



SYSTEMATIC SURVEYING OF TWO THREATENED HANDFISH SPECIES

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Citation

Edgar GJ, Stuart-Smith RD, Cooper AT, Jacques, M (2015) Systematic Surveying of Two Threatened Handfish Species. Report for the Department of the Environment. The Reef Life Survey Foundation and Institute of Marine and Antarctic Studies.

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Catalogue in publishing details

ISBN ##### printed version

ISBN ##### web version



Australian Government
Department of the Environment

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Executive Summary

This report outlines the results of extensive surveys for red (*Thymichthys politus*) and Ziebell's (*Brachiopsilus ziebelli*) handfish undertaken by the Reef Life Survey Foundation as part of a contract with the Department of the Environment. These two species, along with the spotted handfish (*Brachionichthys hirsutus*), are covered under the Recovery Plan for Threatened Handfish, with this project specifically developed to contribute to recovery action 7 under this plan: *Identify all extant colonies of red handfish and Ziebell's handfish.*

Historical sightings of red and Ziebell's handfishes have been becoming increasingly rare in recent years, with the only known population of red handfish with confirmed sightings in the last 13 years at Primrose Sands, and the last confirmed sighting of Ziebell's handfish in Waterfall Bay, Tasman Peninsula in 2005 (Mick Barron pers comm.). This project involved a large team of skilled and experienced community divers which undertook extensive surveys of the most likely locations for both species, based on key locations of historical sightings and what is known of habitat preferences from these.

Surveys were carried out using globally standardised Reef Life Survey Underwater Visual Census (UVC) methodology along 50 m transect lines, which includes a specific survey component for small benthic fishes with cryptic appearance and/or behaviour. This is considered one of the most suitable non-destructive methods for quantitative surveys for fishes such as handfishes, and has the additional benefits of including other ecological components at each site, such as larger fishes, mobile invertebrates and sessile communities, allowing potentially important ecological factors to be considered alongside habitat factors when analysing species location and density data. Surveys using these methods have been used to monitor the red handfish population at the Primrose Sands site since 2010, complemented by off transect searches in isolated habitat patches.

From a total of 100 hours of underwater search effort targeted at key locations for both species, only four red handfish were recorded, all at the same site (Primrose Sands). No Ziebell's handfish were recorded at any site. While further surveys will be undertaken in spring of 2015 (and into the future), project results so far suggest a high probability that additional populations of red handfish at previous sighting locations are either exceedingly small or no longer present. No evidence has been found for remaining Ziebell's handfish populations, but further targeted searches will be undertaken during breeding season (winter/spring), with results provided to the department as available.

Introduction

The Australian Government's Department for the Environment recently undertook a review of the Recovery Plan for Threatened Handfish. This covers three species listed as threatened under the EPBC act: spotted handfish (*Brachionichthys hirsutus*), red handfish (*Thymichthys verrucosus*), and Ziebell's handfish (*Brachiopsilus ziebelli*). The two primary objectives of this recovery plan relating to the latter two species were:

4. Protect extant populations of red handfish and Ziebell's handfish
5. Protect known and likely habitat for red handfish and Ziebell's handfish

In order to make progress towards these objectives, the National Handfish Working Group/Recovery Team identified the most important recovery actions of identifying all extant colonies of red handfish and Ziebell's handfish (recovery action 7), and protecting, and where necessary actively managing, extant populations of red handfish and Ziebell's handfish (recovery action 8). Further actions for these species were to identify habitat preferences and protect all known habitat (recovery actions 9 and 10, respectively).

A key element of success for the recovery plan with respect to these two species, and critical first step, was thus to undertake systematic surveys for both species in all likely habitats. Given the rarity of these species (see below), this represents an enormous task, and is a difficult and costly proposition for professional scientific teams. The Reef Life Survey (RLS) program, founded in 2007 with the support of the Australian Government, has recently demonstrated the enormous enhancement of capacity possible by training and supporting teams of committed recreational divers in scientifically-rigorous survey methods. One such demonstration was in the extremely cost-effective and comprehensive survey of biodiversity in 18 reef systems in the recently declared Coral Sea Commonwealth Marine Reserve (Edgar et al. 2015) – previously only possible for a small number of reefs, and at a large expense. The RLS model of a larger, skilled team of committed divers who donate their time and expertise, but without sacrificing scientific rigour, provided an ideal mechanism to enhance the survey effort possible for rare species such as these handfishes.

Red handfish (*Thymichthys politus*)

Red handfish are endemic to south-east Tasmania. While sightings have been recorded along the south east coast of Tasmania, at present, they are only known from a single location in Fredrick Henry Bay (Gledhill and Green, unpublished). Red handfish are slow-moving, cryptic fish which grows to at least 136 mm total length (Last and Gledhill 2009). Rather than conventionally swimming, they move across the substrate by using their hand-like fins to crawl across the seafloor (DEH, 2005). This allows their diet to predominately include small crustaceans and polychaete worms (Edgar et al. 1982). The species has been sighted in a variety of substrate conditions including the top of rocks,

amongst macro-algae and in sandy areas between rocks and the reef-sand interface (DEH, 2005). They have a depth distribution of 1-20 metres (Last and Gledhill 2009).

There are primarily two colour variations of red handfish. One morph is a uniform vivid red over the body and fin bases with the outer parts of the fins bluish and white; the second morph is a mottled, pale pink with extensive reddish patches and spots (Last and Gledhill 2009).

Determining trends in Red handfish populations is extremely difficult because the species is small, typically well-hidden in macroalgal covered reef, and very rare (Gledhill and Green, unpublished). Historically, the red handfish was also known from a number of locations off Port Arthur, Fortescue Bay, the Actaeon Islands, D'entrecasteaux Channel and the Forestier Peninsula, with the species being sighted in the Fortescue Bay area up until 2001 (Valentine, Pederson, per comm.). There have been no reported observations of the species from the Port Arthur area in recent decades (Gledhill and Green, unpublished).

Red handfish have a low reproductive rate and a very low rate of dispersal (Gledhill and Green, unpublished). Females produce egg masses from around August through to October (DEH, 2005). These egg masses consist of 30-60 eggs connected by tubules and bound together by associated threads (DEH, 2005). They attach the egg masses to erect substrate such as ascidians and green alga, *Caulerpa sp.*, (DEH, 2005), which are then guarded by an adult until they hatch. Once hatched, juveniles have been observed to settle immediately in the vicinity of the egg mass (DEH 2004).

There is evidence to suggest that suitable spawning substrate and habitat degradation are the main contributors to the decline of the red handfish. While red handfish have been observed finding alternate substrate to attach egg masses, such as filamentous algae, this proved unviable as the algae washed away before the eggs were fully developed (Jacques, unpublished).



Red handfish (*Thymichthys politus*)
Photo: Tania Mendo

Ziebell's handfish (*Brachiopsilus ziebelli*)

The largest of the handfish species, Ziebell's handfish has been recorded to reach a maximum total length of approximately 150 mm (DEH, 2001). Typically, the body is pink to white, with purple to brown random blotches. Fins are generally bright yellow and, in some specimens, the yellow extends onto the body adjacent to the fins (Last and Gledhill 2009). Ziebell's handfish move by using their hand-like fins to crawl across the seafloor (DEH, 2005). The species' diet consists of small crustaceans and polychaete worms (Edgar et al. 1982).

Ziebell's handfish have a similar breeding strategy to red handfish, whereby they produce an egg mass structure connected by tubules and threads (DEH, 2005), attach the egg masses to erect substrate which is then guarded until hatched.

Ziebell's handfish are restricted to south eastern Tasmania. The species has been recorded in the D'entrecasteaux Channel, Forestier Peninsula, Tasman Peninsula, Actaeon Islands and Cox's Bight in depths of 10–20 m (Last and Gledhill 2009). Ziebell's handfish have not been observed for approximately 10 years, and the species' current distribution is unknown (Gledhill and Green, unpublished). An historical lack of systematic surveying of the species makes it impossible to determine whether populations are increasing, decreasing or stable (DEH, 2005).

The most recent confirmed sightings of this species are from Waterfall Bay and Deep Glen Bay of the Tasman Peninsula. From previous sightings, it is assumed that the species appears to prefer patches of soft sessile growth on rock, though it has also been found at the edge of giant kelp forests, on rocky substrate, on rock ledges and in cracks on open walls and inside caves in depths of 3-20 m (Gledhill and Green, unpublished). One hypothesis is that it is more common on deeper reefs and is only seen by divers in shallower water when in darker areas of south facing slopes or caves (P. Last pers comm.). Little search effort has been undertaken deeper than 20 m, however, due to substantially reduced bottom time when diving at depths below this.



Ziebell's handfish (*Brachiopsilus ziebelli*) Photo: Andrew Green

Methods

Locations and survey sites

Surveys were targeted at locations where these red and Ziebell's handfishes have previously been recorded, officially (Last and Gledhill 2009) and anecdotally, as well as additional locations at which habitat and local conditions suggest they may also occur. A list of locations of confirmed historical sightings is provided in Table 1, compiled by M. Jacques (Jacques, 2014) and the other authors from the literature and personal communications. Although not complete, this provides an indication of the key locations that formed the basis for survey locations in this project.

Table 1 Historical sightings of red (*Thymichthys politus*) and Ziebell's (*Brachiopsilus ziebelli*) handfish

Date	Location	Sighted by	Species
1965	Researche Bay	Unknown	<i>B. ziebelli</i>
1980	Cox's Bight	Peter Last	<i>B. ziebelli</i>
Apr-80	Actaeon Island	Abalone diver	<i>T. politus</i>
1981	Southport	Peter Last	<i>B. ziebelli</i>
1985	Actaeon Island	Peter Last	<i>B. ziebelli</i>
Jul-83	Actaeon Island	Peter Last	<i>B. ziebelli</i>
Apr-85	Actaeon Island	Abalone diver	<i>T. politus</i>
Jan-87	North Bay	Sarah Quine	<i>T. politus</i>
Jun-87	North Bay	Sarah Quine	<i>T. politus</i>
Jan-95	Primrose Sands	Karen Gowlett-Holmes	<i>T. politus</i>
1995	Actaeon Island	Peter Last	<i>B. ziebelli</i>
1999	Fortescue Bay	Hugh Peterson	<i>T. politus</i>
1999	Arch Rock	Neville Barrett	<i>B. ziebelli</i>
2001	Thumbs, Tasman Peninsula	Joe Valentine	<i>B. ziebelli</i>
2001	Deep Glen Bay	Joe Valentine	<i>B. ziebelli</i>
2001	Actaeon Island	Peter Last	<i>B. ziebelli</i>
2002	Lobster Point	Neville Barrett	<i>T. politus</i>
Apr-02	Port Arthur	Unknown	<i>T. politus</i>
2003	Waterfall Bay	Simon Talbot	<i>B. ziebelli</i>
2003	Deep Glen Bay	Simon Talbot	<i>B. ziebelli</i>
2003	Forestier Peninsula	Peter Last	<i>B. ziebelli</i>
2005	Waterfall Bay	Mick Barron	<i>B. ziebelli</i>
Jan-07	Deep Glen Bay	Joe Valentine	<i>B. ziebelli</i>
Apr-10	Primrose Sands	Michael Jacques	<i>T. politus</i>
Oct-10	Primrose Sands	Jemina Stuart-Smith	<i>T. politus</i>
Apr-11	Primrose Sands	Michael Jacques	<i>T. politus</i>
Nov-11	Primrose Sands	Rick Stuart-Smith	<i>T. politus</i>
Apr-12	Primrose Sands	Michael Jacques	<i>T. politus</i>
Apr-13	Primrose Sands	Michael Jacques	<i>T. politus</i>
Oct-14	Primrose Sands	Rick Stuart-Smith	<i>T. politus</i>

Those locations targeted within this project included:

- Cox's Bight, south west Tasmania
- Tasman Peninsula - Waterfall Bay, Port Arthur, Lobster Point, Fortescue Bay
- Actaeon Islands
- Primrose Sands
- D'entrecasteaux Channel (historical locations and those with similar habitat)

Most recent effort by community divers has gone into the red handfish population at Primrose Sands. Jacques (2014) provides detail on observations from these, representing the most comprehensive summary of the population and habitat characteristics here. A summary table of recent records from Primrose Sands is provided below (Table 2), on which this project builds.

Table 2 Continuity table - Identified individual fish by year

Fish	2010	2011	2012	2013
"Emma" (female)	Sighted with eggs	Sighted with eggs		
"Martha" (female)	Sighted with eggs	Sighted with eggs		
"India" (female)	Sighted - eggs detached			
"Candice" (female)	Sighted	Sighted with eggs		
"Mark" (female)	Sighted			
"Juanita" (male)	Sighted	Sighted with injury	Sighted	
"Jemina" (male)	Sighted	Sighted	Sighted	Possible sighting
Unidentified				Sighted (no photo)
"Rick" (juv)	Sighted with damage			
"Adrian" (male)		Sighted		
"Trudi" (female)			Sighted - eggs detached	
"Banana" (female)				Sighted
Unidentified male			Sighted	
"Ren" (female)			Sighted	
"Alison" (female)			Sighted	
"Grace"			Sighted	
"Amy"			Sighted	
Unid. female (white tail)			Sighted with eggs	
"Liz" (female)			Sighted	Sighted with eggs
"Dickie"			Sighted	
"Gabbi" (female)			Sighted with eggs	
"Eric"			Sighted	
"Yellowsox" (male)			Sighted	
"Tigger"			Sighted	
"Laura-May" (female)			Sighted with eggs	
"Tina" (female)			Sighted with eggs	
"Flea" (female)			Sighted	Sighted
"Stephanie" (female)				Sighted with eggs
"Tippex" (male)				Sighted

"Blueblade" (male)				Sighted with injury
"Tassie" (female)				Sighted
"Arrow" (male)				Sighted
Total Males	3	3	7	4
Total Females	5	3	11	5
Total fish	8	6	18	9

Survey Methodology

Surveys were conducted using the globally standardised RLS methodology, which is based on Underwater Visual Census (UVC) along 50 m transects. Each survey consisted of three components, collectively designed to cover the major groups of fauna and flora present and surveyable using diver-based methods:

- 1.) Fish surveys (known as Method 1, or M1) – surveyed in two 5 m wide by 5 m high bands, parallel with the 50 m transect line.
- 2.) Macroinvertebrate/cryptic fish surveys (known as Method 2, or M2) – surveyed in two 1 m wide by 2 m high bands on either side of the transect line.
- 3.) Sessile flora and fauna photoquadrats (PQs) – taken at 2.5 m intervals along the transect line (i.e. 20 per 50 m transect).

Handfishes may be detected and recorded on any one of the three survey components, but divers focussed on intensively searching for handfishes during Method 2, which is well-designed to detect fishes with cryptic appearance or behaviour and likely overlooked by any other non-destructive survey method.

In addition to quantitative surveys on 50 m transects, divers used remaining dive time after completing transects to undertake intensive searches outside of the 50 m survey area, with any handfish sightings during this aspect contributing 'presence' data (known as Method 0, or M0). Due to the depth range of previous sightings of Ziebell's handfish on the Tasman Peninsula, and potential that they may be more common at depths > 20 m, considerable search effort outside of standardised transects was undertaken at depths of 20-37 m at sites in this area. For these dives, the team was often split into two groups; one surveying quantitative transects at depths of 10-20 m, and another searching a wider depth range, from deeper reef covered in sessile invertebrates, working their way up to shallow macroalgal dominated habitats. Likewise, considerable search effort was spent in the various compartments within Cathedral Caves, which has been one of the more reliable locations for previous sightings of Ziebell's handfish. This additional search time in deeper habitats and caves reduced the number of standardised 50 m transects that could be surveyed, but

complemented standardised transects in allowing coverage of depths at which dive time is too limited to allow completion of standardised transects.

All surveys were undertaken by divers experienced in surveying cryptic fishes, and with the supervision of an experienced scientist.

Detailed information on RLS survey methodology can be found in the online methods manual: http://reeflifesurvey.com/files/2008/09/NEW-Methods-Manual_15042013.pdf, and M1 survey methods described in detail in Edgar and Stuart-Smith (2014).

Results

A total of 100 underwater hours was spent searching for red and Ziebell's handfishes by 19 experienced divers, over 22 sites across southern Tasmania from February to June 2015 (see Figure 1). The dates and search effort associated with each location are presented in Table 2.

Four red handfish were recorded at Primrose Sands and no Ziebell's handfish were found at any of the survey sites. It is possible that two or three of the four red handfishes found were the same individual, but photographic evidence of the spot patterns is not conclusive.

Table 3 Summary of search effort by RLS divers.

Date	Site Name	Latitude	Longitude	No. divers	No. transects	Max. depth searched	Total search time (mins)
27-Feb-15	Deep Glen Bay	-42.971519	147.993258	5	1	36	225
27-Feb-15	Outer Sister	-42.959647	148.005658	5	1	35	225
28-Feb-15	Port Arthur Heads	-43.18807	147.89404	4	1	27	200
28-Feb-15	Port Arthur Jetty	-43.14698	147.85385	4	2	6	380
28-Feb-15	Stewarts Bay	-43.13808	147.86505	5	1	15	375
28-Feb-15	Stinky Bay	-42.99376	147.65686	2	0	9	70
01-Mar-15	The Thumbs	-43.106618	147.983393	5	1	34	250
01-Mar-15	Cathedral Caves	-43.065767	147.955258	6	1	22	360
01-Mar-15	Fortescue central	-43.129544	147.960372	5	1	19	250
02-Mar-15	Outer Lantern	-43.135205	148.009596	5	1	37	275
02-Mar-15	Cathedral Caves	-43.065767	147.955258	6	0	22	330
03-Mar-15	Primrose Sands	-42.898093	147.668991	4	1	6	300
30-Mar-15	Dennes Point	-43.06183	147.35141	2	0	15	120
13-Apr-15	Cox's Bight Outer	-43.53036	146.21422	4	1	28	240
13-Apr-15	Cox's Bight Central	-43.52132	146.21318	4	1	16	240
13-Apr-15	Cox's Bight Middle	-43.52348	146.21297	3	1	20	180
20-Feb-15	Primrose Sands	-42.898093	147.668991	6	0	7	480
21-Feb-15	Primrose Sands	-42.898093	147.668991	2	0	7	160
02-May-15	Primrose Sands	-42.898093	147.668991	5	0	7	400
14-Apr-15	Primrose Sands	-42.898093	147.668991	3	0	7	240
05-Jun -15	Actaeon Islands	-43.52578	146.99627	4	4	12	240
05-Jun -15	Actaeon Islands	-43.53372	146.99447	4	4	12	240
13-June-15	Primrose Sands	-42.898093	147.668991	7	0	7	210

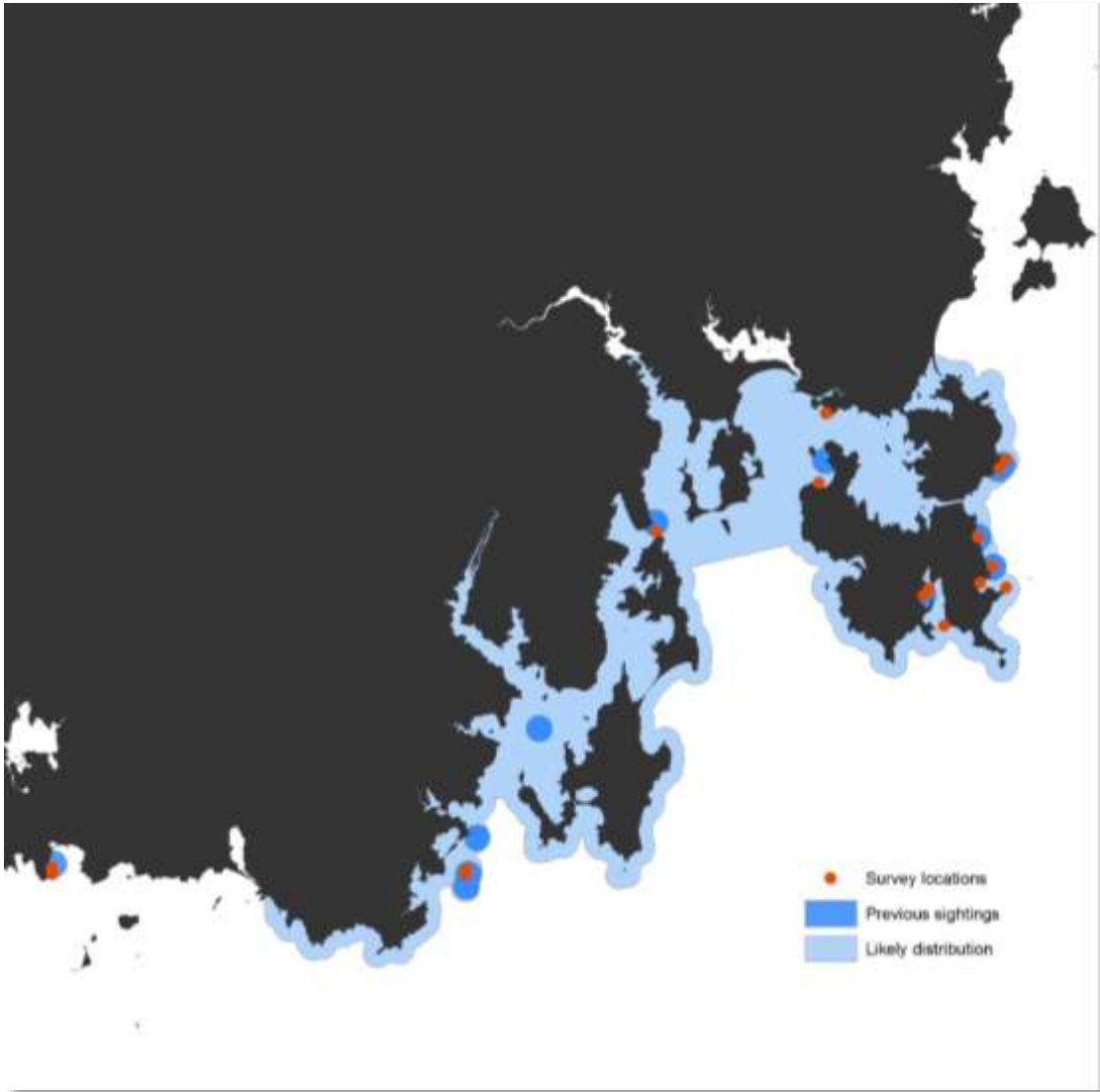
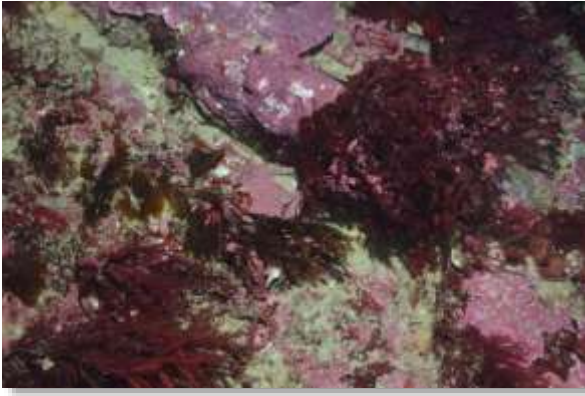


Figure 1 Southern Tasmania showing the likely distribution of Red and Zeibell's handfishes, Locations of historical sightings (Last, 2009) and locations surveyed by Reef Life Survey divers in 2015.

Cox's Bight

Cox's Bight is highly exposed to large, prevailing south/southwest swell and winds (see appendix 1). The bight itself offers some protection from the swell and the south western side is often shaded by high cliffs. The substrate at Cox's Bight mainly comprised low rocky reef, encrusted in coralline algae and sponge (see Slate 2). Large brown algae, such as *Ecklonia radiata* and *Phyllospora comosa* dominated the shallower zones, with *E. radiata* extending to the 20 metre depth contour. No handfishes were found at this location, but patches of potentially suitable habitat existed at depths of 22 m up to 10 m.



Photos: Graham Edgar

Slate 1 Examples of the substrate found at Cox's Bight.

Tasman Peninsula and Port Arthur

The Tasman Peninsula is exposed to south easterly swell and wind. Shallow areas of reef on the most exposed areas are dominated by bull kelp (*Durvillaea potatorum*), which creates an almost certainly unsuitable habitat for handfishes (and many other sessile or mobile invertebrates) due to whiplash from wave action. As a consequence, suitable handfish habitat lies deeper in this area than in more sheltered parts of the coastline.

Surveys were concentrated in particular locations of previous sightings of Ziebell's handfish, which tended to be on sessile invertebrate-dominated reef habitat, in caves and lower light areas on south facing reefs. Slate 3 shows 3 examples of the most common substrate encountered during the Tasman Peninsula surveys. Below 25 – 30 m, the majority of substrate cover consisted of diverse sessile invertebrate growth, with vast areas deeper than 20 m at sites such as the Lanterns, Thumbs, Sisters, Deep Glen Bay and the entrance to Port Arthur appearing very suitable for handfishes, and similar to the known Ziebell's habitat in Cathedral Caves. While as much search effort as possible was placed in these areas during the project (and likely more than has ever likely previously been undertaken in a concerted effort at these depths), considerably more effort would be worthwhile in these areas, particularly during the breeding season when handfishes may be more exposed when guarding eggs.

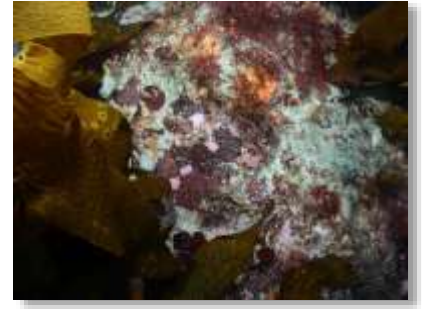
The upper areas of Port Arthur are very sheltered, especially from the prevailing SW swell. Surveys in this area focussed on the area adjacent to the penal colony, where it is believed the previous sightings of red handfish came from. This area contains similar seaweed composition and depth to the Primrose Sands site (below), and appeared a promising location, albeit with significant turbulence caused by the regular tourist ferry service docking here.



a.) Port Arthur, Tasman Peninsula



b.) Cathedral Caves, Tasman Peninsula



c.) Fortescue Bay, Tasman Peninsula

Slate 2 Habitat types at surveyed, Tasman Peninsula and Port Arthur, Tasmania, 2015.

The Actaeon Islands

The eastern side is exposed to all weather, with little wind protection offered from the west due to the low profile of these islands and large SW swells from the Southern Ocean. Much of the southern area of reef was dominated by bull kelp (*Durvillaea potatorum*) in the shallows, with *Macrocystis pyrifera* forests dominating the 10 m zone around the western side of the islands. The rocky reef substrate is predominately covered in crustose coralline algae and foliose red algae.

Previous sightings of both red and Ziebell's handfishes have been made here, and search effort focussed on the areas of diverse red algal understory and adjacent sand patches, assuming these species might be found in similar microhabitat to the other locations.

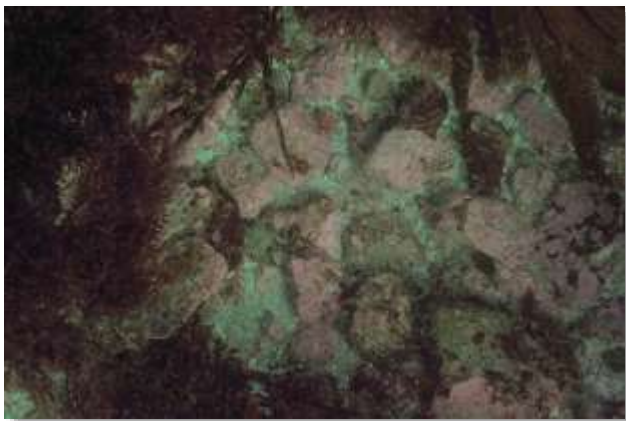


Photo: Antonia Cooper

Primrose Sands, Norfolk Bay, SE Tasmania

The only known location of red handfish in recent years has been Primrose Sands, in Frederick Henry Bay (Jacques, 2014). All sightings at this site have been made in the same patch of rocky reef, approximately halfway between the Primrose Sands beach and the point to the south. This area consists of a coastal strip of low profile reef, with a sand-edge at six to seven metres depth. It is exposed only to larger SW and SE swells, and strong westerly winds. Furoid seaweeds such as *Sargassum* species dominate the substrate, with green foliose seaweeds such as *Caulerpa* species and filamentous algae also common. Seaweed cover appears to be highly seasonal, with the dominant cover of *Sargassum* in winter/spring very sparse in summer/autumn. During the time of low *Sargassum* cover, the division between the area in which a number of previous sightings of red handfish have been made, and areas of reef immediately to the north and south was much more apparent. Over-grazing of macroalgae by the common sea urchin (*Heliocidaris erythrogramma*) was readily apparent either side of an approximately 70 m strip of reef where red handfish sightings occur, which retains some *Sargassum* and a large amount of *Caulerpa* during the summer/autumn period.



Photo: Rick Stuart-Smith



Photo: Luis Henriquez

Slate 3 Primrose Sands substrate during the period of low macroalgal cover in autumn



Red handfish (*Thymichthys politus*) photographed at Primrose Sands by Rick Stuart-Smith



Red handfish (*Thymichthys politus*) photographed at Primrose Sands by Nick Perkins



Red handfish (*Thymichthys politus*) photographed at Primrose Sands by Tania Mendo



Red handfish (*Thymichthys politus*) photographed at Primrose Sands by Tania Mendo

Slate 4 T. politus individuals recorded at Primrose Sands during the 2015 RLS handfish surveys.

Other findings

Surveys in the project also recorded other rarely observed fish species. Of particular interest were two records of the flathead congollis (*Halaphritis platycephala*), at Cathedral Caves and at Cox's Bight. Very few previous records of this species exist, and it is thought to be the basal member of the toothfishes and icefishes (suborder Notothenioidei; P. Last pers comm.). One of these records consisted of two independent sightings of the same individual by two different RLS divers in Cathedral Caves, despite being very well concealed at the back of a deep crevice in a less conspicuous offshoot of the cave network. This provides a good indication of the thoroughness of search effort for handfishes, and the suitability of the divers and combination of methods applied. Despite the huge area of potential handfish habitat at this site, which is the most important location for previous Ziebell's handfish records, 690 minutes of careful searching by experienced divers and this double sighting suggest the project had as good a chance as might be possible that any handfish present might have been detected.



Slate 5 Halaphritis platycephala, Cathedral Caves. Photo: Andrew Green.

Discussion

Although very little reliable information exists on the distribution and movement of red (*Thymichthys politus*) and Ziebell's (*Brachiopsilus ziebelli*) handfishes, it is believed that each occur in small, isolated populations. The lack of additional populations found in this study, but continued presence of red handfish at Primrose Sands certainly supports this idea. As a result, some threats and management options may be specifically related to the locations of remaining populations, while others may be broader threats which may not be possible to manage.

Surveys are still to be completed at Lobster Point as part of this project, but it appears likely that Primrose Sands remains the only currently known population of red handfish. Thus, although continued opportunistic searches for this species are always warranted, it seems that any potential management actions and ongoing monitoring must necessarily be focussed at this site.

This site exists in close proximity to an urban area, and could be adversely affected by coastal habitat degradation and anthropogenic activities (DEH, 2004). Apart from poaching/direct removal of red handfish, the major pathways for human impacts appear likely indirect, through degradation of the seaweed habitat that appears to be important for this species. Red handfish are not only typically observed with egg masses attached to *Caulerpa* fronds, but many sightings tend to be made of individual sheltering directly underneath *Sargassum* plants.

The continued observations of red handfish only within a short strip of this continuous reef system, and summer observations of low seaweed cover either side of this due to sea urchin grazing, suggest that loss of seaweed habitat may represent a key threat to the long-term viability of this population. No historical data on sea urchin densities and seaweed cover on this reef are available, and it is currently impossible to determine whether the area of suitable habitat for handfish to shelter in and attach egg masses to has been reducing in size. However, data from other areas of similar habitat along the Tasmanian coast suggest that depletion of rock lobsters (*Jasus edwardsii*) has released the sea urchin populations on which they prey, which have in turn considerably reduced local seaweed cover (Barrett et al. 2009, Ling et al. 2009). RLS transects at this site have revealed only small lobsters which are too small to consume sea urchins (Ling et al. 2009), and moderate densities of sea urchins (ca. 120 per 50 m² within the area of handfish sightings). Very few lobsters and higher densities of sea urchins are clearly obvious outside of this area (R. Stuart-Smith, pers obs.).

An additional, related threat to this red handfish population is nutrient inputs from adjacent urban and rural land uses. Filamentous algal cover has been observed to be high at this site (although not quantified in this study), and in other studies has been linked to nutrient input from fish farms, and associated with loss of canopy forming seaweed species (Oh 2009). A similar mechanism is very possible at Primrose Sands if local septic system leakage, for example, results in filamentous algal blooms which reduce the canopy of *Sargassum* species, and therefore habitat for handfish to take shelter in. Pollution, siltation and turbidity has been hypothesised to have historically reduced the availability of natural spawning substrate for spotted handfish (*Brachionichthys hirsutus*) in the Derwent Estuary, which may have included *Caulerpa*, and it remains possible that the same could occur for the even more locally-concentrated population of red handfish.

No evidence was found in this study of persistence of any populations of Ziebell's handfish. It is possible that populations still exist, with extensive areas of apparently suitable habitat at locations such as the Actaeon Islands and along the Tasman Peninsula. These require further surveying.

Recommendations

The primary recommendation for Ziebell's handfish is to undertake further intensive survey effort, particularly during the lead up to, and during, the breeding season from July through to September. It is possible that the ability to locate handfish during this project was reduced by the timing, which was necessarily during autumn and early winter. The chances of finding both species are believed to be greatest when they are guarding egg masses, and thus further survey effort would ideally be concentrated during this time, although continued surveys at any time would still be valuable.

For red handfish at Primrose Sands, continued monitoring is recommended of not only the handfish population, but also to quantify any changes in sea urchin and lobster densities and seaweed cover. This is needed to confirm whether the area of habitat for red handfishes is declining, and whether this is possibly indirectly associated with low lobster densities. If this proves to be the case, implementation of a no-take marine reserve, or prohibition of lobster fishing in the broader area may be important and necessary management options to slow or reverse degradation of local seaweed habitat.

Given the indirect nature of such a threat, there is substantial uncertainty over the effectiveness of associated management strategies and indeed also over the continued using this reef by the population (as opposed to moving to another location with more in-tact habitat). This has been the longest-known population of this species observed, and few other options may exist to protect the population, so this option should be considered seriously, even if not guaranteed to be effective. Monitoring of handfish, urchins, lobsters and seaweed cover during any management actions will provide the best indications of success or otherwise.

A further recommendation is to initiate and sustain water quality monitoring at Primrose Sands. This would ideally identify local sources of nutrient input which may be able to be reduced or managed, and put this into context with regional sources of nutrient input.

Acknowledgements

This project was conducted through funding from the Australian Government's Department of the Environment. The Reef Life Survey Foundation would like to thank the following divers for contributing their time and expertise to the surveys. In alphabetical order:

Amelia Fowles	German Soler	Joe Valentine	Nick Perkins
Andrew Green	Graham Edgar	Liz Oh	Paul Day
Antonia Cooper	Ivan Hinojosa	Luis Henriquez	Rick Stuart-Smith
Carolina Garcia	Jemina Stuart-Smith	Matt Cameron	Simon Reeves
Dani Farias	Jeremy Lane	Nev Barrett	Tania Mendo

We would also like to thank Aquenal Pty Ltd, Joe Valentine, Jeremy Lane and Neville Barrett for providing boat support for the surveys and Mick Barron and Karen Gowlett-Holmes for their local knowledge. Big thanks to Tania Mendo, Andrew Green, Nick Perkins and Luis Henriquez for providing species images for this report and final thanks to Justin Hulls for his mapping expertise.

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Inside cover: Rick Stuart-Smith

Contents page: Andrew Green

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Appendix 1. Reef characteristics and habitat type of survey sites. **Wave Exposure:** 1 = Sheltered, wind waves <1 m, 2 = Waves 1-3 m, 3 = Ocean swell <3 m, 4 = Open swell from prevailing direction; **Relief:** 1 = <0.5 m, 2 = 0.5-1 m, 3 = 1-2 m, 4 = >2 m; **Slope:** 1 = <1:10, 2 = 1:10-1:4, 3 = 1:4 -1:2, 4 = >1:2; **Currents:** 1 = None, 2 = weak, 3 = moderate, 4 = strong.

Site Code	Site Name	Wave exposure	Relief	Slope	Currents
TAS104	Deep Glen Bay	3	1	3	1
TAS105	Outer Sister	4	2	4	2
TAS106	Port Arthur Heads	4	2	1	1
TAS107	Port Arthur Jetty	1	1	1	1
TAS28	Stewarts Bay	1	1	2	1
N/A	Stinky Bay	1	2	1	1
TAS108	The Thumbs	4	2	2	2
TAS109	Cathedral	4	3	3	1
TAS120	Fortescue central	2	1	1	1
TAS121	Outer Lantern	4	2	4	2
TAS109	Cathedral	4	3	3	1
TAS79	Primrose Sands	2	1	1	1
N/A	Dennes Point	1	1	1	2
TAS110	Cox's Bight Outer	2	2	1	2
TAS111	Cox's Bight Central	2	2	1	2
TAS112	Cox's Bight Middle	2	2	1	2
TAS79	Primrose Sands	2	1	1	1
TAS79	Primrose Sands	2	1	1	1
TAS79	Primrose Sands	2	1	1	1
TAS79	Primrose Sands	2	1	1	1
TAS150	Actaeon Islands	4	2	2	2
TAS150	Actaeon Islands	4	2	2	3