species" are only protected under the EPBC Act from works in a Commonwealth area or are undertaken by a Commonwealth agency. The proposed works at Flinders Pier are not proposed by a Commonwealth agency and are not located in a Commonwealth Marine Area and so they are not protected under the EPBC Act.

Potential interference of seadragons or any other syngnathid is not a controlled action under the EPBC Act.

5.2.6 Victorian Fisheries Act 1995

As discussed in Section 4.5.1, Syngnathids are protected under the Victorian *Fisheries Act 1995.* No pipefish or seahorses were observed on any of the piles during the survey. It is possible that small pipefish are associated with the biological growth on the piles to be removed, as well as the steel and wooden piles that will remain.

Seadragons

There would be no net change to the length of the seadragon seagrass/bare sand linear boundary habitat along the pier. Most of the seadragon habitat along the pier extends from the middle landing to the offshore end of the pier. This habitat will be unaffected by the removal of the inshore wooden piles and deck.

As discussed previously, seadragons are distributed widely in Victoria. The removal of the inshore wooden piles and deck will not affect the populations of seadragons at a state regional or even local level. It may be considered that the removal of the wooden structure will reduce the above-water ambiance for those approaching the 'seadragon dive site' at Flinders and initially the below-water experience, but for the above reasons, it is unlikely to affect seadragon numbers under the pier.

Procedures to remove piles and deck will be described in a Construction Environmental Management Plan. The procedures to extract or cut piles should be possible without harming any individual seadragons or other obvious syngnathids. As discussed in Section 4.5.1, a Fisheries permit to remove Syngnathids should be obtained to cover the inadvertent removal of small species that may be associated with invertebrate and macroalgal growth on the piles being removed.

5.2.7 Biodiversity

Flinders Pier provides an artificial structure within extensive *Amphibolis antarctica* seagrass beds along the southwestern shore of Western Port. The artificial structure creates conditions beneath the pier that affect the nature of natural seabed community, while the pier piles provide solid habit for the attachment of biota that would otherwise be found on the natural rock and seagrass habitats nearby.

Most, if not all, of the species represented on the wooden piles and under the deck of the parts of the pier proposed to be removed are found associated with other parts of the unaffected pier including the steel piles and that were installed about eight years ago to replace the wooden structure.

Removal of the wooden piles will have no effect on the biodiversity value of the Kennon Cove area and negligible effect on the biodiversity value of the Pier. However, as for appreciation of the seadragon population by divers and visitors in general, some may consider the removal of the wooden structure will reduce the experience of those visiting Flinders to enjoy the maritime and marine biodiversity associated with pier structure.

5.2.8 Seasonality and removal activity scheduling

The marine ecosystem cycle in Western Port is generally strongly seasonal. Phytoplankton, zooplankton, fish larvae and seagrass production begins to increase from late winter/early spring (August and September) and reach peaks in late spring to mid-summer (Bok et al 2017, Bulthuis and Woelkerling 1983, CEE 2020 Melbourne Water 2011, 2018). Seadragon breeding activity at the jetty seems to follow a similar pattern (Section 3.1.3 and 4.3.4).

Fish such as snapper and juvenile King George whiting migrate into Western Port in spring. Productivity declines from late summer through early autumn. Late autumn through winter is quiet period for the much of the marine ecosystem, although various pelagic fish species and oceanic plankton may pass through the bay (Jenkins 2011, Jenkins and Black 1994).

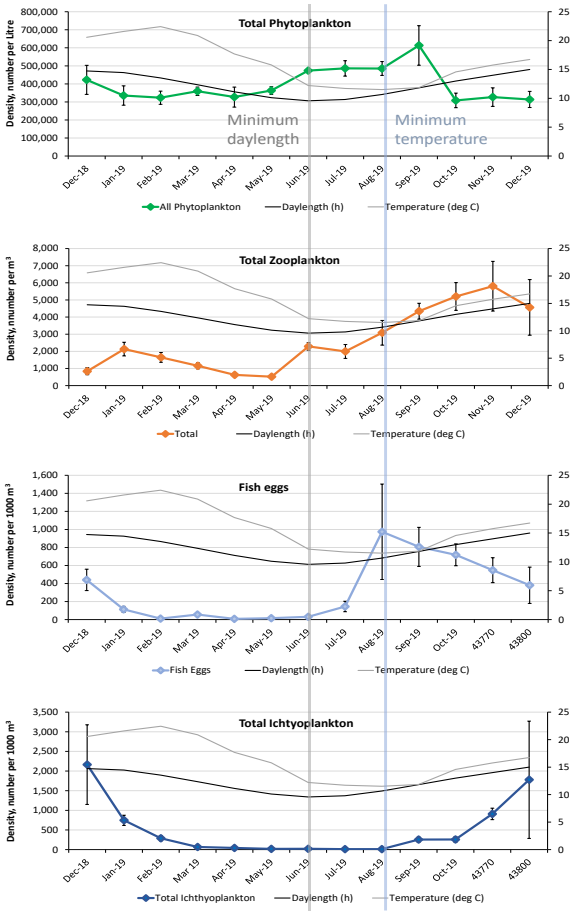

Figure 71. Plankton annual cycle, North Arm Western Port 2020
(CEE 2020)

The effects of activities to physically remove the deteriorating wooden structures should be scheduled for the period of lowest marine biological activity at Flinders to minimise potential effects of the removal activities on the marine ecosystem. Available information suggests that the most appropriate period to schedule the removal activity is between April to August inclusive.

5.3 Marine environmental risk assessment

The project construction activities, potential impact pathways and ecosystem receptors for the Flinders Pier partial removal works to affect marine ecosystem values have been arranged in a risk matrix in in are listed below, together with an ecosystem risk assessment appropriate to the scope of the project and environmental values involved. The risk of each activity or stressor on a marine ecosystem receptor is assessed in five risk categories and corresponding management response listed in Table 5-1.

Table 5-1. Risk table

Risk	Management response options
Negligible	None required
Minor	CEMP
Moderate	CEMP, monitoring
High	Design, construction method reconsider
Very high	Redesign, relocate

CEMP - Construction Environmental Management Plan

Table 5-2. Marine ecosystem impact risk assessment matrix

Stressor	Activity	Receptor	Assessment	Risk	Management	Residual risk
1. Loss of habitat	Removal of nearshore wooden pier piles and deck.	Seagrasses	The removal of the nearshore deck and piles of Flinders Pier will remove *some* of the artificial shading that has reduced the cover of seagrasses directly beneath the pier. It is possible that *Amphibolis* and *Zostera* may slowly recolonise the bare area beneath the wooden pier from the low tide mark to the middle landing.	Negligible	Not required	Negligible
2. Loss of habitat	Removal of nearshore wooden pier piles – **Intertidal**	Pile epibiota	The wooden piles from the shore to the low tide (approximately 110 m of the 180 m to be removed) provide negligible habitat for marine biota. Most of the wetted length of these piles are exposed to the atmosphere while the lower parts are subject to sand scour. Any biota associated with these piles are common, hardy species that are widely represented in Victoria.	Negligible	Not required	Negligible
3. Loss of habitat	Removal of nearshore wooden pier piles – **Subtidal**	Pile epibiota	The wooden piles to be removed from low tide to the middle landing (approximately 70 m of the 180 m to be removed) provide minor habitat for marine biota. The length of pile from the seabed to seasurface ranges from 0 m (at the low tide mark) to almost 1.2 m at the middle landing, at low tide. The pile length below the low tide mark provides artificial habitat for marine species that are common to the natural reefs in the area. The vertical length of the pile habitat available for biota is shorter (0 to 1.2 m) in this 70 m length than the piles over the 140 m of pier extending from the middle landing to seaward (1.2 to 2.2 m). Effects of sand scouring are expected to be greater on the nearshore piles. The ecological assemblage on the wooden piles to be removed is similar to those that have established on the adjacent steel piles that were installed in 2013, but expected	Negligible	Not required	Negligible

	Stressor	Activity	Receptor	Assessment	Risk	Management	Residual risk
				to be lower diversity than the wooden piles over the 140 m of wooden pier extending from the middle landing to seaward. Sculptured concrete casings, wraps or panels are sometimes fitted to smooth piles or wave screens to increase habitat for biological settlement and colonisation.			
4.	Loss of habitat	Removal of nearshore wooden pier piles	Pipefish and seahorses	As discussed above, approximately 110 m of the 180 m of pier to be removed is located in the intertidal area. Pipefish and seahorses are not permanently associated with this habitat. No pipefish or seahorses were observed on any of the piles during the survey or snorkelling visits to Flinders Pier (Chidgey per obs). It is possible that small, cryptic pipefish are associated with the biological growth on the wooden piles to be removed, as well as the steel and wooden piles that will remain. Removed piles should be inspected and any pipefish or seahorses should be returned to the sea. A Permit to remove pipefish and seahorses to be obtained to cover the handling or accidental removal of individuals hidden amongst other biota removed with the piles.	Minor	CEMP Fisheries Permit	Negligible
5.	Loss of habitat	Removal of nearshore wooden pier piles	Fish and seadragons	As discussed above, approximately 110 m of the 180 m of pier to be removed is located in the intertidal area. Mobile biota are not permanently associated with this area. The remaining 70 m of habitat under the pier around the piles from the low tide mark ranges from bare sand and sparse *Zostera* over a length of approximately 30 m, to bare sand between the piles with *Amphibolis* seagrass along the side of the pier over the last 40 m of the removal area. Fish were sparse over this 70 mm long area compared with habitat beneath the middle and offshore landings.	Negligible	Not required	Negligible

	Stressor	Activity	Receptor	Assessment	Risk	Management	Residual risk
				Seadragons may be present on the seabed in the final 40 m length characterised by *Amphibolis* habitat, but appear more common on the more extensive habitat from the middle landing. Fish and seadragons are relatively mobile and will avoid the pile removal activities. Seadragons do not attach to piles, although they may be found in close proximity to piles in *Amphibolis* habitat. In the context of the expansive area of *Amphibolis* habitat suitable for fish and seadragons in the Flinders area, the removal of less than 10 pairs of wooden piles in *Amphibolis* habitat is expected to have negligible effect on *Amphibolis* habitat and negligible effect on fish or seadragon populations in the vicinity of Flinders Pier.			
6.	Disturbance to seabed	Pile removal	Soft seabed faunal community	Disturbance to seabed from pile extraction from deck or diver cutting is expected to be short duration (< 1 hour per pile) and very localised (<1 m). Resulting disturbance and associated turbidity is unlikely to have more than negligible effect on soft seabed biota that are resilient to frequent wave action and natural turbidity events in this area. No long-lived species. Recovery and recolonisation rapid.	Negligible	CEMP	Negligible
7.	Pile removal	Disturbance to seabed	Seagrass	Disturbance to seabed from pile extraction from deck or diver cutting is expected to be short duration (< 1 hour per pile) and very localised (<1 m). Resulting disturbance and associated turbidity is unlikely to have more than negligible effect on seagrasses that are resilient to frequent wave action and natural turbidity events in this area. Works activities should be planned to minimise seabed disturbance.	Negligible	CEMP	Negligible
8.	Access to site via beach	Disturbance to seabed	Seagrass	Vehicle and crane access to the pier is expected to be directly from the access road to the pier deck. Vehicles may	Minor	CEMP	Negligible

Stressor	Activity	Receptor	Assessment	Risk	Management	Residual risk
			access the beach via the ramp from the car park used to beach-launch boats. The beach is covered and uncovered daily by tides and regularly affected by strong wave action. Most of the beach therefore is configured by natural process each day. Barges and larger vessels are likely to be mobilised from boat ramps at Hastings or Stoney Point and moor at the jetty. Hence damage to seagrasses is likely to be minimal and controllable. The *Amphibolis* seagrass zone is undisturbed by beach-launching. Works activities should be planned to minimise vehicle or vessel disturbance of seagrass areas.			
9. Underwater noise	Removal of piles	Fish	Works will be predominantly land based. Pile extraction by crane is expected to produce negligible underwater noise. In-water activities may include underwater, chain-sawing of piles at sand level. Saws would be hydraulic, diver operated chain saws. Underwater hydraulic chainsaws generate underwater noise that is tolerable to the divers operating the saws and is of considerably lower intensity than outboard motors on boats that are launched daily at Flinders Pier or propeller noise from the Pilot vessel moored nearby. The duration of chain sawing is expected to be minutes per pile. The effects of underwater noise on the marine ecosystem from the works in the context of ambient sources is considered to be negligible.	Minor	CEMP	Negligible

Stressor	Activity	Receptor	Assessment	Risk	Management	Residual risk
10. Marine pest introduction	Works vessels and equipment	Marine ecosystem	Equipment including boats may carry marine pest species from Port Phillip Bay to Flinders. In the context of the number of vessels that have and will continue to visit Flinders from Port Phillip Bay, the likelihood of a work vessel in this project introducing a marine pest that establishes a sustainable population at Flinders is very low. Work vessels, trailers, diver and other project equipment should be cleaned, dried and inspected prior to arriving at Flinders. Appropriate biosecurity control measures to be itemised in CEMP.	Minor	CEMP	Negligible
11. Litter	General construction activities	Ecosystem	Various activities may generate litter that could enter the marine environment. Appropriate litter control measures to be itemised in CEMP.	Moderate	CEMP	Minor
12. Litter	Demolition materials	Ecosystem	Various demolition materials may enter the environment creating hazards the marine ecosystem and other uses. Appropriate measures to prevent or clean-up all works materials to be itemised in CEMP.	Moderate	CEMP	Minor
13. Litter	Chainsaw sawdust	Ecosystem	Sawdust from chainsawing may enter the environment. The sawdust will comprise small particles of cellulose. The marine environment at Flinders receives large quantities of cellulose particles regularly from shedding of seagrass leaves and stems from the extensive *Amphibolis* beds in Western Port. Substantial amounts of seagrass leaves accumulate and decompose on the beaches. The risk to the environment from addition of a small amount of wet sawdust that has been exposed to marine conditions for decades is expected to be negligible. Appropriate measures to reduce or contain excessive wood cuttings to be itemised in CEMP.	Minor	CEMP	Negligible

Stressor	Activity	Receptor	Assessment	Risk	Management	Residual risk
14. Spills	General construction activities	Ecosystem	Various works activities may spill hydraulic fluid, lubricants and fuel that may enter the marine environment. Appropriate measures to reduce likelihood of leaks or spills or contain spills to be itemised in CEMP.	Moderate	CEMP	Minor
15. Seasonality	All	All	The marine ecosystem in Western Port is highly seasonal. The period of lowest ecosystem sensitivity to project related disturbance including noise, seabed disturbance and turbidity is autumn to winter. Potential effects of removal of the inner timber piles and deck of Flinders Pier may be further mitigated by scheduling the works over autumn and winter, which should be a condition of the CEMP.	Minor	CEMP	Negligible
16. Removal of biota	Pile removal	Pile attached biota	A range of biota grow, attached to the wooden piles. None are protected under the EPBC or FFG Acts. Various small fish are resident among attached macroalgae and encrusting invertebrates. This may include cryptic pipefish, which are protected under the Fisheries Act. A permit to take protected Syngnathids should be obtained prior to commencement of works. Any obviously healthy syngnathids observed prior to or immediately after extraction of the piles should be returned to the marine environment. This procedure should be included in the CEMP.	Minor	CEMP. Fisheries Permit	Negligible
17. All	All	Protected species including sea dragons	Appropriate measures to reduce contain potential impacts within the works area should result in negligible exposure. Appropriately informed project observers should visually check the works areas daily for obvious protected species prior to work to ensure protected biota will not be harmed by the planned tasks. Procedures to be described in CEMP.	Negligible	CEMP	Negligible

5.3.1 Construction Environment Management Plan

Table 5-2 shows that mitigated risks to the marine ecosystem of the Western Entrance and Kennon Bay are negligible to minor.

A Construction Environment Management Plant (CEMP) will be required for the works. A framework for the CEMP should accompany the MaCA consent application. Details of the CEMP will be prepared specific to the procedures and equipment proposed by the contractor.

All works personnel should be aware of the marine ecosystem values, potential impact pathways and impact mitigation procedures through the CEMP and associated environmental induction prior to commencing work on the project.

6 Conclusion

The present 320 m long Flinders Pier structure is the product of episodes of construction, maintenance and removal activities by various pier managers over the 150 years since the pier was first built in about 1870. Parks Victoria is responsible for the management of the pier, as legislated in the *Parks Victoria Act 2018*, Crown Land Allotment 16B. Parks Victoria proposes to remove the inner 180m of the pier in 2021/22 to reduce the increasing risk to public safety resulting from further deterioration of the structure.

Works on the pier will require approval under the *Marine and Coastal Act 2018* and *Planning and Environment Act 1987.* This report provides documentation of marine ecosystem conditions at the pier, an assessment of potential effects of the removal and mitigation concepts to inform the ecosystem-based management requirements for approval under the Act.

Approximately 120 m of the 180 m length of wooden pier proposed for removal is inshore of the low tide mark. The seabed over the first 80 m comprises bare, flat fine sand and the lower parts of the pier piles close to the low tide mark are sparsely inhabited by common invertebrates including barnacles limpets and marine snails. Sparse ephemeral *Zostera muelleri* seagrass extends alongside the pier from 80 m (just above low tide) to 140 m along the pier at about 1 m below low tide. The seabed beside the remaining 40 m of wooden pier to be removed is habitat for the seagrass *Amphibolis antarctica*. However, the seabed beneath the pier is bare of seagrass because of insufficient light caused by shading from the deck of pier.

The remaining 140 m of wooden pier and the steel and concrete structure provides most of the marine ecosystem values of Flinders Pier including both the natural seagrass habitat and the artificial habitat created by the landing decks and the wooden and steel pier piles. These will be unaffected by the removal of the inner 180 m length of wooden pier.

Flinders Pier is located within extensive Amphibolis antarctica seagrass beds that are distributed along the southwestern shore of Western Port. The artificial structure and conditions at the pier mimic natural reef habitats and conditions that are more dispersed in the natural environment around Kennon Cove and nearby Western Port and Bass Strait. The biota around and under the pier and attached to the pier piles are representative of those in surrounding natural environment.

Flinders Pier provides a relatively safe and confined area of focus for snorkellers and divers to see a range of marine biota that are otherwise naturally dispersed over a wider area of the Flinders coast. The pier provides a formal and informal venue for public marine environmental education and appreciation of a range of ecosystem components. While it is unlikely that removal of the nearshore wooden structure of Flinders Pier would affect the natural biodiversity values of the Kennon Cove ecosystem, removal of the wooden piles as the gateway to the marine ecosystem at Flinders may affect the amenity of the natural history experience for snorkellers and divers.

The potential impact pathways of the possible pier removal works and associated risks to the marine ecosystem have been identified in this study. The potential effects of the proposed

works on marine ecosystem values are localised and temporary. Scheduling of the works for the autumn through winter period, when biological activity in Western Port is naturally low and natural disturbance to the ecosystem through waves and sediment movement is higher than works effects, will reduce the potential works effects on most marine ecosystem values.

The unavoidable effect of the works will be the removal of marine invertebrates, macroalgae and perhaps small cryptic fish such as gobies, blennies and pipefish inhabiting portions of the permanently submerged piles that will be removed. These species are represented on natural reefs in the area as well as the remaining wooden piles and the steel piles installed in 2013.

Risks from removal of the inner wooden length of Flinders Pier to State or Commonwealth protected and threatened species are negligible.

No seagrasses will be removed and any minor, temporary disturbance to seagrasses can be mitigated through good works procedures. Seagrass is likely to re-establish in the nearshore area of seabed presently shaded by the wooden deck that is proposed to be removed.
Fish and seadragons are mobile relative to the spatial scale and speed of the proposed works. They can avoid direct disturbance and potential effects are likely to be negligible.

Good works practices managed through an approved Construction Environmental Management Plan for the pier removal works will ensure all risks to the marine ecosystem are minimised. A Construction Environment Management Plant (CEMP) will be required for the works. A framework for the CEMP will accompany the MaCA consent and planning permit application. Details of the CEMP for the works will be prepared specific to the procedures and equipment proposed by the contractor.

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