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Spotted Handfish monitoring and recovery actions – 2011–2012

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Report for Caring for Our Country

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List of acronyms

ACRONYM	EXPANDED
CMAR	CSIRO Marine and Atmospheric Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEP	Derwent Estuary Program
GPS	Global Positioning System
IMAS	Institute of Marine and Antarctic Studies
RLS	Reef Life Survey
UTas	University of Tasmania

Acknowledgments

This project was conducted with a grant from the Commonwealth Government's Caring for Our Country initiative. Overall management was a collaborative effort between multiple agencies, many of these contributing their own organisation's resources towards planning meetings and effort spent preparing documents. The management team was comprised of:

Christine Coughanowr	DEP	Rick Stuart-Smith	IMAS and RLS
Luke Einoder	DEP	Neville Barrett	IMAS
Jason Whitehead	DEP	Antonia Cooper	IMAS and RLS
Mark Green	CMAR	Joe Valentine	Aquenal Pty Ltd

We would firstly like to thank Mark Stalker and Veolia Environmental Services for providing the dive support vessel and skipper for the community survey component of this project. Without the considerable skills of Mark and his well set up boat the project would have struggled to achieve what it set out to do.

We would like to thank all of the volunteer divers who donated not only their own time and diving equipment on weekends to complete the community surveys, but also their impressive diving skills. In alphabetic order they are:

Amelia Fowles	James Black	Paul Day	Tess Moriarty
Antonia Cooper	Jemina Stuart-Smith	Rick Stuart-Smith	Tim Crawford
Daniel Beard	Keith Martin-Smith	Rita Silver	
Emma Flukes	Lucy Quayle	Sylvia Buchanan	
Garrick Smith	Mark Green	Tania Mendo Aguilar	

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We would like to also extend thanks to Joe Valentine and the Aquenal Pty Ltd team for completing the contracted surveys further down the estuary and for planting and checking the Artificial Spawning Substrates.

Executive summary

The Spotted Handfish (*Brachionichthys hirsutus*) is a small, benthic fish whose current known distribution is limited to a number of discrete locations in the Derwent Estuary, south eastern Tasmania. It is listed as 'critically endangered' by the IUCN and is considered vulnerable to extinction due to habitat loss and modification and invasive species. This project was developed to generate momentum and community engagement for ongoing monitoring of key handfish populations in the Derwent Estuary, with the ultimate aim of establishing a mechanism for long-term sustainability of handfish monitoring efforts.

A combination of population surveys by community divers and contracted consultants targeted four locations in the Derwent Estuary; surveys were undertaken by community divers at Sandy Bay and Battery Point over 2011 and 2012 summers, while Aquenal Pty Ltd consultants surveyed Ralphs Bay and Opossum Bay during 2011. Population surveys were undertaken along 100 m transects (30 – 40 per site), with densities of Spotted Handfish, the invasive Northern Pacific seastar (*Asterias amurensis*) and stalked ascidians (*Sycozoa* spp.) recorded in 1.5 m wide blocks on either side of the transect line. Size (mm), depth (m) and precise location (as recorded by diver-towed GPS) were recorded for all handfish observed, and lateral images of each fish taken using digital photography.

Population surveys suggested stable densities of Spotted Handfish at Battery Point and Opossum Bay, but found fewer fish at Sandy Bay and Ralphs Bay than in previous years (as found by the CSIRO using the same methods). Very low numbers of juvenile Spotted Handfish were found over all the surveys and imply poor recruitment over the last two years. Densities of stalked ascidians were low across all sites, but no decrease was apparent from previous surveys by the CSIRO. Northern Pacific seastar densities were markedly lower at all sites compared with previous surveys, with more than a 20-fold decline recorded in community diver surveys at Battery Point from 2011 to 2012.

A second component of the project was to trial artificial spawning substrates as a means to enhance Spotted Handfish spawning success and recruitment in the wild over a larger scale than previously trialled. Approximately 1700 artificial spawning substrates were constructed and planted at Sandy Bay, Battery Point and Ralphs Bay by University and Aquenal divers. The rate of usage of these by handfish and observations on fouling and persistence were recorded by Aquenal divers in targeted surveys. Although only a small percentage of substrates planted were found to have Spotted Handfish egg masses attached (<1%), the majority of egg masses found during the spawning season at these sites were found on these artificial spawning substrates. Preliminary results were encouraging, but data on the densities of handfish recruits in surveys in the next two years, combined with further targeted research on this method are required to provide a better assessment of the success of artificial substrate planting.

1 Introduction

The Spotted Handfish (*Brachionichthys hirsutus*) is a small benthic fish endemic to eastern Tasmania (Last and Gledhill, 2009; Bruce *et al.*, 1997). It is currently listed as 'critically endangered' on the IUCN redlist (http://www.iucnredlist.org/apps/redlist/details/2958/0), and is considered vulnerable to extinction due to its highly restricted and patchy distribution, low population density, limited dispersal capabilities and a reproductive strategy of producing low numbers of demersal eggs that are highly susceptible to disturbance. The known current population of Spotted Handfish is comprised of nine local 'populations' in the Derwent Estuary (Green, 2007; Green, 2005). Throughout this report, the term 'populations' is loosely used to describe these nine relatively discrete areas in the Derwent Estuary where Spotted Handfish are known to live; the degree of mixing between them is currently unknown.

Although a few isolated populations were observed in Frederick Henry Bay (north of the Derwent Estuary) in the 1980's and 1990's, no Spotted Handfish have been observed outside the Derwent Estuary in over a decade. A single local population in Frederick Henry Bay of an estimated several hundred Spotted Handfish was quantitatively surveyed twice in 1999, but a third survey over the same area in 2005 found no handfish, suggesting local extinction had possibly occurred (Green, 2005). There have been no reported observations of Spotted Handfish at this site since 2005. Other locations in Frederick Henry Bay around Sloping Island, off Carlton Bluff and off Sloping Main in 4–15 metres were searched in 2008 but no handfish were located (Green, 2008).

A recovery program for the species was initiated in 1996, with an initial survey of a number of locations in its known range (Barrett *et al*., 1996). Only six individual handfish were located during this survey, but the locations where they were found were targeted later to try and locate breeding colonies and collect adults to develop captive breeding protocols (Bruce *et al*., 1997). The first Recovery Plan was written for the years 1999-2001 (Bruce and Green, 1998) and the recovery program has progressed intermittently since then.

Little is known about the biology and ecology of the Spotted Handfish. It appears to occur primarily on unconsolidated substrate ranging from well sorted, coarse sand and shell grit to areas of fine sand and silt in depths between 2–30 m, but is most often found on fine silt in 5–10 m. It spawns during September and October, with females laying eggs on small, vertical, semi-rigid structures. Stalked ascidians, *Sycozoa* spp., provide the primary spawning substrate within the Derwent Estuary, although spawning around seagrasses, sponges, small seaweeds in the genus *Caulerpa* and polychaete worm tubes has been recorded for Spotted Handfish and other handfish species.

It is not known what has driven the apparent large scale reduction in the historic range of Spotted Handfish from disjunct populations off eastern Tasmania to the current populations confined to south eastern Tasmania; Last and Gledhill (2009) suggest aggressive commercial scallop dredging from the 1960's to the 1980's was a key threat. In the Derwent Estuary, introduced marine species and urban, rural and industrial development of the estuary shores are believed to be the primary contemporary threats, through mechanisms such as potential reduction in available spawning substrate, egg loss due to siltation or overgrowth by epiphytic algae, and a general decline in habitat quality. Observations of Northern Pacific seastars (*Asterias amurensis*) consuming stalked ascidians and a measured reduction in stalked ascidian density concurrent with an increase in Northern Pacific seastar density has led to the hypothesis that predation of stalked ascidians may have resulted in reduced spawning success of Spotted Handfish, but direct evidence of this link is lacking.

Laboratory trials showed that Spotted Handfish would use plastic rods as spawning substrate (Green and Bruce 2000), and that such artificial substrates may be used to augment depleted or low quality substrate in the wild. Artificial spawning substrates were initially trialled at two field sites in the Derwent estuary; the rods buried in the sand to form vertical structures on the seafloor (Green and Bruce, 2001). Numerous handfish egg masses were counted on artificial substrates during these trials, and a subsequent measured increase in juvenile density following the trials (Green and Bruce, 2001) suggested that this method

represented a viable management strategy to increase spawning success of wild populations, and thus warranted further application.

Monitoring the population is an essential part of any threatened species Recovery Plan and is the first Action listed in the Australian Government's *National Recovery Plan for four species of handfish* (DSEWPaC, 2005). Population surveys are required to identify further declines or recovery, assess the effectiveness of management actions and to guide research. Ongoing monitoring of known handfish populations and installation of artificial spawning substrates are currently believed to be the most appropriate actions for the Spotted Handfish.

Spotted Handfish typically occur at low densities and are patchily distributed. In addition, they are small (mature adults typically range from 70–110 mm) and relatively cryptic, meaning that survey protocols must be rigorous and consistent to enable robust estimates of population densities and dynamics. Standardised survey procedures have been developed for monitoring spotted handfish populations within the Derwent estuary (Cooper *et al*., 2012). These methods involve Underwater Visual Census (UVC) along transects lines, with the use of diver-towed GPS. The use of diver-towed GPS in population surveys has a number of advantages, including being able to record precise locations for individuals, clearly delineate the area surveyed and determine patterns of movement if individuals can be distinguished from one another. Such methods have been used in population surveys of other rare species (e.g. the weedy seadragon. See Sanchez-Camara *et al*., 2011), and theoretically show great promise for use in Spotted Handfish population surveys.

Primary objectives of this project were to (i) provide new information on Spotted Handfish population densities and dynamics through population surveys, including initiating the use of towed GPS for this species, and (ii) install arrays of artificial spawning substrates at locations of key populations.

The support of local communities and other stakeholders is essential to maximise the success of any conservation actions, and it was recognised during the development of this project that involvement of the local community would provide ongoing benefits in terms of project sustainability and the generation of community awareness of threats facing this species. The Reef Life Survey program (www.reeflifesurvey.com) has recently demonstrated the enormous success of the model of providing free training and ongoing support to experienced and committed recreational divers who then volunteer their time and expertise to dive surveys. This project aimed to follow a similar model, to integrate the collection of required data for handfish population surveys with the need to engage and gain support of the local community.

Three of the Derwent Estuary populations were considered potentially suitable for community surveys as they are close to population centres, have relatively easy access and have locations on the shore where divers can store equipment and take breaks between dives. Of these, Sandy Bay and Battery Point were selected for two primary reasons:

1. They are both close together, thus increasing the potential for detection of any mixing between populations, increasing our knowledge of handfish spatial requirements.
2. They are on the western shore which is generally more protected from the prevailing westerly wind and sea breezes that are common during summer.

In addition to the two populations monitored through community surveys, two additional populations were monitored in the project by environmental consultants from Aquenal Pty Ltd: Droughty Point and Opossum Bay. These populations were considered less suitable for community monitoring for two main reasons:

1. They are more difficult to access and more exposed to prevailing weather conditions,
2. The locations of these populations are less well known amongst the public and it was desirable to not advertise their locations amongst the public in order to keep physical disturbance by divers to a minimum.

Section 2.1.1 provides more details on the locations of the four populations studied in the project.

2 Methods

2.1 Site information

The Sandy Bay study area is along one of Hobart's main recreational beaches (Nutgrove beach) and is characterised by urban development to the water's edge. The development is mainly residential but there is also a small sailing club and a restaurant at the southern end. There are a few vessel moorings and a swimming platform in the study area. Several storm water outlets also terminate at the beach head. A sewerage outfall lies to the south of the main study area and in 2011 a small area closer to this feature was examined. Access to the study area was via the beach (Figure 2.1). The study area ranged from 3–13 m in the southern area (marked LSB in Figure 2.1), and from 4–11 m along the Nutgrove Beach area.

The Battery Point study area is very close to Hobart's CBD and is also characterised by urban development to the water's edge. At the southern end there is a rowing club on reclaimed land and many vessel moorings are scattered through the survey area. A commercial slipway lays approximately half way and the CSIRO Marine Laboratories are situated at the northern end of the study area. There are several point sources of storm water and the Hobart Rivulet terminates close to the study area. Access to the study area was via small public jetties on the foreshore (Figure 2.1). Depth of the study area ranged from 3–12 m.

The Ralphs Bay study area is located on the eastern side of Droughty Point, extending along approximately 1 km of coastline, in the 2–10 m depth range. The survey area lies approximately parallel to the coast and the shoreline in the area consists predominately of small rocky outcrops, interspersed by gravel beaches. A narrow strip of she-oak (*Allocasuarina verticillata*) dominated vegetation occurs on the coastal fringe, with grazed farmland dominating the adjacent land. At the northern end of the study area, the seafloor is gently sloping, with a steeper profile towards the southern end.

The Opossum Bay study area is located directly offshore from the northern end of Opossum Bay beach, in the 5–12 m depth range. The survey area lies parallel to the beach, along approximately 400 m of coastline. The adjacent coastal strip consists predominately of grazed farmland, with the coastal township of Opossum Bay occurring near the southern extremity of the study area. The seafloor profile is consistent across the study area, sloping gently from 5 to 12 m.

The location of the Ralphs Bay and Opossum Bay study areas is shown in Figure 2.3.

2.2 Population survey protocols

The most reliable and efficient method for surveying Spotted Handfish is to use fixed length transects with a search zone 1.5 metres either side of the line in depths of greater than 6 metres of water (Green and Bruce, 1998). This project used fixed length transects of 100 metres with two transects set end to end for efficiency. Divers could then survey both transects without having to locate the beginning of the second one underwater. It is important that transect lines settle gently onto the seafloor and do not scare the handfish out of the zone checked by divers. It is also important that the transect lines have as little impact on the habitat as possible. Transect lines were constructed from strong, light weight braided nylon builders line which is also highly visible underwater (see Cooper *et al*., 2012). Surveys at each location were conducted over consecutive days, where practical, to reduce the chance of finding the same fish on different transects due to fish movement. Transects were successively set and retrieved over the survey area during the survey period as the divers completed checking each search zone. Divers counted numbers of Spotted Handfish, the stalked ascidian (*Sycozoa* spp.) and the Northern Pacific seastar (*Asterias amurensis*) using a 1.5 metre long guide to define the search zone. Handfish observed outside of the search zone were processed but not included in the density analysis. Processing a handfish involved measuring to

the nearest mm, recording digital images of both sides of the fish and the recording the water depth measured by the diver's instruments. A floating GPS unit (see Cooper *et al*., 2012), logging the divers track, was towed by divers and this was positioned over the divers when digital images were being recorded. General observations were made of the associated habitat at each site.

For surveys conducted by Aquenal Pty Ltd in the handfish breeding season (spring 2011), divers also searched for Spotted Handfish egg masses. When an egg mass was located, a digital image was taken and the spawning substrate (e.g. stalked ascidian, artificial spawning substrate) and number of eggs was estimated. The presence or absence of nearby Spotted Handfish was also noted.

Data from the underwater datasheets, GPS data and image data were collated at the end of each survey. The time stamp from the digital image was used to geo-locate the handfish location with the GPS data. In 2011, this was done by all divers entering their data after each days diving, which along with filling the SCUBA tanks made for very long days. In 2012, this was streamlined by employing a dedicated surface attendant to assist the vessel skipper set transects, arrange fills for SCUBA tanks and to manage the data collation; which enabled the entire team to finish several hours earlier.

(a) Sandy Bay – beach head divers base

(b) Sandy Bay – The Veolia support vessel loads divers

(c) Battery Point – jetty 1

(d) Battery Point – jetty 2, Veolia vessel in background

Figure 2.1 Diver bases on the shore at Sandy Bay and Battery Point

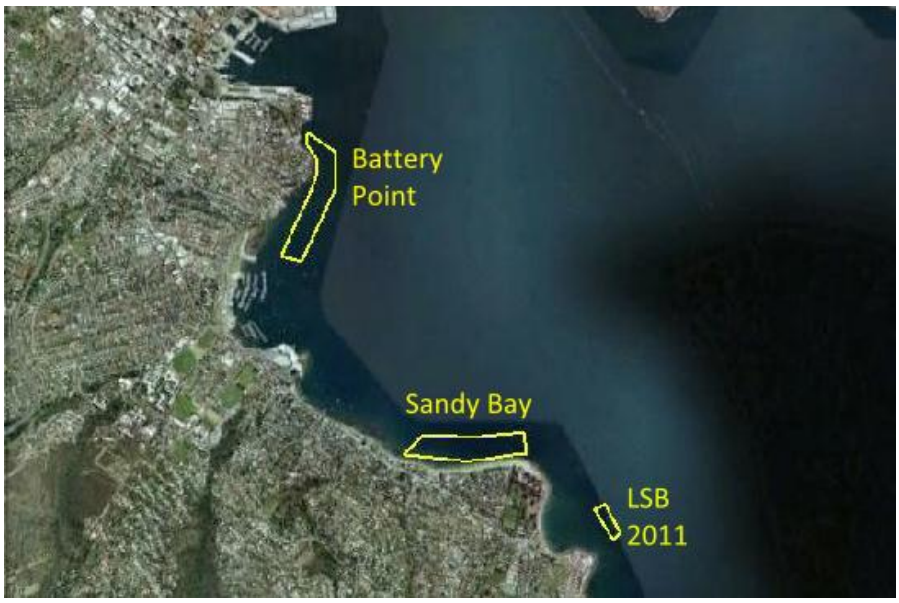


Figure 2.2 Location of community sampling study sites in the Derwent Estuary. The area marked LSB was included in the Sandy Bay 2011 survey but not the 2012 survey.

Figure 2.3 Locations of Aquenal sampling study sites at Opossum Bay (top) and Ralph's Bay (bottom).

2.3 Artificial spawning substrates

Approximately 1700 artificial spawning substrates were constructed from PVC, as described in the *Spotted Handfish Community Manual*, following the design and materials tested previously by Green and Bruce (2000). At the Sandy Bay and Battery Point sites, 900 individual substrates were planted in the sediment, deployed in arrays of 100 along 50 m transects, in the 6–9 m depth range. At Ralphs Bay, 800 artificial spawning substrates were planted by Aquenal staff, with deployments at this site made in arrays of 200 along 100 m transects. Transects at Ralphs Bay were positioned along the 7 m depth contour. Substrates were planted immediately prior to the Spotted Handfish breeding season, in August and early September 2011 for Sandy Bay and Battery Point, and in August 2011 at Ralphs Bay.

An indication of artificial spawning substrate usage at Ralphs Bay was gleaned from the population surveys, since the randomly positioned survey transects typically intersected the artificial spawning substrate transects. However, since only a fraction of all of the artificial spawning substrates present were checked during the population surveys, additional dedicated surveys were conducted to quantify usage of artificial spawning substrates deployed in 2011. To achieve this, the transects used to deploy artificial spawning substrates in 2011 were carefully followed and the presence of artificial spawning substrates and egg masses noted. During this process, divers also counted the number of dislodged artificial spawning substrates, to ascertain levels of substrate loss.

Aquenal staff also checked a subset of artificial spawning substrates at Sandy Bay and Battery Point, by targeting the artificial spawning substrates in the manner described above.

2.4 Data analysis

The mean density and associated standard error was calculated for handfish, stalked ascidians and seastars recorded on population survey transects. This was compared to previous survey data and a two tailed Chi-square test with one degree of freedom ($\chi^2_{0.05,1} = 3.34$) performed to check for significant differences between density estimates. Data from CSIRO surveys in 2006, which used directly compatible methods, were also included in analyses and graphs for comparison.

3 Results

3.1 Population surveys

Led by MG and RSS, a team of community divers successfully undertook population surveys over two weekends in each year, with 17 volunteer divers in total providing time and expertise to the project. The dates and search effort associated with these surveys are presented in Table 3.1, and those of contracted surveys by Aquenal in Table 3.2.

Table 3.1 Summary of search effort for community diver surveys

Study population	Survey Dates	Divers each day	Transects searched	Area searched (Ha)	Total survey area (Ha)
Sandy Bay	8 January 2011 9 January 2011	5 6	34	1.02	21
	14 April 2012 15 April 2012	8 7	40	1.20	20
Battery Point	12 March 2011 13 March 2011	9 9	40	1.20	14
	19 May 2012 20 May 2012	4 6	34	1.02	14

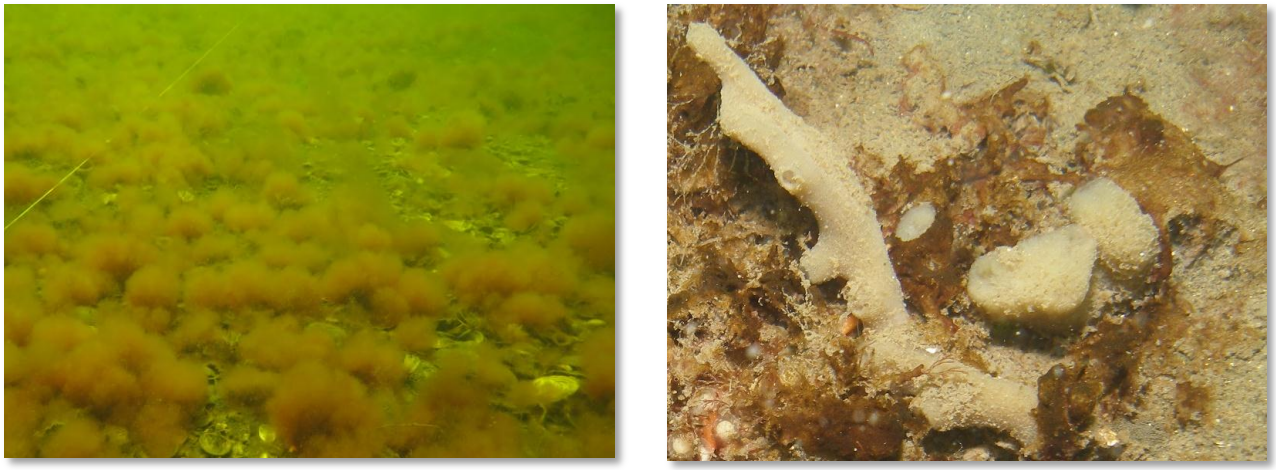
Table 3.2 Summary of search effort for Aquenal surveys

Study population	Survey Dates	Transects searched	Area searched (Ha)	Total survey area (Ha)
Ralph's Bay	3 October 2011 5 October 2011 6 October 2011	30	0.9	16
Opossum Bay	13 October 2011 18 October 2011 19 October 2011	30	0.9	9

3.1.1 SANDY BAY

The substrate at the Sandy Bay study area was largely soft sediments, changing starkly from coarse sand close to the beach to finer silt at the bottom of a steep slope (approximately 5 metres depth) about 30 metres from the shore. Patches of low profile reef occurred close to the shore at the northern end. Extensive patches of red filamentous algae (**Error! Reference source not found.**a) were present in the shallower waters in 2011, but were absent during the 2012 survey. A settlement of commercial scallop (*Pecten fumatus*) spat was also noted in 2011, often attached to the filamentous algae. A few small scallops

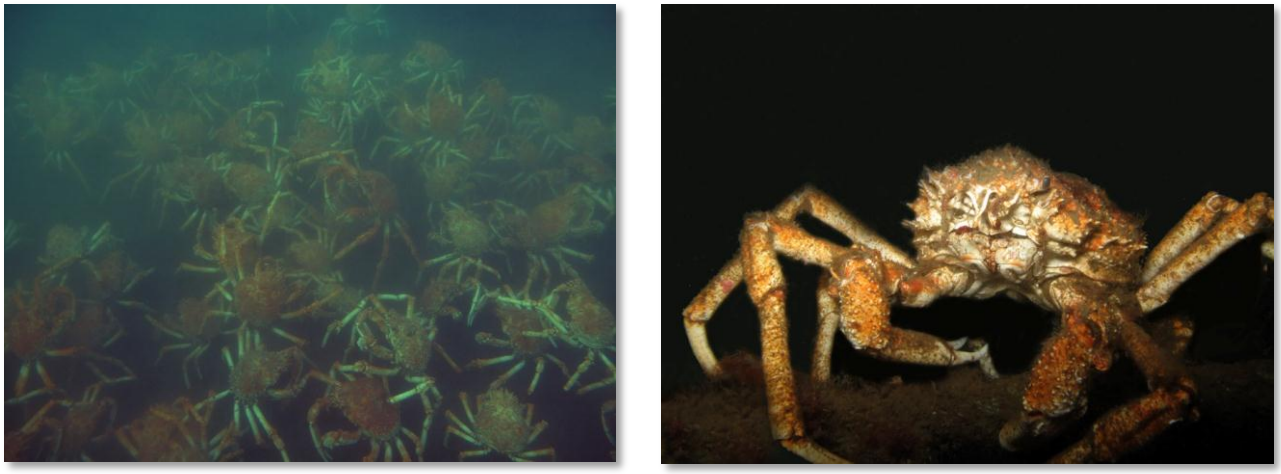
were also noted on transects during the 2012 survey. In 2012 there were also numerous small brown sponges (**Error! Reference source not found.**b) which were not observed during 2011. Dense aggregations of the spider crab, *Leptomithrax gaimardii* (**Error! Reference source not found.**) were observed in localised parts of the survey area 2012, and it was later reported that huge aggregations of these crabs had been observed in the study area during the summer prior to the survey. Fishes observed along transects included sand flathead (*Platycephalus bassensis*), stingarees (*Urolophus paucimaculatus*), blennies (*Parablennius tasmanianus*), stinkfish (*Eocallionymus papilio*), seahorses (*Hippocampus abdominalis*) and seamoths (*Pegasus lancifer*), as well as numerous introduced triplefins (*Forsterygion varium* and *Grahamina gymnota*).



(a) Red filamentous algae in 2011

(b) Small brown sponges in 2012

Figure 3.1 Associated benthic habitat biota at Sandy Bay.



(a) Spider crab aggregation

(b) Spider crab – adult male

Figure 3.2 Spider crab, Leptomithrax gaimardii, at Sandy Bay in 2012.

The densities of the stalked ascidians and introduced Northern Pacific seastars were relatively low compared to previous surveys by CSIRO in 2006 (**Error! Reference source not found.**). Stalked ascidian density was stable between all survey periods ($\chi^2 < 3.84$), however, the density of Northern Pacific seastars

underwent a highly significant reduction in density (χ^2 = 2924) throughout the study area between 2006 and 2011. The difference in seastar abundance between 2011 and 2012 was also significant (χ^2 = 864).

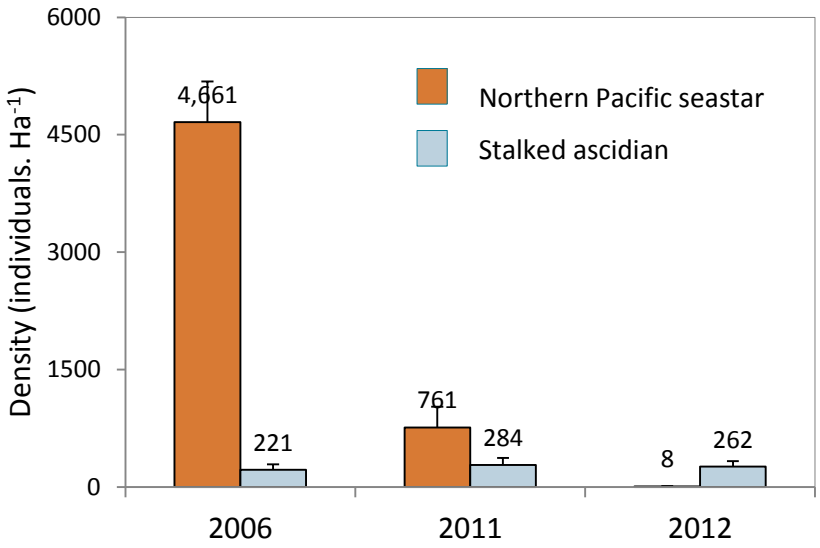


Figure 3.3 Mean density (± SE) of stalked ascidians (Sycozoa spp.) and Northern Pacific seastars (Asterias amurensis) at Sandy Bay in 2011 and 2012. The 2006 data are from CSIRO surveys.

The densities of Spotted Handfish surveyed at Sandy Bay are presented in **Error! Reference source not found.**. Handfish densities varied between years, with the highest densities observed for both juvenile and mature fish in the 2011 surveys. Adult density was significantly lower in 2012 than in 2006 (χ^2 = 7.3) and 2011 (χ^2 = 17.8). Few juveniles were observed in the 2012 surveys.

Photo records suggested that no individual handfish were observed more than once between the 2006, 2011 and 2012 surveys.

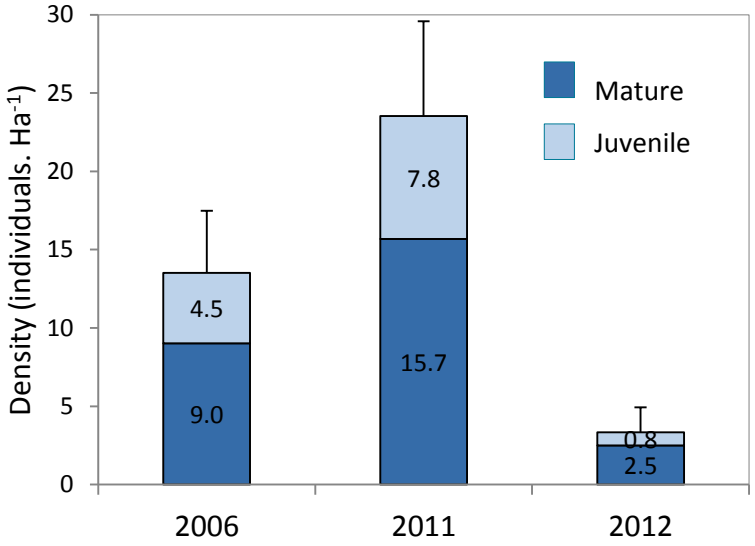


Figure 3.4 Mean density (± SE) of Spotted Handfish at Sandy Bay in 2011 and 2012. The 2006 data are from CSIRO surveys.

3.1.2 BATTERY POINT

The Battery Point study area was mainly comprised of very soft sediments, but small patches of rubble bottom occurred at the northern end in the shallows. A reasonable amount of anthropogenic debris was observed on the bottom, including pieces of train track, engine blocks and empty drums. Mooring blocks and chains were also common, with some large areas of silt swept clean by the movement of the chain over the bottom. The associated benthic biota was similar to that found at Sandy Bay. A very small aggregation of juvenile spider crabs was observed at the northern end of the study area in 2011, but no aggregations of this species were observed in 2012.

Similar to observations at the Sandy Bay site, the densities of the and Northern Pacific seastars in the Battery Point study area were lowest in 2012 and highest in the 2006 CSIRO surveys (**Error! Reference source not found.**). The differences in seastar densities between 2006 and 2011, and 2011 and 2012 were both significant (χ^2 = 246 and 3711, respectively). Very few stalked ascidians were observed on any survey in the Battery Point study area in any year, so the density was effectively zero per hectare.

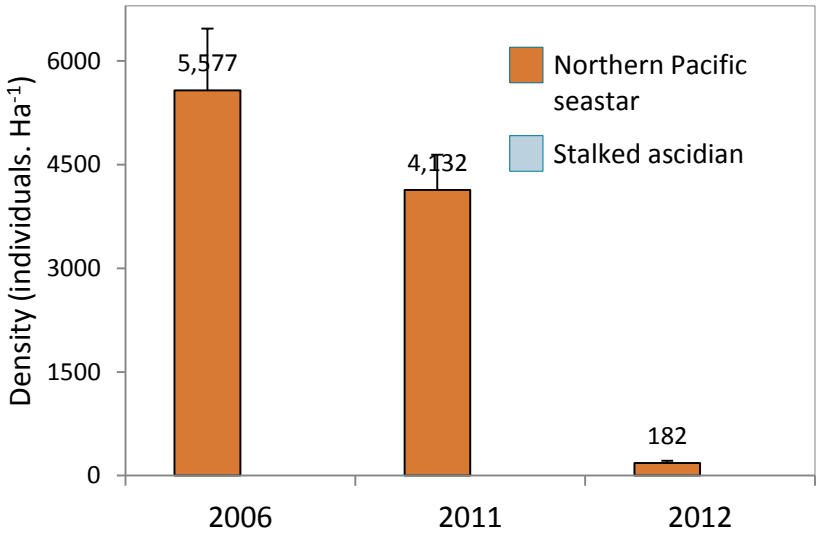


Figure 3.5 Mean density (± SE) of Northern Pacific seastar (Asterias amurensis) at Battery Point in 2011 and 2012. The 2006 data are from CSIRO surveys. Note: no stalked ascidians were found at this site.

In contrast to Sandy Bay, the density of mature Spotted Handfish at Battery Point was highest in 2012 (**Error! Reference source not found.**). Mature fish density in 2012 was significantly greater than in 2006 (χ^2 = 4.83). Few juveniles were observed at this site in any year.

As for Sandy Bay, photo records suggested no individual handfish were observed more than once between all surveys.

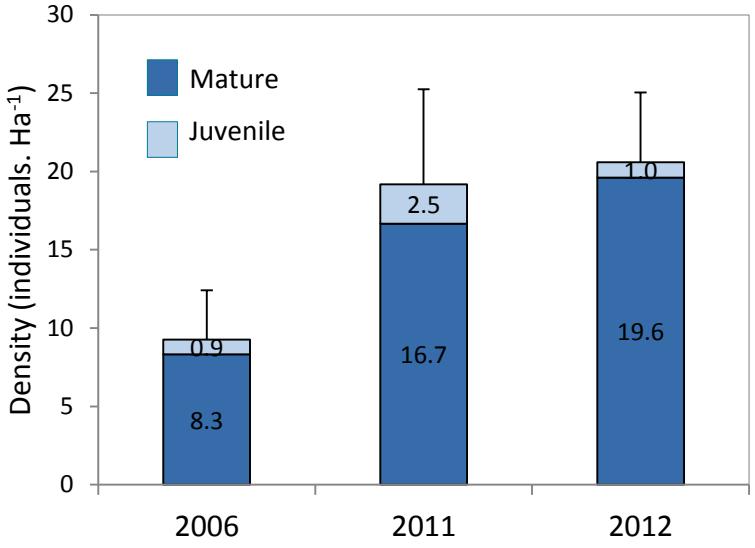


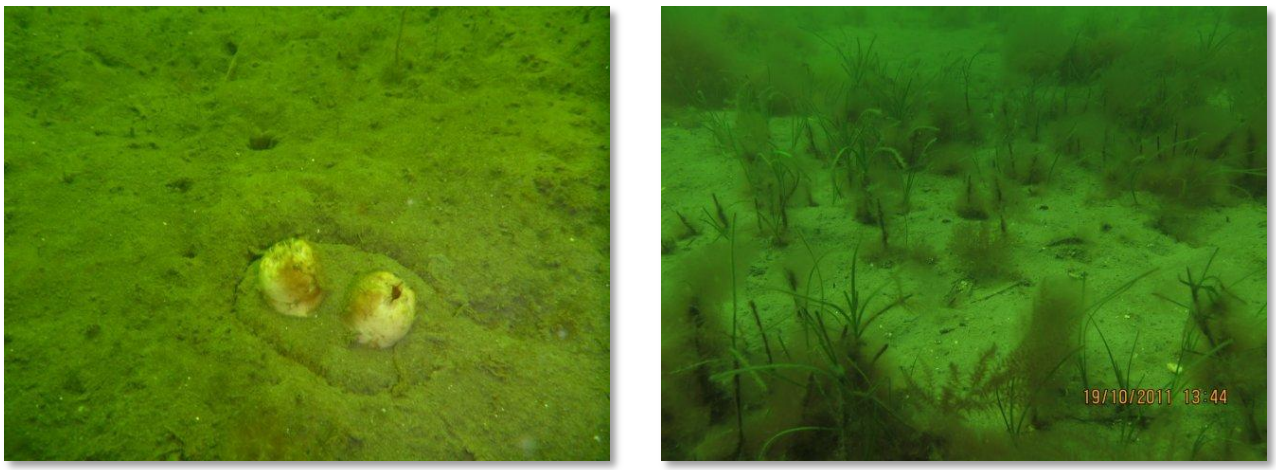
Figure 3.6 Mean density (± SE) of Spotted Handfish at Battery Point in 2011 and 2012. The 2006 data are from CSIRO surveys.

3.1.3 OPOSSUM BAY

Featureless soft sediment was the dominant habitat across the survey area, with finer sediments in deeper water, grading to coarser sand in shallower sections. Solitary ascidians (*Ascidia sydneiensis*) were common on the soft sediment (Figure 3.7a), while small (< 4 cm) stalked ascidians (*Sycozoa* spp.) were observed at very low densities. The occasional seagrass strand was observed in deeper sections of the study area (7–12 m), with a band of seagrass (*Heterozostera tasmanica*) adjacent to the shallow edge of the survey area, in 4–5 m depth (Figure 3.7b). The shallower margin of seagrass was also searched qualitatively (i.e. outside of the survey area, not on transects), but no handfish were observed in this zone. Spider (*Leptomithrax gaimardii*) and pie crust crabs (*Metacarcinus novaezelandiae*) were also observed, but at much lower densities compared to Ralphs Bay.

Fishes observed on the survey transects included gobies (*Nesogobius* sp.), a stargazer (*Kathetostoma leave*), skates (e.g. *Spiniraja whitleyi*) and stingarees (*Urolophus cruciatus*). A number of draughtboard shark (*Cephaloscyllium laticeps*) eggs cases were also observed attached to star pickets within the study area.

No Northern Pacific seastars were observed at the study site during the spring 2011 surveys, and few stalked ascidians were present. Historical data on Northern Pacific seastars and stalked ascidians collected by the CSIRO at Opossum Bay (Figure 3.8) show that densities of Northern Pacific seastars have typically been lower than at the other sites, and also appear to have undergone a decline since the late 1990s.



(a) Solitary ascidians (*Ascidia sydneiensis*) in 2011

(b) Seagrass adjacent to inner edge of survey area

Figure 3.7 Associated benthic habitat biota at Opossum Bay.

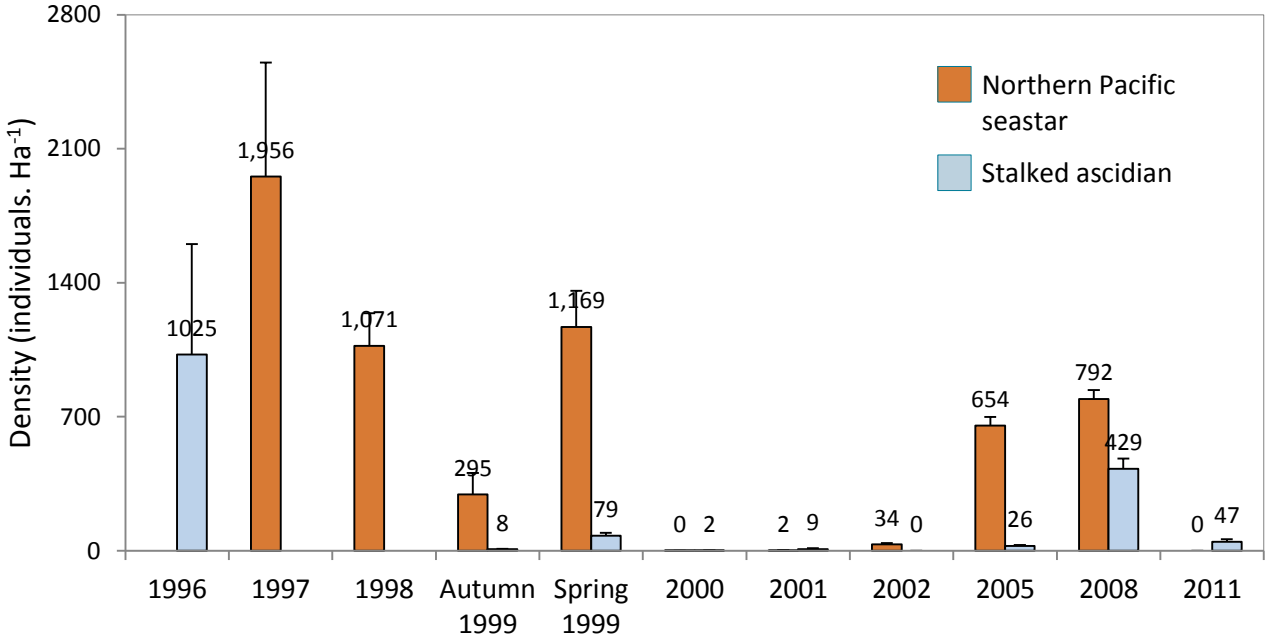


Figure 3.8 Mean density (± SE) of Northern Pacific seastar (Asterias amurensis) at Opossum Bay from 1996 to 2011. The 2011 data were collected by Aquenal Pty Ltd. All previous data are from CSIRO surveys.

The Spotted Handfish density at the Opossum Bay site in 2011 was comparable to those recorded in CSIRO surveys going back to 1998 (Figure 3.9). Inter-annual variation in the size/age structure of the Opossum Bay is clearly evident, however, and despite the 2011 surveys recording comparable total density, this was made up largely of adults, suggesting poor recruitment at this site in recent years. Handfish were distributed across the survey area, with no strong depth-related pattern of abundance. Some fish were found immediately adjacent to the solitary ascidians (see Figure 3.10). Four Spotted Handfish egg masses were observed during the surveys. Two egg masses were attached to red algae, one was attached to a piece of drift seagrass and one was attached to stick debris. Two of the egg masses did not have an adult Spotted Handfish in attendance.

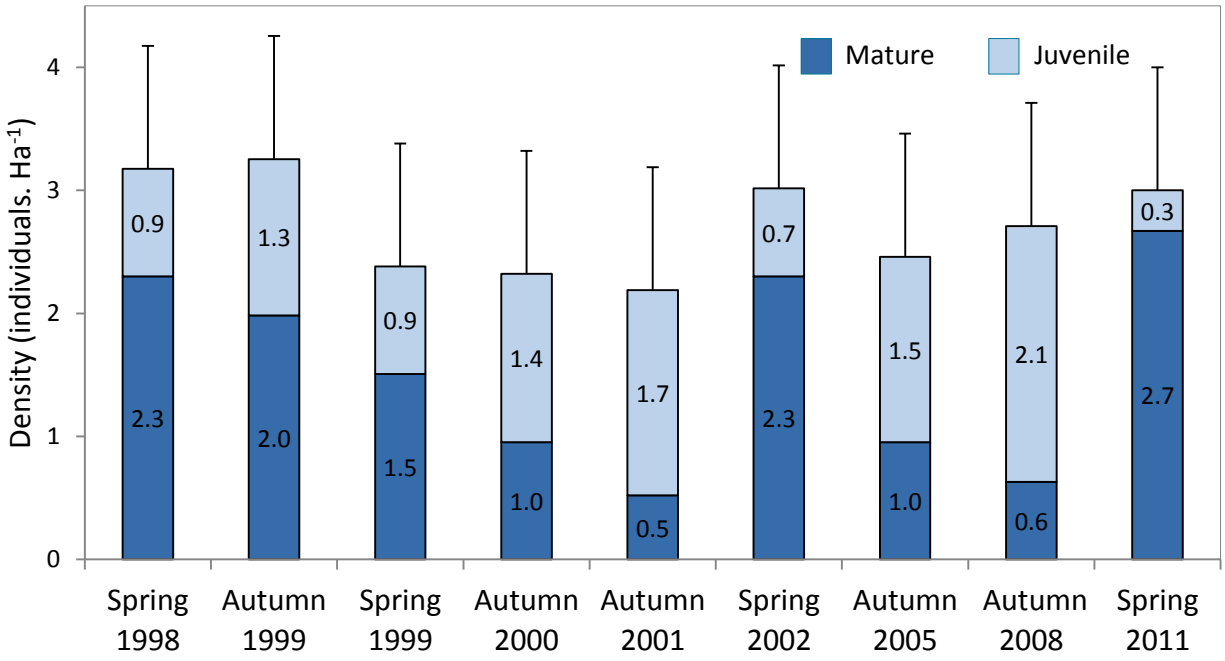


Figure 3.9 Mean density (± SE) of Spotted Handfish at Opossum Bay from 1998 to 2011. Based on data from CSIRO and Aquenal.

(a) Spotted Handfish adjacent to *Ascidia sydneiensis*

Figure 3.10 Spotted Handfish at Opossum Bay in 2011.

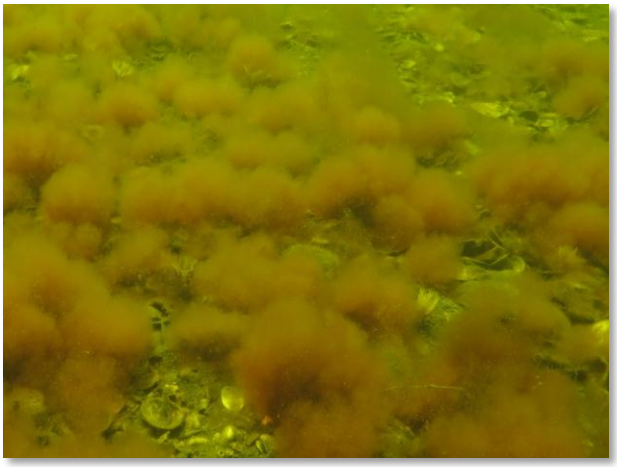
3.1.4 RALPHS BAY

There was considerable variation in habitat type at Ralphs Bay, attributable to differences in depth across the survey area. Soft sediments dominated in deeper parts of the survey area (5–10 m), with sparse dead shells and drift algae present (Figure 3.11a). The drift algae was mainly filamentous red algae, but *Ulva* sp. and *Codium* sp. were also observed amongst the drift. The abundance of red algal drift was considerably higher in the shallower sections of the survey area (< 5 m, see image (Figure 3.11b)). The survey area also tended to be dominated by broken shells in depths less than 4 m.

Sparse solitary ascidians were present (*Ascidia sydneiensis*) across the survey area, but no stalked ascidians were observed. The fanworm *Myxicola infundibulum* was commonly observed on soft sediments.

The diversity and abundance of crabs was high at Ralphs Bay. Spider crabs (*Leptomithrax gaimardii*) were the most common species, but pie crust (*Metacarcinus novaezelandiae*), pebble (*Ebalia intermedia*) and shore crabs (*Pargrapsus gaimardii*) were also recorded. Fishes observed on survey transects included gobies (*Nesogobius* sp.), skates (e.g. *Spiniraja whitleyi*), stingarees (*Urolophus cruciatus*) and flathead (*Platycephalus bassensis*).

(a) Typical soft sediment habitat in deeper (5-10 m) parts of the Ralphs Bay study site, spring 2011



(b) Red algal drift commonly observed at Ralphs Bay in depths < 5 m, spring 2011

Figure 3.11 Associated benthic habitat biota at Ralphs Bay.

Northern Pacific seastars were observed in low densities and were two orders of magnitude lower in 2011 compared to those recorded by CSIRO in 2008 surveys at this site (Figure 3.12). Interestingly, Spider crabs were occasionally observed feeding on Northern Pacific seastars during the survey (Figure 3.13).

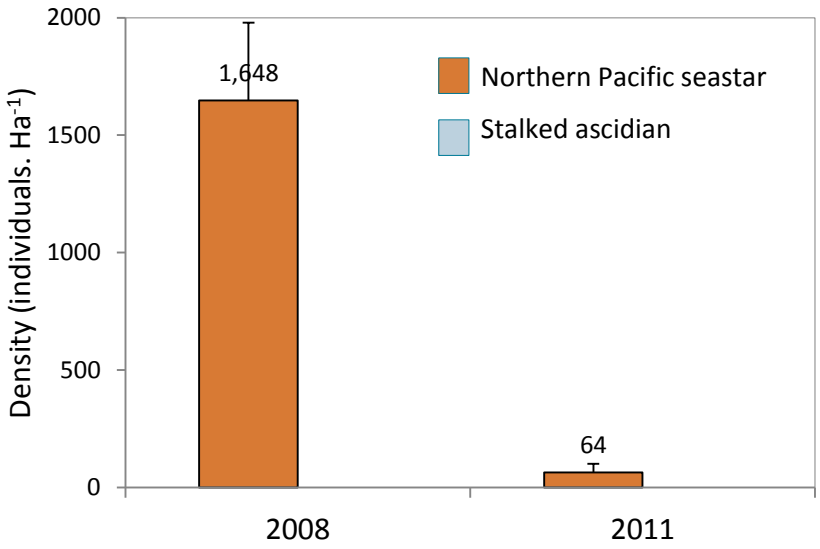


Figure 3.12 Mean density (± SE) of Northern Pacific seastars (Asterias amurensis) at Ralphs Bay in 1998 and 2011. The 2008 data are from CSIRO surveys. Note: no stalked ascidians were found at this site.

(a) Spider crab feeding on Northern Pacific seastar at Ralphs Bay, spring 2011

Figure 3.13 Spider crab feeding on Northern Pacific seastar at Ralphs Bay, spring 2011.

Spotted Handfish densities at Ralphs Bay appear to be gradually declining in comparison with previous CSIRO surveys (Figure 3.14). In 2011, Spotted Handfish were observed across the depth range of the survey area, but they appeared to be in greater numbers around the 5-7 m depth range. This coincides with the depth range where the artificial spawning substrates were deployed. Any potential 'attraction' of handfish by artificial spawning substrates remains speculative, since they were intentionally planted in what was considered the preferred depth range and where most handfish were previously observed at this location (based on previous CSIRO surveys).

Another feature of the 2011 surveys was that no juvenile handfish were observed at Ralphs Bay. Another feature of the 2011 surveys was that no juvenile handfish were observed at Ralphs Bay. This result, while not unexpected (given that previous CSIRO surveys have also recorded extremely low juvenile abundance at this site (Figure 3.14)), was disappointing as artificial spawning substrates were planted at this location in 2008 in an attempt to bolster recruitment (Alenius, 2008).

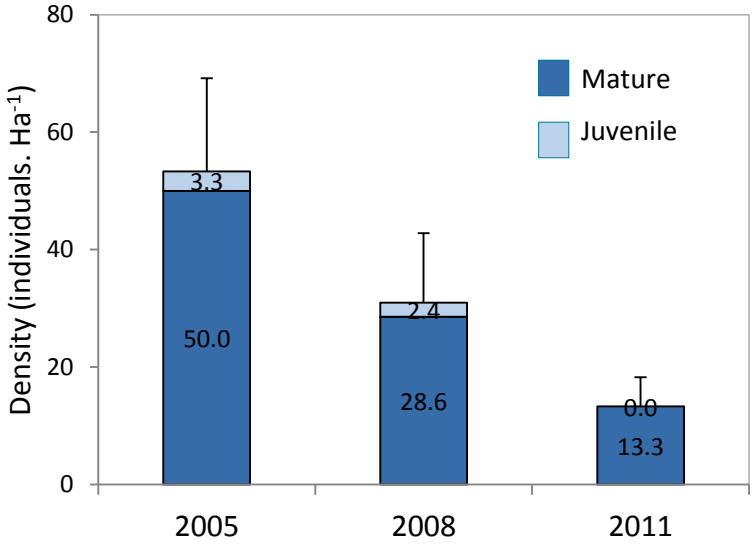


Figure 3.14 Mean density (± SE) of Spotted Handfish at Ralphs Bay from 2005 to 2011. The 2005 and 2008 data are from CSIRO surveys.

A total of six handfish egg masses were recorded during the population survey at Ralphs Bay. Five of these egg masses were attached to artificial spawning substrates, while the sixth egg mass was found in a hollow in the sediment. At least one of the handfish egg masses was observed on an artificial spawning substrate deployed in an earlier CSIRO/UTas study (Alenius, 2008).

3.2 Artificial Spawning Substrate

3.2.1 UTILISATION OF ARTIFICAL SPAWINING SUBSTRATES FOR SPAWNING

While the population surveys provided an indication of artificial spawning substrate usage, dedicated surveys of artificial spawning substrates deployed in 2011 provided more quantitative data to describe artificial substrate usage. All of the substrates planted in 2011 at Ralphs Bay (800) were checked by Aquenal during the spring 2011 breeding season, while a considerable number (549) of those planted at Sandy Bay/Battery Point were also checked. A summary of the results are provided in Table 3.3.

Table 3.3 Summary of artificial spawning substrate utilisation by Spotted Handfish during spring 2011

Site	Transect #	Number substrates checked	Number substrates dislodged	Substrates with eggs	Substrate with fish (no eggs)	% substrates with eggs
Ralphs Bay	1	200	2	1	3	0.88
	2	200	3	4	2	
	3	200	4	1	2	
	4	200	6	1	8	
Battery Point	1	170	2	1	3	0.42
	2	70	0	0	0	
Sandy bay	1	117	0	0	0	0.32
	2	60	0	0	0	
	3	132	0	1	1	

Overall, utilisation of artificial spawning substrates planted in 2011 was low, with egg masses found on 7 of the 800 substrates at Ralphs Bay (0.88%) and 2 of the 549 at Sandy Bay/Battery Point (0.36%). Figure 3.15 shows images of Spotted Handfish utilising artificial spawning substrate. While overall utilisation of artificial spawning substrates appears low, as noted in section 3.1.4, the proportion of egg masses observed on artificial spawning substrates was high relative to natural substrates. The reason for planting so many artificial substrates was to maximise the chance that handfish could find them when required, but this does result in an apparent low utilisation value. A small number of artificial spawning substrates were also observed during the population surveys at Opossum Bay, although none were seen with eggs. A number of Spotted Handfish were observed directly adjacent to artificial spawning substrates without eggs, which suggests some handfish had not completed spawning at the time of the substrate check.

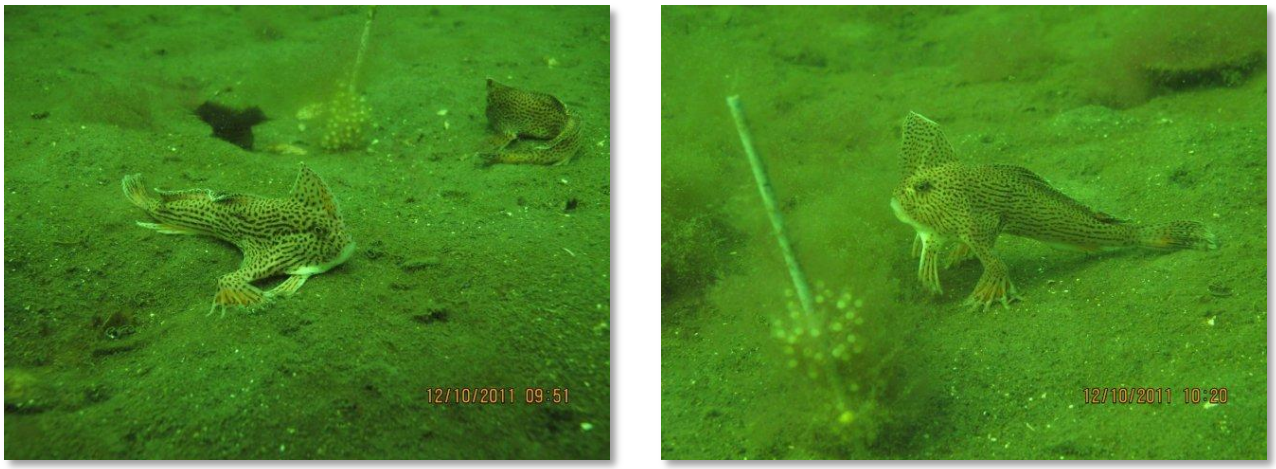


Figure 3.15 Spotted Handfish attending egg masses on artificial spawning substrates at Ralphs Bay, spring 2011

3.2.2 GENERAL ARTIFICAL SPAWNING SUBSTRATE OBSERVATIONS

A relatively small proportion of artificial spawning substrates had been dislodged; indicating that the substrate plant-out process itself was successful at all sites (Table 3.3). The occasional artificial spawning substrate was found lying on the substrate, but the majority from 2011 and many from the previous CSIRO/UTas study in 2008 were still in the upright position at Ralphs Bay.

The substrates were typically fouled by filamentous algae, with hydroids on some of the substrates at Sandy Bay. The substrates also tend to trap drift algae, which was particularly common at Ralphs Bay. Examples of typical fouling levels are provided in Figure 3.16. Fouling levels did not appear to be a major deterrent to handfish, since eggs were observed on some substrates with high levels of fouling.

Numerous substrates known to be from the 2008 deployment were still in place and tended to have higher fouling loads than those deployed in 2011, especially those in shallower depths (i.e. approx. 5 m). Although some of the substrates deployed in the previous CSIRO/UTas study incorporated different materials and were easy to identify, distinguishing the remainder from those deployed in this study was not always straightforward.

(a) Relatively clean artificial spawning substrate from 2011 deployment

(b) Artificial spawning substrate from 2011 deployment with filamentous algae and hydroids

(c) Artificial spawning substrate from 2011 deployment with accumulated drift algae

(d) Artificial spawning substrate from 2008 CSIRO/UTas deployment with filamentous red algae

Figure 3.16 Examples of typical fouling levels on artificial spawning substrates at Ralphs Bay, spring 2011

4 Discussion

Numerous Spotted Handfish were recorded during population surveys in the Derwent Estuary over the two-year duration of this study (2011 and 2012). Spotted Handfish densities were generally in the range observed during previous surveys by the CSIRO, particularly at Battery Point and Opossum Bay, where the total densities appeared to be relatively steady. Low numbers of juveniles observed at all sites, however, suggests poor recruitment during the previous 2 years, which fell in between the last CSIRO surveys (Autumn 2008) and those associated with this project. The impacts of consecutive years of poor recruitment on the population is unknown, but given the life history of the species, it could be expected to be a major concern if persistent over three or more years. Of particular concern is the population at Ralphs Bay, which does not appear to have had any noticeable recruitment since before 2008 and has declining numbers of adults. A key recommendation of this study is thus to continue population surveys into the future, especially in 2013 and 2014, with specific attention given to densities of juveniles.

Involvement of recreational divers in the population surveys was highly successful, each survey weekend seeing a team of enthusiastic divers participating. Involvement of community divers allowed between 34 and 40 transects to be surveyed on each weekend; the equivalent search effort would take 4–6 days for a team of 2–3 scientific divers. Involving community divers not only reduced costs and time, but importantly also generated awareness and a local sense of stewardship amongst the divers involved. It is estimated that >80% of divers involved will continue to provide skilled volunteer support for future surveys, with the dropout largely due to divers no longer in Tasmania. The process of continued community diver support will be aided and be most sustainable in the long term if a local dive club or community group with suitable dive infrastructure (particularly owning a large number of cylinders) commits to taking the lead on organisation of survey weekends. The Tasmanian University Dive Club has already expressed a keen interest in taking on this responsibility, and discussions are currently under way.

Another positive and interesting result of the population surveys was that the densities of Northern Pacific seastars (*Asterias amurensis*) were the lowest observed in any surveys undertaken at the handfish sites studied in this project. Clearly the reasons for this could be many and are unknown, but one hypothesis is that emigration or mortality may have occurred as a result of the mass aggregations of spider crabs (*Leptomithrax gaimardii*) which occurred in the estuary in early 2012. The longer time frame of the decline in Northern Pacific seastars observed (densities were dropping prior to the 2012 mass spider crab aggregations) and widespread decline in Northern Pacific seastars across all four sites (spider crab aggregations were only observed at Sandy Bay) suggest that other factors may have been driving this decline. However, the potential role of spider crab aggregations in reductions in densities of both Northern Pacific seastars and Spotted Handfish between 2011 and 2012 at Sandy Bay shouldn't be eliminated. Spider crabs were observed consuming Northern Pacific seastars during the study, and there is also anecdotal evidence that Northern Pacific seastars actively avoid spider crab aggregations (SD Ling, pers comm). Spotted Handfish may similarly be displaced by spider crab aggregations, which represent a natural hazard in the form of trampling, or even potentially physical damage or predation. Trauma consistent with the sort of damage that would result from crab claws (skin lesions and a tail amputation) has been observed by report author MG since 1997. Mass spider crab aggregations are natural phenomena that have long been known to occur in the Derwent Estuary, possibly to facilitate spawning or for protection during moulting (Poore and Ahyong, 2004). The ecological implications of these remain an avenue for further research.

The observations and questions raised about Northern Pacific seastars in this study also highlight the lack of information on the populations of this invasive species. It is known to have significant impacts on native biota in the estuary (Grannum *et al*., 1996) and is relatively easy to monitor, yet no consistent long-term efforts have been undertaken to track trends in population densities. Monitoring Northern Pacific seastars as part of ongoing Spotted Handfish surveys will provide a very important source of long-term data for this species, particularly as it captures critical areas of spatial overlap with the Spotted Handfish.

This study also identified low densities of stalked ascidians (*Sycozoa* spp.) at the sites of the key handfish populations. Previous observations by Green and Bruce (1999) revealed a dramatic decline in stalked ascidian densities at Opossum Bay between 1996 and 1999 (shown in Figure 3.7), and while this may potentially be symptomatic of a broader decline throughout the estuary, the absence of adequate historical data at other sites and over longer time scales prevents conclusions relating to long-term trends in this important spawning habitat for Spotted Handfish. Regardless of this, the Derwent Estuary is a highly modified system, with contemporary benthic communities known to be very different from those present before European settlement (Edgar and Samson, 2004). The availability of biogenic vertical structures that provide spawning habitat for Spotted Handfish is likely to have been considerably reduced by anthropogenic pressures. *Caulerpa* species, for example, are abundant in the lower western portion of the estuary and in the context of other Tasmanian estuaries it may be fair to expect that they would extend further up the system if sedimentation, pollution and reduced water clarity were not as severe.

A goal of this project was to increase availability of potential spawning substrate for Spotted Handfish in light of such human impacts (this goal has been further justified by the observation of recent poor recruitment identified in the population surveys). Although only a small percentage of artificial spawning substrates planted in this project were found to have Spotted Handfish egg masses attached (<1%), the vast majority of egg masses observed during the spawning season were found on these artificial substrates. The two-year duration of this project was not long enough to assess the ultimate success of the artificial spawning substrates in terms of increasing Spotted Handfish recruitment, but the observations added further evidence that natural spawning substrate availability and use appears to be low, and that artificial spawning substrates represent an attractive alternative that is used by spawning fish. These results provide support to the recommendations resulting from the original trials that artificial substrates represent an important management option. The following are key considerations and recommendations for the continued testing and use of the artificial spawning substrates as identified in the project:

1. The spawning substrates and fish that use them should be closely monitored over an entire breeding season, and attempts made to track juveniles following hatching. This would require intensive diving work and would best be suited to an honours project or undertaken by consultants.
2. Recommendation 1 should ideally be followed up by further population surveys over the subsequent two summers, in the same location and in at least two control locations where no substrates were planted, to assess whether any noticeable increase in recruitment occurs. Although there are not enough historical site-specific data to put any recruitment data into the context of natural variability, and movement patterns are completely unknown, such an approach remains the best option currently available.
3. Artificial spawning substrates attract fouling, and it is unknown whether this affects their use by handfish, or additionally whether newly planted substrates are more likely to be used than ‘old’, cleaned substrates (or vice versa). To provide some preliminary information to guide whether substrates should be cleaned each year, whether new substrates should be planted or whether neither is worthwhile, it is suggested that a simple experiment could be employed. Although difficult to statistically assess with confidence, providing an array of substrates that includes ‘old’, fouled substrates, ‘old’ cleaned substrates, and newly constructed substrates in a random order and then assessing usage patterns, will allow a preliminary assessment and may be enough to increase success rates of future substrate maintenance or planting.

Also trialled during this project was the incorporation of towed GPS in the survey methods. This allowed the location of individual handfish to be recorded with a high level of accuracy and provided clear maps of handfish locations throughout the study areas (not presented in this report due to sensitivity of information). These maps suggested fairly regular distribution of handfish, but a small degree of clumping evident. Photographs of individual handfish were compared with images from previous CSIRO surveys and no ‘re-captures’ were found. During the study it was decided, however, that a more detailed assessment of

the photo ID method for identifying individual handfish was needed, particularly to determine the degree of ontogenetic variation in marking patterns (and thus applicability of this method for identifying individuals between years). An honours project at the University of Tasmania (by Tess Moriarty) has recently begun to examine this. If the photo ID method is proven successful between years, continued population surveys using towed GPS in future years will likely provide invaluable data on movement of individuals, the degree of mixing between 'populations' and possibly add to existing knowledge of the species' life history.

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