Issues Paper:

Population status of and threats to four handfish species listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*

The recovery plan linked to this paper is obtainable from:
http://www.deh.gov.au/biodiversity/threatened/publications/recovery/4-handfish/index.html

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Executive Summary

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a comprehensive legislative framework to protect Australia's marine environment. The EPBC Act provides for recovery plans to be made for the purposes of the protection, conservation and management of species that are listed as threatened under the Act.

Four species of handfish are listed as threatened under the EPBC Act: spotted handfish (*Brachionichthys hirsutus*), red handfish *(Brachionichthys politus)*, Waterfall Bay handfish *(Sympterichthys sp. [CSIRO #T1996.01])* and Ziebell's handfish *(Sympterichthys sp. [CSIRO #T6.01])*. This paper provides background information on the biology of and threats to these species. It should be read in conjunction with the handfish recovery plan, which can be downloaded from: http://www.deh.gov.au/biodiversity/threatened/publications/recovery/4-handfish/index.html

Handfish are small, colourful, relatively sedentary, benthic fish that prefer to 'walk' on their pectoral fins rather than swim. These pectoral fins are hand-like, hence their common name. The handfish species covered by this paper are all endemic to Tasmania. Their abundance is considered to be low. Although there is relatively little known about these species, they appear to have some key biological attributes in common, including:

- they move by using their hand-like fins to crawl across the bottom;
- they all depend upon vertical structures for spawning substrate;
- they all have a low rate of dispersal;
- females remain with the eggs until hatching; and
- when the eggs hatch, fully formed young emerge.

The key threats to these handfish species are those posed to their habitat, specifically spawning substrate, and include:

- introduced species such as the Northern Pacific seastar (*Asterias amurensis*), which has depleted spawning substrate used by the spotted handfish in the Derwent estuary;
- pollution from industrial storm water and sewage that may deplete spawning substrate;
- siltation of key estuarine habitat caused by land clearing; and
- coastal developments, particularly those that involve dredging, as both the spotted handfish and the red handfish live in shallow coastal environments in close proximity to major urban and industrial areas.

In addition, personal collection and the aquarium trade threaten handfish populations by removing individuals from the wild. Under the Tasmanian *Living Marine Resources Management Act 1995*, a person, in State waters, must not take or have possession of handfish without a permit.

A key issue for all of these species is a lack of biological and ecological knowledge, particularly in relation to their distribution, abundance, population trends and threats. The spotted handfish is the most studied of the four species.

1. Introduction

1.1 Purpose

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a comprehensive legislative framework to protect Australia's marine environment. A list of threatened species has been established under Part 13 of the EPBC Act. Species on this list are listed as either extinct in the wild; critically endangered; endangered; vulnerable; or conservation dependent. Listed threatened species are protected to help ensure their long-term survival.

The EPBC Act provides for recovery plans to be made for the purposes of the protection, conservation and management of listed threatened species. Recovery plans must set out the recovery objectives and actions required to achieve those objectives, identify performance indicators and in addition identify who is responsible for implementing the actions and the timeframes involved.

Four species of handfish are listed as threatened under the EPBC Act: spotted handfish *(Brachionichthys hirsutus)*, red handfish *(Brachionichthys politus)*, Waterfall Bay handfish *(Sympterichthys sp. [CSIRO #T1996.01])* and Ziebell's handfish *(Sympterichthys sp. [CSIRO #T6.01])*. Information on the conservation status and date of listing for these species is provided in Table 1.

Table 1: Handfish species requiring recovery plans under the EPBC Act.

Species common name	Species scientific name	EPBC Status	Date of listing
Spotted handfish	*Brachionichthys hirsutus*	Endangered	16 July 2000
Red handfish	*Brachionichthys politus*	Vulnerable	04 March 2004
Waterfall Bay handfish	*Sympterichthys sp.* [CSIRO #T1996.01]	Vulnerable	16 July 2000
Ziebell's handfish	*Sympterichthys sp.* [CSIRO #T6.01]	Vulnerable	16 July 2000

In 1999 the spotted handfish was listed as endangered in Tasmania under the *Threatened Species Protection Act 1995*. The red, Waterfall Bay and Ziebell's handfish are not listed as threatened in Tasmania. However, all species of handfish are protected in Tasmania, under the *Living Marine Resources Management Act 1995*, which makes it is an offence to collect the species without a permit (Tasmanian Government 2003). The Tasmanian Minister for Environment and Planning can issue a permit for the take of handfish for the purpose of:

a) scientific research;
b) the promotion of fishing or fish products;
c) the development of fisheries;
d) the development of fishing technology;
e) educational and community awareness programs;
f) fish stock depletion or enhancement;
g) the collection, keeping, breeding, hatching, or cultivating of rare or endangered fish;
h) sport or recreation purposes by a person who in the opinion of the Minister, would otherwise

be unable by reason of that person's disability to engage in fishing methods permitted under this Act (Pullen pers. comm. 2005).

However it is unlikely that the Tasmanian Minister for Environment and Planning would issue a permit that would threaten handfish populations (Pullen pers. comm. 2005). To date the Tasmanian Department of Primary Industries, Water and Environment has not issued a permit for the take of handfish other than for scientific research (Pullen pers. comm. 2005).

1.2 Scope and limitations

This issues paper summarises available information on the biology of the four handfish species listed in Table 1, and identifies the threats to their long-term survival in the wild. Generally, these species are not well known and there is limited information on their abundance, distribution and general biology. For two of the species (Waterfall Bay and Ziebell's handfish), there is also uncertainty as to their taxonomic status. Furthermore, there is an unequal amount of information available for each of these species.

This is not a recovery plan and hence does not prescribe management actions necessary to address any identified population declines. However, this document should be read in conjunction with the Recovery Plan for Four species of Handfish which has been developed by the Australian Government Department of the Environment and Heritage (DEH) and is available at: http://www.deh.gov.au/biodiversity/threatened/publications/recovery/4-handfish/index.html

1.3 General biology, distribution and abundance of handfishes

Handfish belong to the Brachionichthyidae family and are endemic to southern Australia. Between eight and ten different species of handfish have been identified, however the taxonomy of the Brachionichthyidae family has not been fully resolved, with more work on some species needed (Pogonoski *et al.* 2002: 119). Most of the identified species of handfish are endemic to Tasmanian waters. [1]

Compared to most other fish found in Australian waters, the majority of handfish species appear to have extremely restricted distributions and small populations (Pogonoski *et al.* 2002:119; Last *et al.* 1983). For instance, some species of handfish are known from areas that are only a few hectares in size (Last pers. comm. 10 December 2004).

Little is known about the biology of handfish as they are only occasionally observed by divers or collected during dredging or trawling operations (Pogonoski *et al.* 2002: 119). Some handfish species have only been discovered in the last 30 years (DEH 2001). Handfish are found in diverse habitats – some species are estuarine, inhabiting shallow waters of as little as two metres depth, while others are found in much deeper shelf waters down to 200m (Pogonoski *et al.* 2002: 119).

Handfish are generally small, with an adult size range of 56-150mm (Pogonoski *et al.* 2002). The group is related to the anglerfishes of the family Antennariidae. They have a modified first dorsal spine, called the illicium, which is used to attract prey (Edgar *et al.*1982: 36). Handfish also have two separate dorsal fins, with the first having two spines (Last *et al.* 1983: 249). The

[1] Appendix 1 summarises available information on key characteristics of recognised handfish species.

pectoral fins of handfish are arm-like, and enable the species to crawl on the seafloor (Last *et al.* 1983: 249).

The ventral fins of handfish (the fins on the underside) are located near the throat and have one spine and four 'rays' (or points) (Last *et al.* 1983: 249). The gill openings are small pores that are located above and behind the pectoral fins (Last *et al.* 1983: 249). Handfish do not have true scales; they are either smooth skinned or covered with minute spines (Last *et al.* 1983: 249).

There is a varying amount of information on the diet of handfish. Handfish have been observed to feed on small worms and crustaceans (Pogonoski *et al.* 2002), but for the majority of the species there is very little known.

Handfish have an unusual reproductive strategy. Unlike most other fish species that have been observed, handfish species, such as the red and spotted handfish, lay one small egg mass in spring that consists of about 100-200 eggs (Bruce *et al.* 1997). The egg mass is attached to a vertical structure on the seafloor (such as a sponge) and is tended by the female until fully formed juveniles hatch, after 7-8 weeks (DEH 2004; DEH 2001; Bruce 1998).

These characteristics, when coupled with the relatively sedentary behaviour of the group, combine to greatly restrict the ability of handfish to increase rapidly in abundance and/or disperse. Thus, it is thought that once handfish abundance declines in a region, their recovery will be slow and their ability to recolonise disturbed areas will be limited (DEH 2004).

2. Species Profiles

2.1 Spotted handfish

2.1.1 Taxonomy

Class	Actinopterygii
Order	Lophiiformes
Family	Brachionichthyidae
Species	*Brachionichthys hirsutus*
Common name	Spotted handfish
Alternative names	Spiny handfish, Tortoiseshell fish (Last *et al.* 1983).

2.1.2 Description

Spotted handfish are small, colourful, slow moving benthic fish that are easily approached and photographed (see Figure 1). Spotted handfish grow to a maximum size of 120mm (Bruce *et al.* 1997). They use their illicium to probe egg masses, sometimes extending and resting it on the seafloor (Bruce *et al.* 1998). The species has a relatively short, rounded body that tapers towards the tail (Last *et al.* 1983: 250). The body is covered with tiny spines (Last *et al.* 1983: 250). The upper surface and sides of the head and body are white or pale pink, and they are covered with numerous orange, brown or black spots that have orange borders (Last *et al.* 1983: 250). The density of spots varies between individuals (Edgar *et al.* 1982: 36).

The markings on spotted handfish are also unique, which makes it possible to identify individuals within populations (Bruce *et al.* 1997). Individual patterns of spots do not change with season, substrate type or behaviour although some changes in pattern can be observed over time as individuals grow (i.e. larger spots may break in two; Bruce *et al.* 1999).

Figure 1: Spotted handfish, photo by T. Carter.

2.1.3 Distribution

Spotted handfish are endemic to south-eastern Tasmania, and have been found in areas of the lower Derwent River estuary, Frederick Henry Bay, D' Entrecasteaux Channel and the northern regions of Storm Bay (Figure 2; Bruce *et. al.* 1998). It appears that the majority of the population is now contained within small isolated areas within its historic range (Spotted Handfish Recovery Team 2002). Within the Derwent estuary, the total known area within which

spotted handfish may be found is approximately 3km^2, with most mature fish being found within an area of 0.6km^2 (Spotted Handfish Recovery Team 2002). In Frederick Henry Bay the known area of occupancy for the species is 0.3km^2 (Spotted Handfish Recovery Team 2002). Figure 2 identifies these sites and sites at which other species of handfish are found.

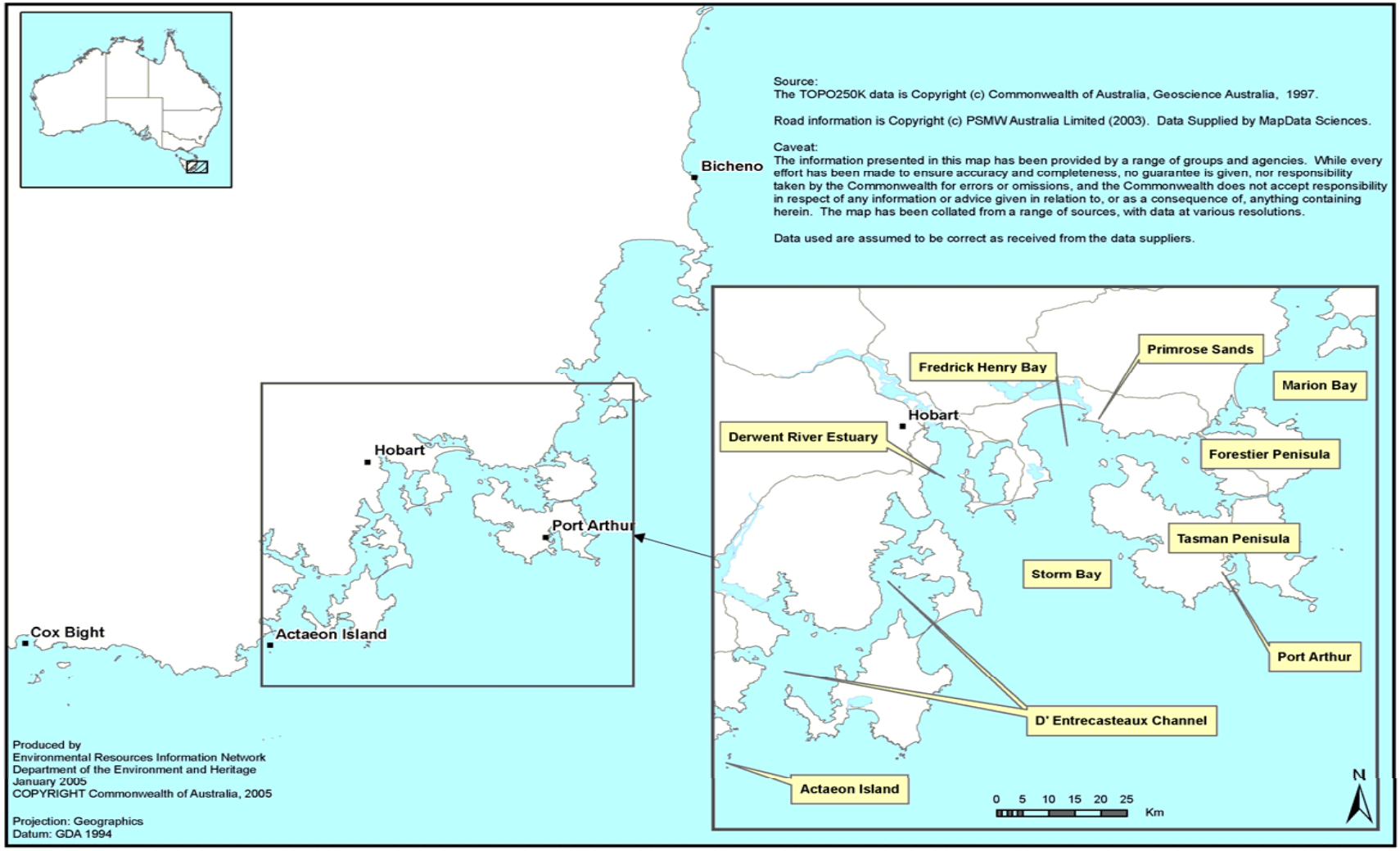

Figure 2: Key sites at which spotted, red, Waterfall Bay and Ziebell's handfish are found

Key spotted handfish sites are: the lower Derwent River estuary, Frederick Henry Bay, D' Entrecasteaux Channel and the northern regions of Storm Bay. Key red handfish sites are: Primrose Sands in Frederick Henry Bay, Port Arthur, Forestier Peninsula and at Actaeon Island. Key Waterfall Bay handfish sites appear to be: the Tasman and Forestier Peninsulas. The Ziebell's handfish is found along the east coast of Tasmania from Bicheno to Actaeon Island and in Cox Bight.

2.1.4 Life history characteristics

Life span

The longevity of spotted handfish is yet to be determined (Bruce *et al.* 1999: 378), however there is some information available on growth rate. Spotted handfish in the Derwent estuary at two years old are approximately 70mm in length (Green and Bruce 2001: 6). In their third year of growth, specimens attain a further 5-10mm in length, and approximately 2mm every year thereafter (Green and Bruce 2001: 6). This suggests that when spotted handfish in the Derwent estuary are 100mm long, they are 12-16 years of age (Green and Bruce 2001: 6). However, most of the spotted handfish found at sites surveyed in the Derwent estuary are 81-90mm in length, making them between 4-10 years of age (Green and Bruce 2001: 6).

The relative age and growth of spotted handfish obtained at one key site, Frederick Henry Bay, has made it difficult to draw conclusions about the lifespan of the species generally. At this site, the spotted handfish appears to grow larger and faster than at Derwent estuary sites (Green and Bruce 2001: 6). One specimen observed three times in 12 months had grown from 60mm to 93mm, which far exceeds growth rates observed at sites in the Derwent estuary (Green and Bruce 2001: 6). The reasons for this are unclear and more data on the growth of spotted handfish at this site needs to be collected (Green and Bruce 2001: 6).

Growth rates of females suggest that maturity is reached at 2-3 years of age, at a size of 75-80mm in length (Bruce *et al.* 1999: 378). Size of males at maturity is yet to be determined, however the smallest male to fertilize eggs in captivity was 87mm long (Bruce *et al.* 1999: 378).

Diet

Spotted handfish eat small crustaceans, polychaete worms (Bruce *et al.* 1998; Edgar *et al.* 1982: 36) and small molluscs (Kuiter 1996).

Reproduction

Spotted handfish have a low breeding capacity. The female lays 80-200 eggs that are held together in a vertical structure by threads (Last and Bruce 1996-97: 20) and generally attached to small, vertical, semi-rigid structures on the sea floor (Spotted Handfish Recovery Team 2002). The spotted handfish commonly uses stalked ascidians *(Sycozoa spp)*, seagrasses, sponges, small macrophytic algae and polychaete worm tubes as spawning substrates (Spotted Handfish Recovery Team 2002: 2).

Spawning generally occurs from September to October, during early spring (Pogonoski *et al.* 2002: 120; Last and Bruce 1996-97: 20). Spotted handfish in aquaria have been observed performing what appears to be courtship behaviour prior to spawning (Bruce *et al.* 1997). After laying the egg mass, the female guards the eggs for 6-7 weeks until they hatch (Bruce 1998). Eggs are approximately 4mm in diameter and are contained in 'flasks' that are inter-connected in a single mass by fine tubules (Last and Bruce 1996-97: 20). Eggs observed in aquaria began hatching 51 days after spawning and had finished hatching 57 days after spawning (Bruce *et al.* 1997). The spotted handfish does not have a pelagic larval phase, the eggs hatching into fully formed juveniles (Pogonoski *et al.* 2002). Hatchlings have been observed settling in the immediate area surrounding the location of the egg mass (Bruce *et al.* 1997).

2.1.5 Population

Size

Surveys and anecdotal reports suggest that there are approximately 300-400 mature spotted handfish within the areas that have been regularly surveyed (Spotted Handfish Recovery Team 2002). In the Derwent estuary two breeding colonies have been found (Spotted Handfish Recovery Team 2002). A single reproductive colony has been found in Frederick Henry Bay (Spotted Handfish Recovery Team 2002). These three sites are the only known areas within which spotted handfish are commonly found (Spotted Handfish Recovery Team 2002).

Trends

The spotted handfish was common throughout the lower Derwent estuary and adjoining bays prior to the mid 1980s, but has suffered a decline in distribution and abundance in recent years (Pogonoski *et al.* 2002: 120). Anecdotal reports cited in Bruce *et al.* (1999: 378) suggest that the population declined relatively rapidly in the 1980s around the Hobart region. This decline appears to have coincided with the introduction of the Northern Pacific seastar (Bruce *et al.* 1999: 378), which is believed to have been introduced in the 1970s or early 1980s as larvae in ballast water, or as juvenile or adult seastars on the hulls of international ships (CSIRO 1998). However the exact cause of the decline in spotted handfish populations is not fully understood (Bruce *et al.* 1999: 378).

Barrett *et al.* (1996) conducted a survey in 1996 and failed to locate spotted handfish in most of the locations where the species was historically common. However, a survey done at a site in the lower Derwent estuary in spring of 2002 suggested that the population of adults had recovered to those originally observed in the spring of 1998 (Green pers. comm. 13 July 2004). This population was found to have dropped to <25% of the level reported in autumn 2001, but juveniles were abundant, which was attributed to the installation of artificial spawning substrate (small plastic rods) before the 1999 breeding season (Green pers. comm. 13 July 2004).

The age structures of the three known colonies were assessed during surveys undertaken from 1998 to 2001 (Green and Bruce 2002). At one of the two sites in the lower Derwent estuary, the number of adult spotted handfish (those greater than 71mm in length) had declined over this period (Green and Bruce 2002). At another site in the lower Derwent estuary, a three-fold increase in mature fish was observed in spring 1999 (Green and Bruce 2002). The reason for this increase is unknown but it is considered likely that fish may have moved into the area to breed (Green and Bruce 2002).

Determining the age structure of the population at the site at Frederick Henry Bay is difficult as a significant proportion of the spotted handfish observed there were greater than 100mm in length (Green and Bruce 2002). The criteria used to estimate age at the Derwent estuary sites therefore may not be directly transferable to this site. The number of mature fish observed at this site (those greater than 71mm) doubled in spring 2000 (Green and Bruce 2002). This increase was attributed to fish moving into the area to breed (Green and Bruce 2002). However, comparatively few immature fish (less than 71mm) were found at this site in spring 2000, despite the presence of available spawning substrate at this site (Green and Bruce 2002). The small immature population observed at this site during this survey is attributed to the exposure of this site to weather which can dislodge or damage egg masses and reduce hatchling production (Green and Bruce 2002).

2.1.6 Important habitat of the spotted handfish

Spotted handfish are commonly found in areas in which the seafloor is made up of coarse sand and shell grit or over areas of fine sand and silt (Spotted Handfish Recovery Team 2002: 2). The species has been recorded from depths between 2-30 meters but observations suggest that they are most common in 5-10 meters (Spotted Handfish Recovery Team 2002: 2). They are often found in shallow, shell-filled hollows near rocks (Bruce *et al.* 1998).

Availability of suitable spawning substrate (as detailed in section 2.1.5) appears to be critical to the reproduction capacity of spotted handfish. Due to their limited distribution and observed decline, all of the areas within which spotted handfish are found can thus be considered important habitat.

2.1.7 Threats

The cause of the reported decline of the spotted handfish has not been determined. The principle threat to spotted handfish appears to be reduced abundance and distribution of benthic organisms suitable for egg mass attachment (Spotted Handfish Recovery Team 2002: 3). This reduction in abundance and distribution of suitable spawning substrate appears to limit the reproductive success of spotted handfish (Spotted Handfish Recovery Team 2002: 3). The reasons for this reduction in spawning substrate are not entirely clear (Bruce *at al.* 1999; Green and Bruce 2001). Suggested causes include the cumulative impact of pollution from industrial, storm-water and human effluent sources; heavy metal contamination of sediments; increasing siltation caused by land clearing; and the introduction of the Northern Pacific seastar (Spotted Handfish Recovery Team 2002; Green and Bruce 2001; Bruce *et al.* 1999).

Whilst the decline of the spotted handfish at sites in the Derwent estuary is not fully understood, it appears to have coincided with the discovery of and increase in abundance of the Northern Pacific seastar (Bruce *et al.* 1999). The Northern Pacific seastar is now abundant in areas where spotted handfish were once common. The primary impact of the Northern Pacific seastar on handfish colonies appears to be caused by its predation on spawning substrate, such as stalked ascidians (Bruce and Green 1999).

Another threat observed at a site in the Derwent estuary was a high abundance of a fast growing oyster *(Electroma georgiana)* that attaches to spotted handfish egg masses. The proliferation of this oyster, at this site, 'may have affected the recruitment of spotted handfish by smothering egg masses, hindering development and hatching of emerging fish or by smothering sediments and restricting access of small juvenile fish to benthic prey' (Green and Bruce 2000: 10).

At the Frederick Henry Bay site, storms during the breeding season of the spotted handfish over successive years could threaten the population (Spotted Handfish Recovery Team 2002). This is because seagrass forms a part of the primary spawning substrate at this site and is susceptible to storm damage. Apart from seagrass and algae being important for the reproduction of the spotted handfish, they also provide habitat for invertebrates upon which spotted handfish prey (Spotted Handfish Recovery Team 2002: 3). Thus, decreasing areas of seagrass and algae are likely to impact food availability for spotted handfish populations.

Historically scallop dredging and Danish seine fishing have occurred in the D' Entrecasteaux Channel, at Frederick Henry Bay and at Storm Bay (Spotted Handfish Recovery Team 2002). However there has been no commercial or recreational scallop dredging in the D'Entrecasteaux Channel, Frederick Henry Bay or Storm Bay since the late 1980s and there has not been any Danish Seine fishing in the D'Entrecasteaux Channel or Frederick Henry

Bay since at least 1995 (Pullen pers. comm. 2005). These fishing practices are thought to have decreased the area of important habitat to spotted handfish and caused population declines in these areas (Spotted Handfish Recovery Team 2002). Apart from these fishing practices, any form of fishing that degrades the benthic habitat of the spotted handfish can be considered to pose a threat to the species (Spotted Handfish Recovery Team 2002).

2.1.8 Current efforts to manage threats

Collection

Collection of spotted handfish is an offence in Tasmania unless a permit has been issued under the *Living Marine Resources Management Act 1995*. However, the Tasmanian Department of Primary Industries, Water and Environment have never issued a permit for the take of handfish other than for scientific research (Pullen pers. comm. 2005).

Captive breeding and release

Spotted handfish have been bred successfully in captivity (Bruce *et al.* 1997). Spotted handfish were initially bred in captivity in 1996, however all of the juveniles in that trial died within 29 days of hatching (Bruce *et al.* 1997). The cause of hatchling mortality was not fully understood but coincided with critical stages in the life history of the species (Bruce *et al.* 1997). In 1997/98 eighteen juvenile spotted handfish were spawned, hatched and raised in captivity to an age of seven months (Green and Bruce 2000). These fish were hatched from two egg masses that totaled approximately 200 eggs (Green and Bruce 2000). The total survival rate from these egg masses was approximately 9% of spawned eggs and 34% of hatchlings (Green and Bruce 2000). In 1998/1999, 158 (37%) of 423 hatchlings survived in captivity to an age of 6 months (Green and Bruce 2000). All of these handfish were tagged and the surviving 155 (three died after tagging) were released at the site from which their parents had been captured (Green and Bruce 2000). However, in surveys post October 1999 no sightings of these tagged handfish were made, which suggests high mortality post release (Green and Bruce 2001).

Artificial spawning substrate

The introduction of artificial spawning substrate has been trialed at two sites in the Derwent estuary after trials in aquaria showed that spotted handfish would use plastic rods as spawning substrate (Green and Bruce 2000). These rods were buried in the sand to form vertical structures on the seafloor that spotted handfish may use as alternative spawning substrate to stalked ascidians (Green and Bruce 2001). During the breeding season at one of the two sites, 52 egg masses were observed attached to the artificial spawning substrates, with only two egg masses attached to stalked ascidians (Green and Bruce 2000). The artificial spawning substrate at the other site was not as successful, with most lost due to heavy weather (Green and Bruce 2000).

To further assess the capacity of artificial spawning substrate to increase spawning and reproductive success, it was deployed again in 1999 at a site in the lower Derwent estuary (Green and Bruce 2001). Of the 550 artificial spawning substrates deployed at the site in 1999, 420 remained in 2000 and 11 had been used for spawning (Green and Bruce 2001). The installation of artificial spawning substrate thus appears to increase spawning in areas where natural spawning substrate has become depleted. However there are some problems with the use of artificial spawning substrate that may affect the rate of hatchling emergence (Bruce 1998), namely:

- the growth of algae and the settlement of native oysters on the artificial spawning substrate, which have been observed smothering egg masses; and

- artificial spawning substrate is susceptible to being washed away during storms (Bruce 1998).

Habitat rehabilitation and population surveys
In 2002, algae *(Caulerpa spp.)* was transplanted from Frederick Henry Bay to a site in the lower Derwent estuary at which spawning substrate was depleted (Green and Coughanowr 2003). These algae are used as spawning substrate at the Frederick Henry Bay, and initial results at the site in the lower Derwent estuary have also been encouraging (Green and Coughanowr 2003).

In 2004, a project to assess the abundance of the Northern Pacific seastar in order to quantify and restore spawning substrate and to conduct population surveys was funded through the Australian Government's Natural Heritage Trust. At the time of writing this project is still underway and involves further transplantations of algae (*Caulerpa sp*.) to rehabilitate spawning substrate at a site in the Derwent estuary. Under this project, population surveys will also be conducted at previously surveyed sites and at an additional two sites in Frederick Henry Bay (Green pers. comm. 29 November 2004).

Fishing restrictions
Scallop dredging is no longer permitted in the range of the spotted handfish (Spotted Handfish Recovery Team 2002). Danish seine fishing is prohibited in the Derwent estuary and within one nautical mile of the shore (Spotted Handfish Recovery Team 2002). At the time of writing, there was only one Danish seine fishing licence holder operating out of Hobart (Pullen pers. comm. 2005). Whilst these restrictions on Danish seine fishing provide some protection to known spotted handfish populations, Danish seine fishing still occurs within the historic range of spotted handfish (Spotted Handfish Recovery Team 2002).

Storm water management
Water quality in the Derwent estuary has improved over the last ten years (Coughanowr 1997). Local Councils bordering the Derwent estuary have conducted a number of storm water projects over the five year period from 1999 to 2004 (Tasmanian Government 2004). These projects have included the installation of gross pollutant traps, restoring wetlands and education programs (Tasmanian Government 2004). A review of the water quality of the Derwent estuary showed that between 1997 and 2003 there was general improvement, with reductions in faecal bacteria and heavy metal loads in the system (Green and Coughanowr 2003).

Reducing heavy metal contamination
The level of heavy metals measured in biota in the Derwent estuary has decreased since the 1970s (Dineen and Noller 1995). The Australian and Tasmanian Governments jointly funded a project in 2003 to identify the worst affected areas and how best to avoid further heavy metal contamination.

2.1.9 Issues for the recovery of the species

- The spotted handfish has a restricted, fragmented distribution and is uncommon within its range.
- The spotted handfish has a low reproductive capacity and a very low rate of dispersal.
- The species is known to have declined in abundance since the 1980s (Pogonoski *et al.* 2002: 120).
- The greatest threat to the species seems to be habitat degradation, namely reduced

abundance and distribution of benthic organisms suitable for egg mass attachment. This decline in abundance of spawning substrate appears to have been caused by the cumulative impact of pollution from industrial, storm-water and human effluent sources; heavy metal contamination of sediments; increasing siltation caused by land clearing; and the introduction of the Northern Pacific seastar (Spotted Handfish Recovery Team 2002).

- The spotted handfish is also threatened by collection for aquarium display (Spotted Handfish Recovery Team 2002). However under the *Living Marine Resources Management Act 1995* collection is only allowed if the Tasmanian Minister for Environment and Planning has issued a permit (Pullen pers. comm. 2005).
- Key information gaps for the species include precise information on habitat, distribution, abundance and threats.

2.2 Red handfish

2.2.1 Taxonomy

Class	Actinopterygii
Order	Lophiiformes
Family	Brachionichthyidae
Species	*Brachionichthys politus*
Common name	Red handfish

2.2.2 Description

Red handfish are small, slow moving benthic fish that are mostly red in colour (see Figure 3). The species grows to a maximum size of 80mm in length and has a moderately short and slightly compressed body that tapers towards the tail (Last *et al.* 1983: 251). Red handfish are 'covered in fleshy wart like papillae' (Last *et al.* 1983: 251). Unlike spotted handfish, this species is not covered in tiny spines (Last *et al.* 1983: 251).

The upper surface and sides of red handfish are red with lighter areas of pink (Last *et al.* 1983: 251, see Figure 3). They also have small darker patches on the sides (Last *et al.* 1983: 251). The ventral surface is light pink or white (Last *et al.* 1983: 251). The iris is bright red and the pupil is black (Last *et al.* 1983: 251). The dorsal, caudal (tail fin) and anal fins, and the upper surfaces of the ventral and pectoral fins have alternating pink, red and bright blue markings (Last *et al.* 1983: 251). The fin margins and lower surfaces of the ventral and pectoral fins are mostly pink or white (Last *et al.* 1983: 251).

Figure 3: A front view of a red handfish photo by T. Carter

2.2.3 Distribution

The red handfish was first collected near Port Arthur in the 19th Century and has only been recently rediscovered at a small reef near the Actaeon Islands (Last *et al.* 1983: 251). The largest known population has been found at Frederick Henry Bay (DEH 2004). The species has also been found from Port Arthur to Marion Bay (DEH 2004). Six specimens have been collected from around the Forestier Peninsula and the Actaeon Islands (Pogonoski *et al.* 2002).

2.2.4 Life history characteristics

Life span

There has been no research conducted on the age-growth relationship of red handfish (Bruce *et al.* 1997). During surveys conducted at a site in 1996, observed specimens ranged in size from 50-80mm in length (Bruce *et al.* 1997). Three of the four pairs observed differed markedly in size, with the difference in size of specimens being between 6 and 30mm (Bruce *et al.* 1997). These observations suggest that there is a sexual dimorphism in this species, with males being smaller than females and having dark markings between the rays of the first dorsal and pectoral fin (Bruce *et al.* 1997).

Diet

The red handfish feeds on small crustaceans and worms (Edgar *et al.* 1982: 36).

Reproduction

During the surveys conducted in 1996, egg masses were observed in late October and early November (Bruce *et al.* 1997). The egg masses observed varied in size from an estimated 30-60 eggs (Bruce *et al.* 1997). The structure of the egg masses were similar to those of the spotted handfish, with eggs contained in transparent 'flasks' connected by tubules (Bruce *et al.* 1997). All of the egg masses observed in the field were guarded by an adult red handfish and were attached to the same green alga *(Caulerpa simpliciuscula)* (Bruce *et al.* 1997).

Observations of red handfish in aquaria suggest that females guard the eggs until hatching (Bruce *et al.* 1997). The act of spawning has also been observed in aquaria and takes over nine hours (Bruce *et al.* 1997). Upon hatching, red handfish are fully developed and are yellow/orange (Bruce *et al.* 1997). Some specimens have a pattern of black and white markings on their pectoral fins (Bruce *et al.* 1997).

Anecdotal reports suggest that the red handfish has a low reproductive rate and a very low rate of dispersal. Once hatched, juveniles have been observed to settle immediately in the vicinity of the egg mass (DEH 2004).

2.2.5 Population

Size

The red handfish population has not been systematically surveyed (Green pers. comm. 13 July 2004; Gowlett-Holmes pers. comm. 30 November 2004). The red handfish however seem to have a very small and fragmented population and is currently confined to less than ten sites in south-eastern Tasmanian waters, covering a total area of no more than a few hundred square kilometers (DEH 2004). The species has a very restricted distribution and is uncommon within its range. The largest known population, estimated at about 12 individuals, occurs inshore in Frederick Henry Bay (DEH 2004). These factors make it unlikely that the overall population of the species exceeds one thousand individuals in the wild (DEH 2004).

Trends

The red handfish population is not known to have declined (Bruce *et al.* 1999: 370) but the lack of systematic survey of the species makes it impossible to determine whether populations are increasing, decreasing or stable.

2.2.6 Important habitat of red handfish

The surveys conducted during 1996 indicated that red handfish live around reefs in more exposed areas than those in which spotted handfish are typically found (Bruce *et al.* 1997). During these surveys, red handfish were also found in a variety of locations, such as on the top of rocks, amongst macro-algae and in sandy areas between rocks and the reef-sand interface (Bruce *et al.* 1997). The species inhabits mixed sand and rocky reef habitats at depths of between 2 and 20m (DEH 2004).

The green alga *(Caulerpa simpliciuscula)* that has been observed to be their preferred spawning substrate of red handfish appears to be critical to spawning success. Unlike spotted handfish bred in captivity, red handfish did not use the artificial spawning substrate provided (see Bruce *et al.* 1997).

Due to their limited distribution, all of the areas within which red handfish are found can be considered important habitat.

2.2.7 Threats

The species is under pressure from collection. The species is of interest to private and commercial aquarium collectors because of its unusual appearance, and there have been anecdotal reports that the red handfish is one of several Tasmanian handfish species subject to small scale collection for illegal trade (DEH 2004). Scientists regard collection as a threat to the red handfish because of the ease with which this species can be taken (DEH 2004). The threat of collection, combined with the species' low reproductive rate and highly restricted distribution, has the potential to cause a rapid and unsustainable population decline (DEH 2004).

2.2.8 Current efforts to manage threats

Captive breeding

Breeding red handfish in captivity was attempted but was unsuccessful, as the egg masses spawned by two females were not fertilised by the males in their respective tanks (Bruce *et al.* 1997). It is unknown why the eggs were not fertilised, but no courtship behaviour was observed. It is thus considered likely that the males used were too young to fertilise the eggs (Bruce *et al.* 1997).

Collection

Collection of red handfish is an offence in Tasmania unless a permit has been issued under the *Living Marine Resources Management Act 1995*. However, the Tasmanian Department of Primary Industries, Water and Environment have never issued a permit for the take of handfish other than for scientific research (Pullen pers. comm. 2005).

2.2.9 Issues for the recovery of the species

- The red handfish has a restricted, fragmented distribution and is uncommon within its range.
- The red handfish appears to have a low reproductive rate and a very low rate of dispersal.
- The preferred spawning substrate of the red handfish is the green alga *Caulerpa simpliciuscula*. The red handfish has not been observed using artificial spawning substrate, which may mean that *Caulerpa* is critical as a spawning substrate.

- Collection is a key threat to red handfish as the species can be easily taken and is prized by fish collectors. However under the *Living Marine Resources Management Act 1995* collection is only allowed if the Minister for Environment and Planning has issued a permit (Pullen pers. comm. 2005).
- Protection of habitat critical to the red handfish will be important to its survival in the wild.
- Information gaps for this species include precise information on habitat, distribution, abundance and threats.

2.3 Waterfall Bay handfish

2.3.1 Taxonomy

Class	Actinopterygii
Order	Lophiiformes
Family	Brachionichthyidae
Species	*Sympterichthys* sp. [CSIRO #T1996.01]
Common name	Waterfall Bay handfish

Taxonomic issues

The taxonomy of this species has not been resolved; however, it is likely that the Waterfall Bay and Ziebell's handfish populations may represent colour morphs within the one species (Last pers. comm. 10 December 2004; Gowlett-Holmes pers. comm. 30 November 2004).

2.3.2 Description

There is no published description of the Waterfall Bay handfish available.

2.3.3 Distribution

There is no published information on the distribution of the Waterfall Bay handfish. However anecdotal reports suggest the species may be observed around the Tasman and Forestier Peninsulas area (Gowlett-Holmes pers. comm. 30 November 2004).

2.3.4 Life history characteristics

There is no published information on the life span, diet or reproduction of the Waterfall Bay handfish.

2.3.5 Population

There is no published information on the population of the Waterfall Bay handfish. However it is considered likely to be rare within its range. There is no evidence of population decline, but the lack of systematic survey of the species makes it impossible to determine whether populations are increasing, decreasing or stable.

2.3.6 Important habitat of Waterfall Bay handfish

There is no published information on the habitat of this species, however, it is likely to have a restricted distribution and a low rate of dispersal. Therefore, all areas within which the Waterfall Bay handfish can be found should be considered important.

2.3.7 Threats

Threats to this species have not been identified. However, it is considered that the species is likely to suffer similar threats to those of other handfish species listed as threatened under the EPBC Act.

2.3.8 Current efforts to manage threats

Collection of handfish is an offence in Tasmania unless a permit has been issued under the *Living Marine Resources Management Act 1995*. However, the Tasmanian Department of Primary Industries, Water and Environment have never issued a permit for the take of handfish other than for scientific research (Pullen pers. comm. 2005).

2.3.9 Issues for the recovery of the species

- There is very little published information on this species.
- Information gaps for this species include precise information on habitat, distribution, abundance and threats.
- The Waterfall Bay handfish appears to have a restricted distribution and low abundance and is believed to have a low reproductive rate and limited dispersal.
- Collection is probably the key threat to Waterfall Bay handfish. However under the *Living Marine Resources Management Act 1995* collection is only allowed if the Tasmanian Minister for Environment and Planning has issued a permit (Pullen pers. comm. 2005).

2.4 Ziebell's handfish

2.4.1 Taxonomy

Class	Actinopterygii
Order	Lophiiformes
Family	Brachionichthyidae
Species	*Sympterichthys sp.* [CSIRO #T6.01]
Other scientific names	*Brachionichthys sp. 1* (Edgar *et al.* 1982: 38).
Common name	Ziebell's handfish
Alternative names	Actaeon handfish, Yellow-finned handfish (Pogonoski *et al.* 2002: 127, Last *et al.* 1983: 251).

Taxonomic issues

The taxonomy of this species has not yet been resolved, however it is likely that the Waterfall Bay and Ziebell's handfish populations may represent colour morphs within the one species (Last pers. comm. 10 December 2004; Gowlett-Holmes pers. comm. 30 November 2004).

2.4.2 Description

Ziebell's handfish is the largest handfish species identified, reaching a maximum size of 150mm in length (Last *et al.* 1983: 252). Like all of the other handfish species covered by this paper Ziebell's handfish are colourful, relatively sedentary benthic fish (DEH 2001; Figure 6).

The Ziebell's handfish has a relatively short, rounded body that tapers toward the tail (Last *et al.* 1983: 251). It has loose, smooth skin unlike the red handfish, which has papillae, and the spotted handfish, which has spines (Last *et al.* 1983: 251). The body is pink white, with the upper surface and sides having purple to brown randomly-placed blotches (Last *et al.*1983: 251). The fins are generally bright yellow. In some specimens, the yellow extends onto the body adjacent to the fins (Last *et al.* 1983: 251). The modified first dorsal spine or illicium is pink to white (Last *et al.* 1983: 251).

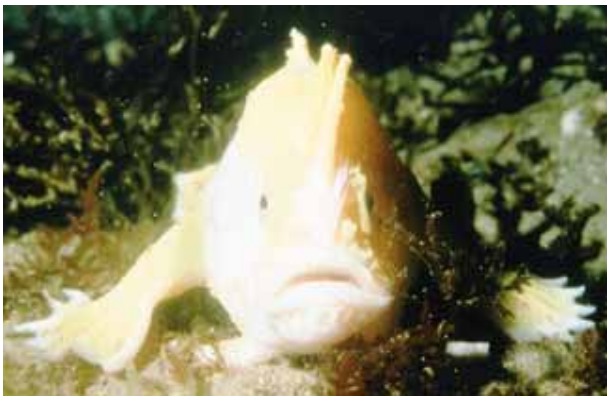

Figure 4: The front view of a Ziebell's handfish, photo by Peter Last.

2.4.3 Distribution

Ziebell's handfish has been found between Bicheno and the Actaeon Islands along the east coast of Tasmania and at Cox Bight in southern Tasmania (Last pers. comm. cited in Pogonoski *et al.* 2002: 127). It is currently known from three fragmented populations at the Actaeon Islands, in

Cox Bight and at the Tasman Peninsula (DEH 2001). The Tasmanian Underwater Photography Society only discovered the species during surveys in 1977-81 (DEH 2001). Since its discovery, dive groups have undertaken *adhoc* surveys and have found that the Actaeon Island population appears to be confined to a rocky-bottomed area of about 20km^2 (DEH 2001).

2.4.4 Life history characteristics

Life span
There is no published information on the life span of the species.

Diet
The diet of this species is relatively unknown but probably consists of small invertebrates (Pogonoski *et al.* 2002: 127) such as crustaceans and worms (Edgar *et al.* 1982: 38). Individuals have been known to survive in aquaria on shrimp for long periods (Pogonoski *et al.* 2002: 127).

Reproduction
Egg masses have been found around sponges in depths of twenty meters (Pogonoski *et al.* 2002: 127). Bruce *et al.* (1999) stated that the egg masses of Ziebell's handfish are very similar to those of the spotted handfish. Once hatched, juveniles have been observed settling in the immediate area surrounding the location of the egg mass (DEH 2001).

2.4.5 Population

Size
The Ziebell's handfish population has not been systematically surveyed (Green pers. comm. 13 July 2004; Gowlett-Holmes pers. comm. 30 November 2004). However adhoc surveys done by Tasmanian dive groups suggest that the population of Ziebell's handfish is small (DEH 2001).

Trends
There is no evidence of population decline, but the lack of systematic survey of the species makes it impossible to determine whether populations are increasing, decreasing or stable.

2.4.6 Important habitat of Ziebell's handfish

The Ziebell's handfish has been found on the edge of towering kelp *(Marcrocystis pyrifera)* at the Actaeon Islands and in Cox's Bight (Edgar *et al.* 1982: 38; Last *et al.* 1983: 252). The species is found at depths of between 3 and 20m (DEH 2001). The Ziebell's handfish appears to require soft-bottomed habitats, with patches of rock that support sponge and algae communities, which they use as spawning substrate (DEH 2001).

Due to the restricted distribution of known populations of Ziebell's handfish and their low dispersal, the areas in which they are found should be considered important habitat.

2.4.7 Threats

The threats to the Ziebell's handfish have not been determined. Suggested threats include habitat degradation and collection (DEH 2001). Anecdotal reports suggest that Ziebell's handfish is subject to collection and small-scale illegal trade (DEH 2001).

2.4.8 Current efforts to manage threats

Collection of handfish is an offence in Tasmania unless a permit has been issued under the *Living Marine Resources Management Act 1995*. However, the Tasmanian Department of Primary Industries, Water and Environment has never issued a permit for the take of handfish other than for scientific research (Pullen pers. comm. 2005).

2.4.9 Issues for the recovery of the species

- There is very little published information on this species.
- Information gaps for this species include precise information on habitat, distribution, abundance and threats.
- The Ziebell's handfish appears to have a restricted distribution and low abundance and is believed to have a low reproductive rate and limited dispersal.
- Collection is probably the key threat to Ziebell's handfish. However under the *Living Marine Resources Management Act 1995* collection is only allowed if the Minister has issued a permit.

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Appendix 1: Summary of recognised handfish species

Common Name	Scientific Name	Description	Distribution and Habitat
Spotted handfish	*Brachionichthys hirsutus*	Short rounded body, tapers towards the tail. Coloured white to pinkish and covered with orange, brown or black spots. Reaches a maximum size of 120mm (Last *et al.* 1983).	Endemic to Tasmania – found in Derwent estuary and surrounding bays. Occurs on coarse to fine sand in depths of 5-40m (Pogonoski *et al.* 2002).
Red handfish	*Brachionichthys politus*	Short rounded body, tapers towards tail. Coloured red with lighter areas of pink. Reaches a maximum size of 80mm (Last *et al.* 1983).	Endemic to Tasmania – found around Port Arthur region and at the Actaeon Islands (Pogonoski *et al.* 2002). Occurs on sand and around rocky reefs in depths of 2-20m (Pogonoski *et al.* 2002).
Waterfall Bay handfish	*Sympterichthys sp.* [CSIRO #T1996.01]	There is no published description of this species. There are taxonomic issues with this species. The Waterfall Bay and Ziebell's handfish populations may represent colour morphs within the one species.	Endemic to Tasmania – found around the Tasman and Forestier Peninsula area. Occurs around rocky reefs in depths of 20-25m and in caves at depths of 12m
Ziebell's handfish	*Sympterichthys sp.* [CSIRO #T6.01]	Short rounded body, tapers towards the tail. Loose smooth skin. Coulored pinkish white with purple/brown blotches and yellow fins. Reaches a maximum size of 150mm (Last *et al.* 1983). However, there are taxonomic issues with this species (as outlined above).	Endemic to Tasmania – found from Bicheno to the Actaeon Islands along the east coast of Tasmania and at Cox's Bight in southern Tasmania (Last pers. comm. cited in Pogonoski *et al.* 2002: 127). Occurs on the edge of forests of towering kelp over sand at the Actaeon Islands and in Cox's Bight (Edgar *et al.* 1982: 38).
Australian handfish	*Brachionichthys sp. 2* (Last *et al.* 1983).	Short rounded body, tapers towards the tail. Covered with minute spines. Coloured white with yellow or orange lines. Reaches a maximum size 80mm.	Found from southern Queensland to South Australia and Tasmania (Pogonoski *et al.* 2002: 124). Rarely found in shallow water, prefers waters of 40-100m (Pogonoski *et al.* 2002: 124).
Storm Bay handfish	*Brachionichthys sp. 3* (Last *et al.* 1983).	Short rounded body, tapers towards the tail. Covered with fleshy wart-like papillae, does not have spinules. Coloured grey to white with faint black blotches. Reaches a maximum size of 80mm (Last *et al.* 1983).	Endemic to Tasmania (Last *et al.* 1983). Nothing is known about the habitat of this species, as only one specimen has been collected at Storm Bay (Last *et al.* 1983).
Warty handfish	*Sympterichthys verrucosus*	There is no published description of this species. Collected specimens have ranged between 42-75mm (Pogonoski et al. 2002).	Continental shelf waters from South Australia east to at least the New South Wales –Victoria border (Pogonoski *et al.* 2002: 127). Nothing is known

Common Name	Scientific Name	Description	Distribution and Habitat
			about the habitat of the species except that it is found at depths of 82-225m (Pogonoski *et al.* 2002)
Loney's handfish	*Brachionichthys sp. 3* (Edgar *et al.* 1982).	There is no published description of this species. It reaches a maximum size of 150mm (Edgar *et al.* 1982).	Endemic to Tasmania – found only at Waterfall Bay on the Tasman Peninsula (Edgar *et al.* 1982). Rocky reef (Edgar *et al.* 1982).