# Syngnathids of the Spencer Gulf
## – morphometrics and isotopic signatures

Report to Nature Foundation SA Inc.

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Cover photograph of Leafy Seadragon by S. Sorokin/AIMS

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## ACKNOWLEDGEMENTS

The Spencer Gulf prawn bycatch survey was funded by PIRSA Fisheries and the Spencer Gulf and West Coast Prawn Fishermen's Association. Examination of the Syngnathid specimens was funded by Nature Foundation SA Inc. SARDI Aquatic Sciences provided substantial in kind support. Specimens were collected at sea by Dave Craig, Cameron Dixon, Derek Hamer, Graham Hooper, Chris Izzo, Shane Roberts and Kate Rodda. Specimens were weighed, photographed and preserved by Stuart Alexander, Lorenzo Andreacchio, Nadine Hackett and Luciana Bucater. Ralph Foster provided data from the South Australian Museum. Karl Shelley helped with pipefish measurements. Sasi Nayar and Milena Fernandes provided advice on the stable isotope analysis. Michelle Braley and Sonja Hoare provided access and advice for freeze-drying and grinding of the specimens. Special thanks to Kathryn Wiltshire for speeding up the grinding process.

## EXECUTIVE SUMMARY

This report presents results and key findings from a laboratory study of seven Syngnathid species (*Filicampus tigris*, *Hippocampus bleekeri*, *Histiogamphelus cristatus, Leptoichthys fistularius*, *Phycodurus eques, Phyllopteryx taeniolatus*, and *Stigmatopora argus*) collected opportunistically as bycatch during a prawn trawl survey of Spencer Gulf in February 2007.

Morphometric data were obtained from a total of 112 individuals and used to examine spatial variations in population structure. Stable isotope signatures were also examined in two seadragon species (*P. taeniolatus* and *P. eques*) and one seahorse species (*H. bleekeri*) to assess trophic linkages to the adjacent benthos.

Size frequency data indicated that the potbelly seahorse (*H. bleekeri*) reproduced throughout the year. In contrast, two seadragon species (*P. taeniolatus* and *P. eques*) showed distinctly annual periodicity in reproduction. These results were consistent with other published data for southern Australia.

The isotopic signatures ($\delta^{13}$C and $\delta^{15}$N values) for seadragons (*P. taeniolatus* and *P. eques*) and potbelly seahorse (*H. bleekeri*) were similar, indicating that they occupy similar trophic levels in Spencer Gulf. The $\delta^{15}$N values for all three species increased significantly with size, and smaller fish were found to feed at half a trophic level below larger fish.

The $\delta^{15}$N values for weedy seadragons (*P. taeniolatus*) were found to increase significantly with depth.

While $\delta^{13}$C values showed no clear spatial patterns, a strong latitudinal gradient was observed in $\delta^{15}$N values. Notably, $\delta^{15}$N values for *P. taeniolatus, P. eques* and *H. bleekeri* all increased significantly towards the top of the gulf. It is suggested that this geographical pattern reflects reduced flushing and increased nutrient loading in the upper gulf.

Because the isotopic signatures for male and female seahorses (*H. bleekeri*) did not differ significantly, there was no evidence for any gender-related differences in diet for this species.

The $\delta^{15}$N values were generally higher in seahorses collected for sites where seagrass was not collected in trawls. Unfortunately the significance of this result is unclear, as the presence of seagrass in any given trawl was not necessarily an

accurate indication of its growth at a particular site (i.e. due to the widespread occurrence of drifting bundles of live detached seagrass).

This study provides some important insights into the biology and distribution of Syngnathids in Spencer Gulf, and highlights significant gaps in our understanding of these protected species. In particular, further work is needed, to better estimate population sizes and the risks posed to these by human impacts (e.g. fishing and pollution).

# 1. INTRODUCTION

## 1.1 Background

### 1.1.1 Syngnathidae

There are approximately 320 species of seahorse, sea dragons and pipefishes (Family Syngnathidae) worldwide, of which approximately 34 occur in southern Australia (Kuiter 1999). Although this group of fish is assigned total protection status in South Australia, much remains unknown about their biology and distribution. Priorities for research include a better understanding of their population dynamics and critical habitats (Pognoske et al. 2002; Browne 2003), as well as better information on their dietary requirements, growth rates, reproductive output and vulnerabilities to human impacts (Foster and Vincent 2004, Martin-Smith 2006).

All Syngnathidae are listed species under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act*) and are protected from activities that may result in their death or injury (DEWHA 2009). In addition, in South Australia the family Syngnathidae is fully protected under the Fisheries Management Act 2007. Their protection is due to 'The uncertainty regarding the conservation status of many Syngnathids' (PIRSA 2006).

### 1.1.2 Stable Isotope analysis

Carbon and Nitrogen make up about 50% of the dry weight of living organisms. These elements naturally occur as stable isotopes $^{12}C$, $^{13}C$, and $^{14}N$, $^{15}N$ – the heavier isotope of each being a much rarer component than the lighter isotope. Animals take on the isotopic composition of the prey that they consume. During synthesis into new tissue the isotopic ratio of the heavier isotope to the lighter isotope is very slightly enriched in a process called fractionation. This enrichment enables researchers to use the naturally variable ratios between the stable isotopes of Carbon ($^{13}C/^{12}C$) and Nitrogen ($^{15}N/^{14}N$) to assign an 'isotopic signature' to an animal and to ascertain where it is situated in a food chain. In particular, stable isotope measurements are useful for tracing the transfer of organic matter in benthic food webs (Peterson 1999) and for examining links between benthic habitats and fishes (Connolly et al. 2005; Hindell 2006).

## 1.2 Objectives

During February 2007, SARDI researches undertook a gulf-wide survey to quantify the distribution of marine organisms on the seafloor in the Spencer Gulf. This survey was principally designed to underpin a risk assessment of bycatch in the Spencer Gulf Prawn Fishery, and involved the collection, in trawl shots, of approximately 4.2 tonnes of marine biota from 120 depth-stratified sampling stations. Of the 395 benthic species collected during the trawl survey, seven were representatives of the family Syngnathidae. This preserved collection offers unprecedented information on the composition and distribution of Syngnathids in the Spencer Gulf.

The purpose of this report is to:

1. Document the geographical distributions of all seven Syngnathid species collected from the Spencer Gulf.
2. Describe the external morphological characteristics of each Syngnathid species, and evaluate the significance of any spatial or sexual dimorphism.
3. Document the stable isotope values of the three most abundant Syngnathid species collected from the Spencer Gulf and evaluate spatial variations in relation to environmental conditions.

## 2. METHODS

Syngnathids were collected in trawl shots at up to 120 sampling locations (>10 m depth) in Spencer Gulf, during a fishery-independent survey of prawn bycatch in February 2007. The survey stations are shown in Figure 1 and distribution of the seven Syngnathids in Figure 2. Full details of the survey methods are presented in Currie et al. (2009).

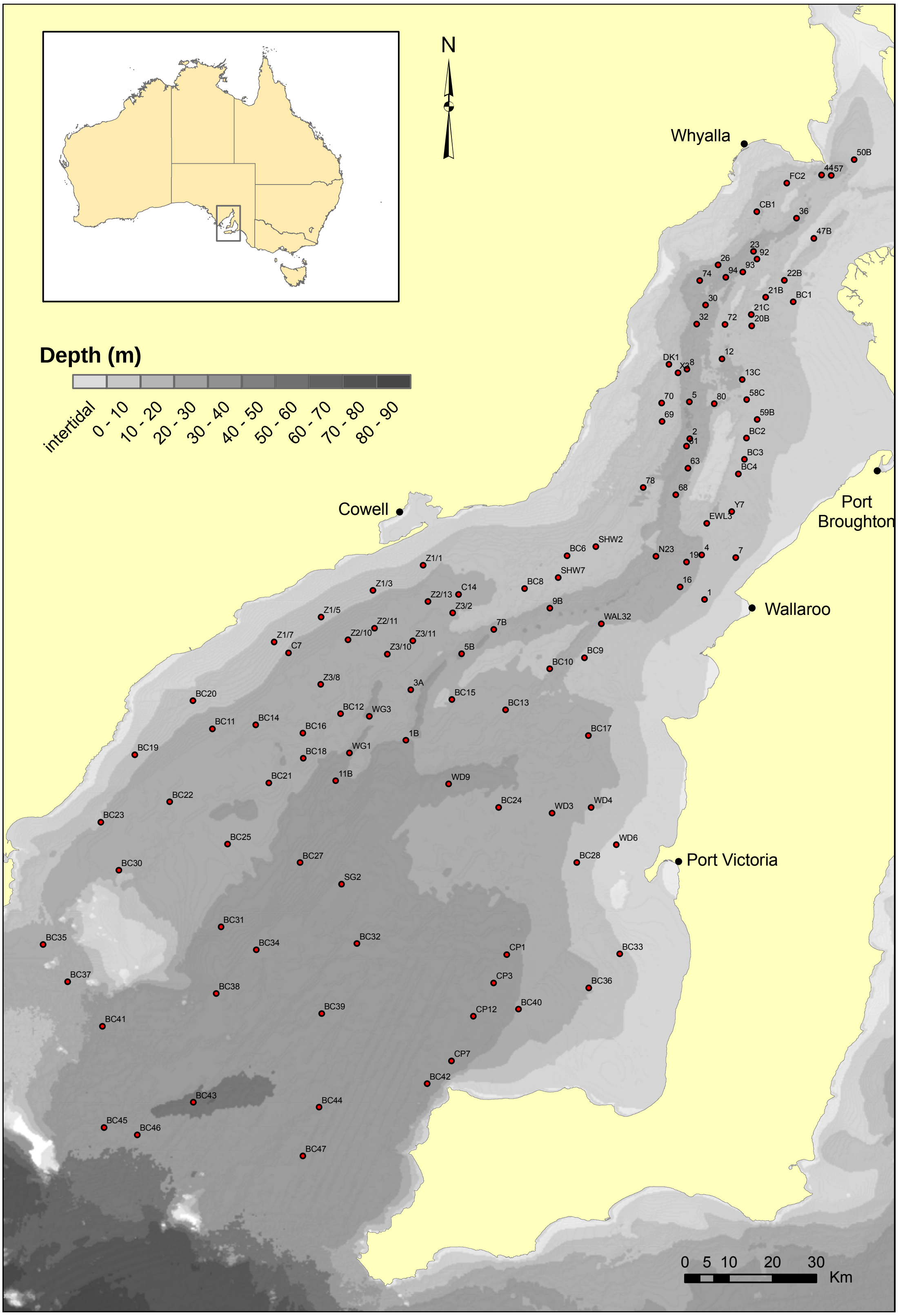

**Figure 1.** Map showing the location of 120 sites in Spencer Gulf sampled by prawn trawls during February 2007.

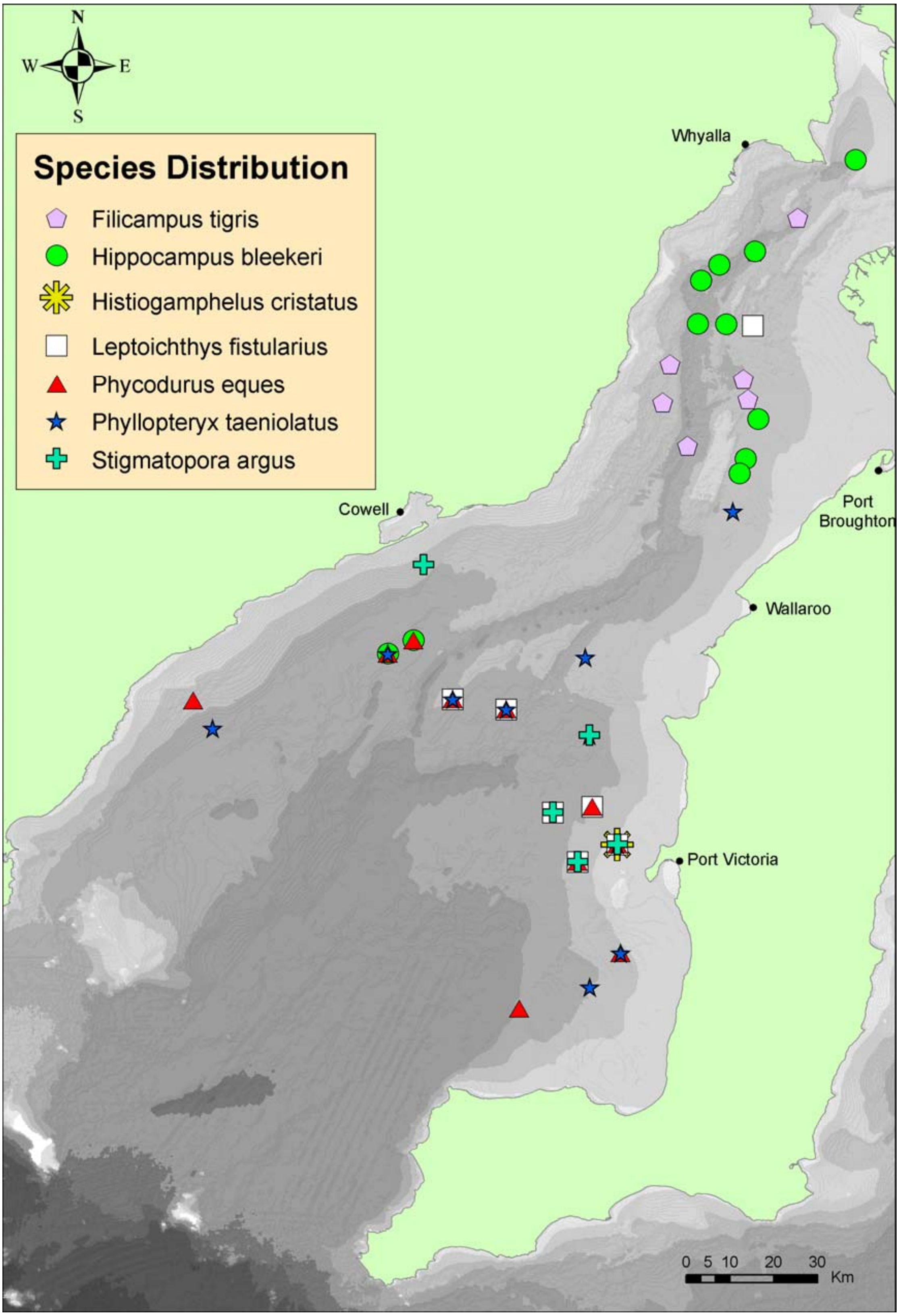

**Figure 2.** Distribution of the seven Syngnathids, collected as bycatch in the Spencer Gulf. Collection data for each species are given in Appendix 1.

## 2.1 Morphometrics

The following measurements were taken for each species: Wet weight, snout length, head length, dorso-ventral depth, trunk length, tail length (total length was calculated by adding head, trunk and tail lengths); head:snout and tail:trunk ratios were also calculated. Size frequency graphs were produced for fish where $N>10$. The sex of the fish was recorded from external observations, either by presence of pouch in seahorses, or evidence of recent egg carrying in pipefish or seadragons.

## 2.2 Stable Isotopes

White muscle flesh was removed from either side of the backbone of the fish. The samples were then placed in heat-sterilised glass vials, frozen, and freeze-dried over night. The dried tissue was subsequently ground in a ball-mill for 10 minutes to produce a homogenized powder, before being analysed in an isotope ratio Isoprime mass spectrometer. The values of the ratios are expressed as the change ($\delta$) in the ratio in parts per thousand differences from a standard (air for nitrogen and PeeDee belemnite limestone carbonate for carbon). Values were calculated using the following equation:

$$\delta X = [R\text{sample}/R\text{standard}-1] \times 10^{3}$$

where X is $^{13}C$ or $^{15}N$ and $R$ is the corresponding ratio $^{13}C/^{12}C$ or $^{15}N/^{14}N$

Regression analyses were performed to test the null hypotheses that there was no relationship between isotope values and (a) fish size, (b) water depth and (c) position in the Gulf for each species. As $\delta^{15}N$ values were found to vary with fish size, these data were transformed ($\delta^{15}N_{trns}$) using the regression equation of best linear fit to standardise each value to a 100 mm long animal. This adjustment for size meant that subsequent analyses were performed on isotope values independent of fish size. One-way analyses of variance were performed to test the null hypotheses that there was no relationship between (d) presence of seagrass and (e) the sex of fish (length was removed as a factor by transformations, as above, being done with separate regressions for males and females and for fish found with or without seagrass presence).

## 3. RESULTS

### 3.1 Morphometrics

The raw morphometric data recorded for each individual Syngnathid is presented in Appendix 2. Size frequency graphs for those four species with > 10 individuals are presented in Figure 3. These graphs suggest that the two seadragons (*P. taeniolatus* and *P. eques*) are represented by two distinct cohorts. The seahorse (*H. bleekeri*), by comparison, shows a continuous, but narrower, distribution of sizes, while the pipefish (*L. fistularius*) has a scattered, broader, distribution (Figure 3).

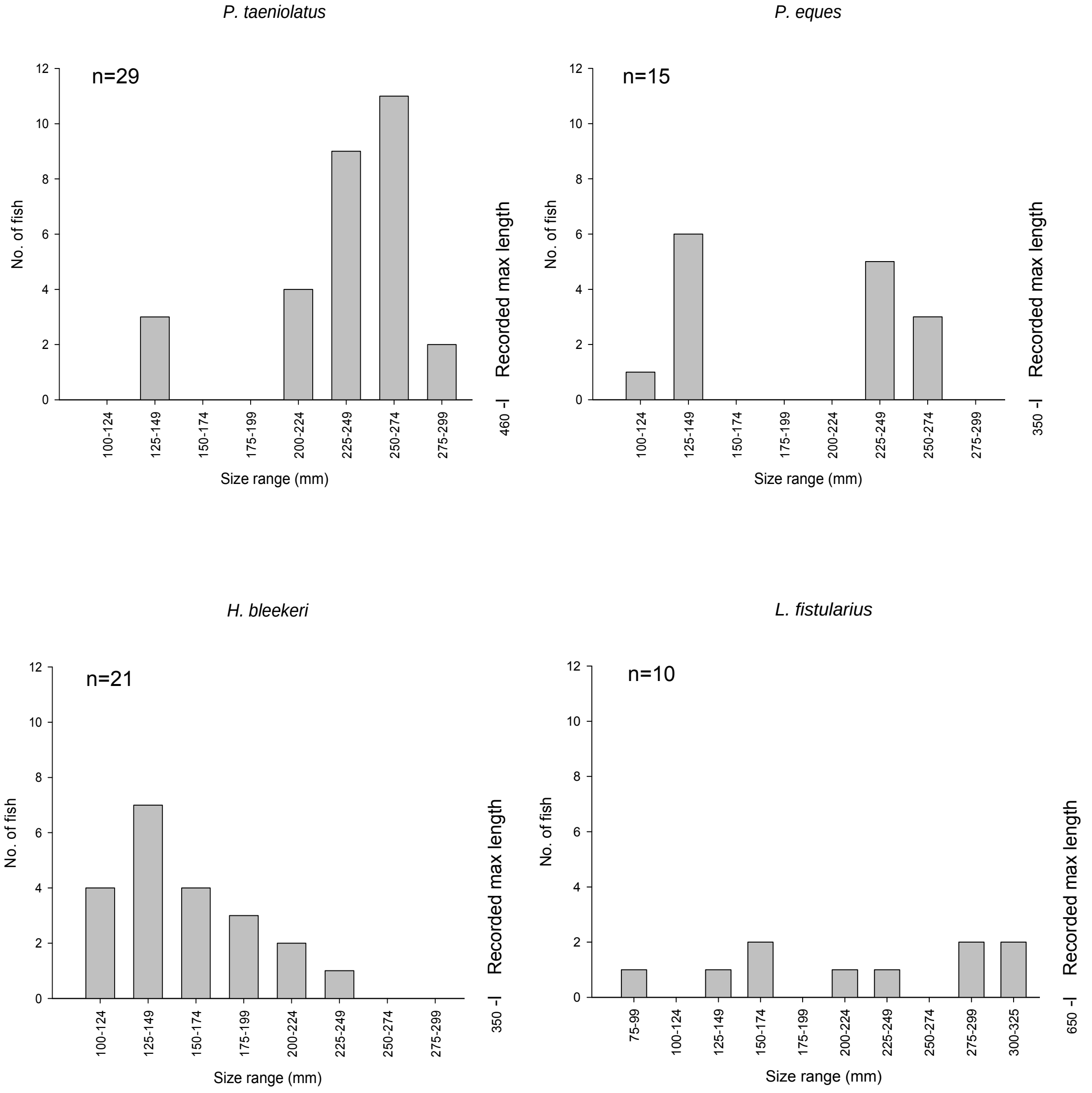

**Figure 3**. Size frequency graphs for *P. taeniolatus*, *P. eques*, *H. bleekeri* and *L. fistularius*. Recorded maximum lengths are from other studies (see Appendix 1).

## 3.2 Stable isotopes

### 3.2.1 Isotopic signatures

The mean stable isotope values of $\delta^{15}N$ and $\delta^{13}C$, for weedy seadragon (*P. taeniolatus*), leafy seadragon (*P. eques*) and the potbelly seahorse (*H. bleekeri*) were found to be broadly similar (Figure 4). As the standard errors for these isotopic values overlap, it may be inferred that all three species occupy a similar trophic position within Spencer Gulf.

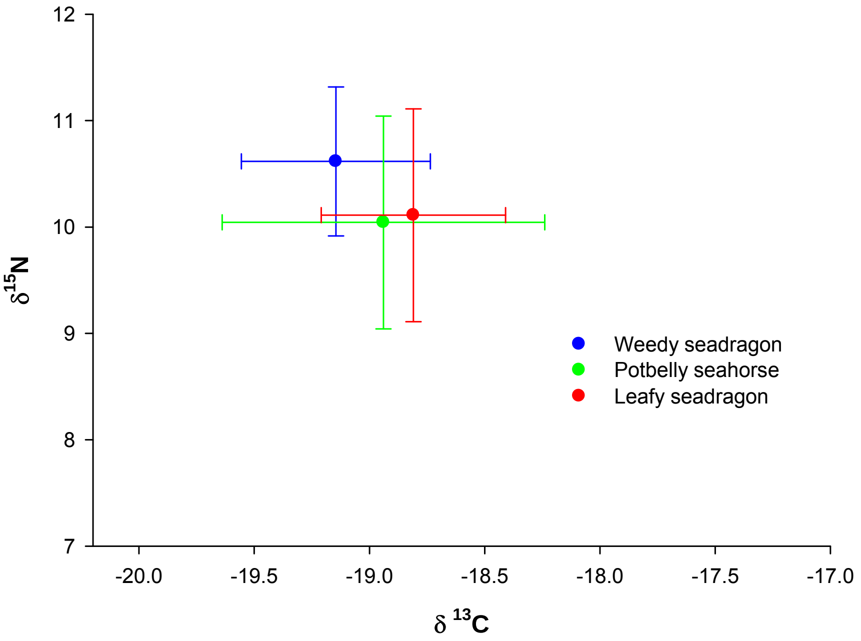

**Figure 4.** Plots of $\delta^{13}C$ and $\delta^{15}N$ values (mean ± SE) for *P. taeniolatus*, *P. eques* and *H. bleekeri* in the Spencer Gulf.

### 3.2.2 Analyses of isotope values

*(a) Fish length vs. isotope values*

Fish lengths and $\delta^{15}N$ isotope values were significantly related in weedy seadragon (*P. taeniolatus*), leafy seadragon (*P. eques*) and potbelly seahorse (*H. bleekeri*) (Table 1, Figure 5). In all three species the relationship was positive and isotope values increase as the size of the fish increased. These relationships indicate that juveniles of all three species are feeding at approximately half a trophic level below the adults. To take account of this nitrogen enrichment with size, $\delta^{15}N$ values were standardised prior for all subsequent analyses and are denoted $\delta^{15}N_{trns}$.

**Table 1.** Results of a regression analysis to test for a relationship between the total length of fish and isotope values (significant values at the 0.05 level are given in bold).

| | **Isotope** | **$r^2$** | **P** |
|---|---|---|---|
| *P. taeniolatus* | $\delta^{13}C$ | 0.0016 | 0.876 |
| | $\delta^{15}N$ | 0.41 | **<0.001** |
| *P. eques* | $\delta^{13}C$ | 0.20 | 0.092 |
| | $\delta^{15}N$ | 0.43 | **0.007** |
| *H. bleekeri* | $\delta^{13}C$ | 0.05 | 0.344 |
| | $\delta^{15}N$ | 0.21 | **0.044** |

*(b) Water depth vs. isotope values*

In weedy seadragons (*P. taeniolatus*) $\delta^{15}N$ values increase with depth (Table 2, Figure 6). In contrast, $\delta^{15}N$ values for leafy seadragon (*P. eques*) and potbelly seahorse (*H. bleekeri*) show no significant variation with depth.

**Table 2.** Results of a regression analysis to test for a relationship between water depth and isotope values (significant values at the 0.05 level are given in bold).

| | **Isotope** | **$r^2$** | **P** |
|---|---|---|---|
| *P. taeniolatus* | $\delta^{13}C$ | 0.017 | 0.473 |
| | $\delta^{15}N_{trns}$ | 0.122 | **0.049** |
| *P. eques* | $\delta^{13}C$ | 0.043 | 0.460 |
| | $\delta^{15}N_{trns}$ | 0.006 | 0.792 |
| *H. bleekeri* | $\delta^{13}C$ | 0.067 | 0.271 |
| | $\delta^{15}N_{trns}$ | 0.076 | 0.239 |

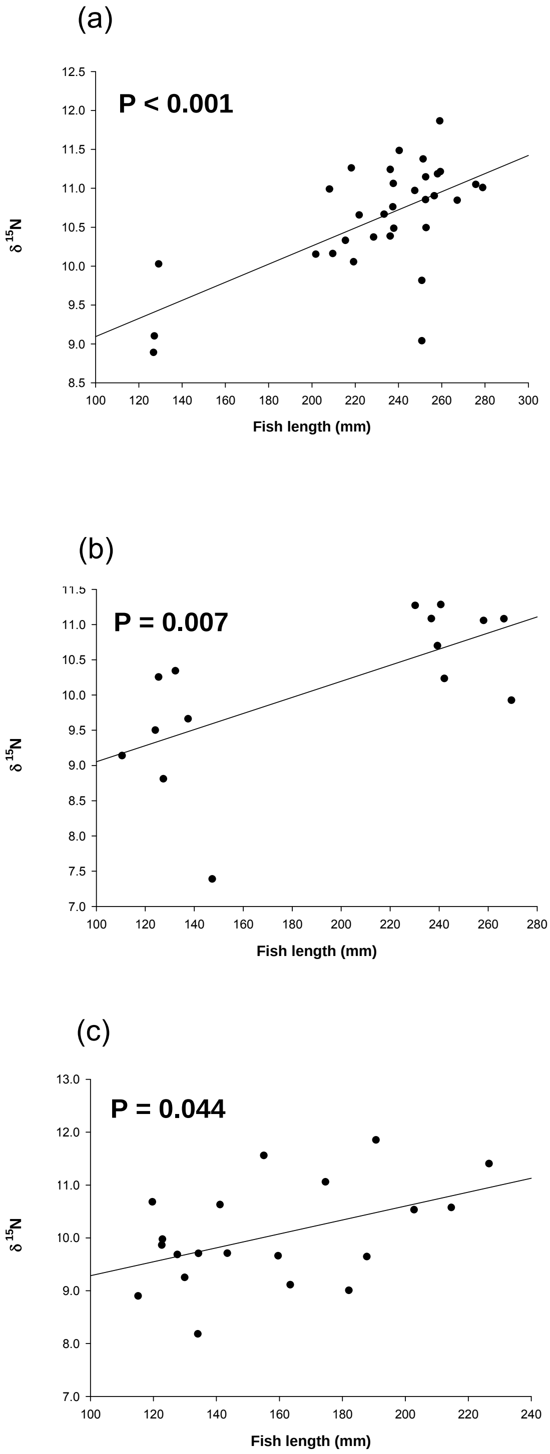

**Figure 5.** Plots showing significant relationships between isotope values (‰) and fish length for (a) *P. taeniolatus*, (b) *P. eques* and (c) *H. bleekeri*.

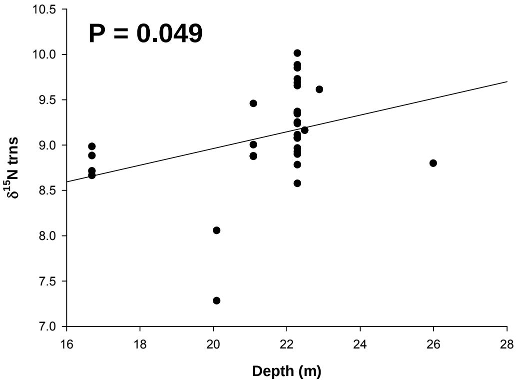

**Figure 6**. Plot showing significant relationship between $\delta^{15}$N isotope values (‰) and depth for *P. taeniolatus*.

### *(c) Position in the Gulf vs. isotope values*

Stable isotope values in weedy seadragon (*P. taeniolatus*), leafy seadragon (*P. eques*) and potbelly seahorse (*H. bleekeri*) all varied with latitude (Table 3, Figure 7). In all three species $\delta^{15}$N was highest in the north of the Spencer Gulf, and declined with increasing distance to the south. Latitudinal relationships in $\delta^{13}$C values were not consistent between species. Notably, $\delta^{13}$C values for weedy seadragons decreased towards the south of the Gulf, while $\delta^{13}$C values in potbelly seahorses increased. In addition, $\delta^{13}$C values in leafy seadragons showed no clear latitudinal trend.

**Table 3.** Results of a regression analysis to test for a relationship between distance from the top of the Spencer Gulf (TOG) and isotope values (significant values at the 0.05 level are given in bold).

| | **Isotope** | **$r^2$** | **P** |
|---|---|---|---|
| *P. taeniolatus* | $\delta^{13}$C | 0.217 | **0.007** |
| | $\delta^{15}$N $_{trns}$ | 0.358 | **<0.001** |
| *P. eques* | $\delta^{13}$C | 6.20E-03 | 0.780 |
| | $\delta^{15}$N $_{trns}$ | 0.379 | **0.014** |
| *H. bleekeri* | $\delta^{13}$C | 0.432 | **0.002** |
| | $\delta^{15}$N $_{trns}$ | 0.284 | **0.015** |

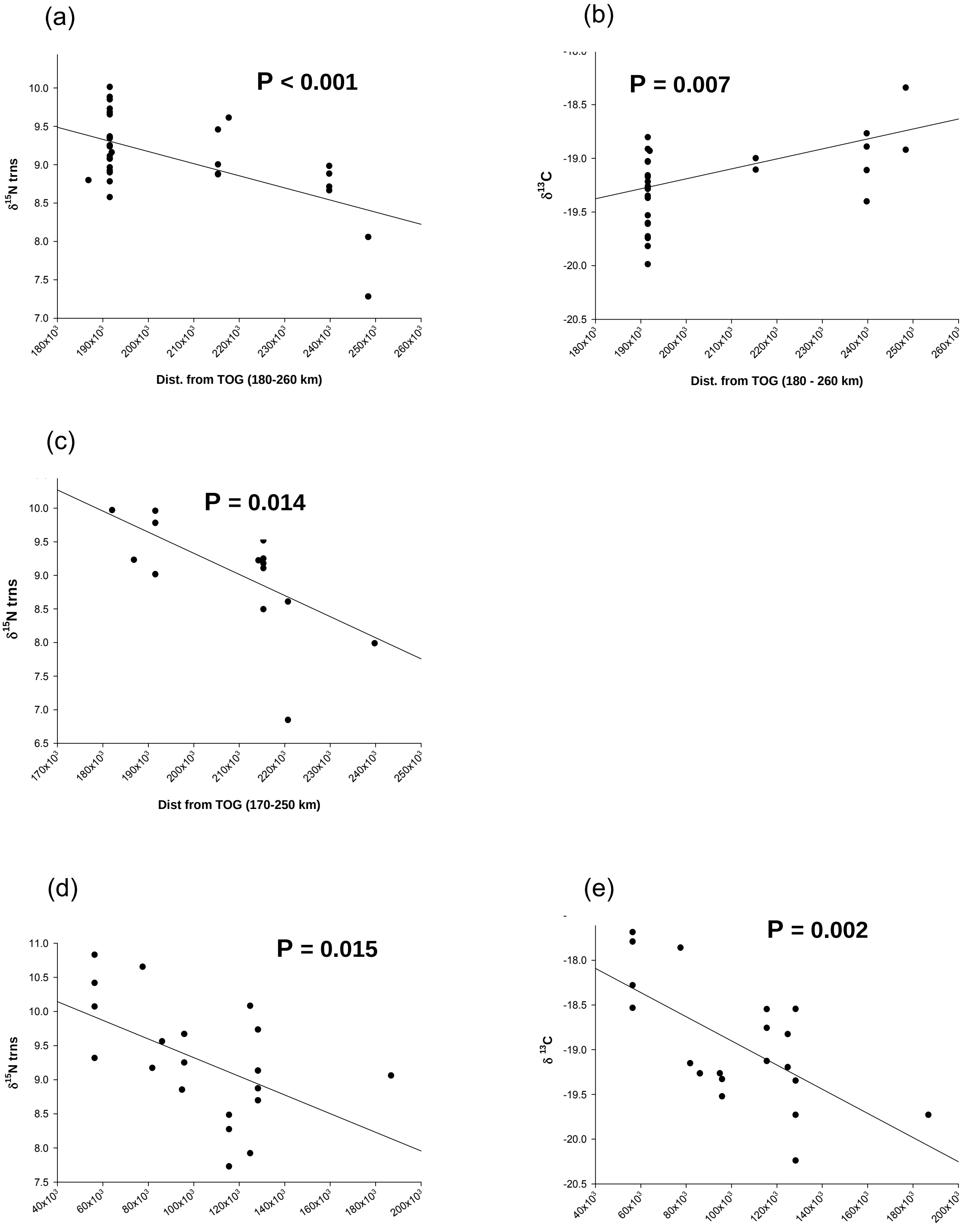

**Figure 7.** Plots showing significant relationships between isotope values (‰) and distance from the top of gulf for *P. taeniolatus* (a) $\delta^{15}N_{trns}$, (b) $\delta^{13}C$; *P. eques*, (c) $\delta^{15}N_{trns}$; and *H. bleekeri* (d) $\delta^{15}N_{trns}$, (e) $\delta^{13}C$. NB. *P. eques* $\delta^{13}C$ was not significant and not shown.

(d) *Presence of seagrass vs. isotope values*

One-way ANOVA tests were used to determine if the stable isotope values differed significantly in individuals collected inside and outside of seagrass habitat. All Syngnathid species collected during the study were found in association with seagrass, with only seahorses also found at sites with no seagrass present. As a consequence, this ANOVA test could only be applied to seahorses. Results of this test (Table 4, Figure 9) indicate that $\delta^{15}$N values are significantly higher from areas supporting seagrass. By comparison, $\delta^{13}$C values did not vary significantly in relation to the presence of seagrass (Table 4, Figure 8).

**Table 4.** Results of an ANOVA test for a difference between isotope values of *H. bleekeri* collected inside (n=6) and outside (n=14) areas supporting seagrass (significant values at the 0.05 level are given in bold).

| Isotope | F | P |
|---|---|---|
| $\delta^{13}$C | 0.449 | 0.511 |
| $\delta^{15}$N trns | 20.689 | **<0.001** |

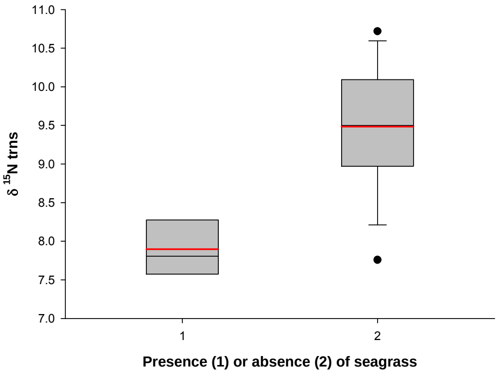

**Figure 8.** Box plot showing the significant difference in $\delta^{15}$N (trns) values for *H. bleekeri* collected from areas with (1) and without (2) seagrass. Black line indicates median value. Red line indicates arithmetic mean.

### (e) *Sex of fish vs. isotope values*

One way ANOVA tests were also applied to determine if the isotopic signatures of Syngnathids varied with gender. Due to limitations in the number of individuals that could be accurately assigned a gender, this test could only be applied to seahorses. There is no significant difference in the isotopic signatures of male and female seahorses (Table 5).

**Table 5.** Results of an ANOVA test to determine significant differences in the isotopic signatures of male and female *H. bleekeri*.

| Isotope | F | P |
|---|---|---|
| $\delta^{13}C$ | 1.264 | 0.275 |
| $\delta^{15}N$ trns | 0.271 | 0.609 |

# 4. DISCUSSION

## 4.1 Morphometrics

The two size cohorts recognised in the weedy seadragon (*P. taeniolatus*) population suggest that reproduction and recruitment in this species occurs over a discrete period. This result is consistent with the observations of Sanchez-Camera *et al.* (2005) who reported that weedy seadragons in New South Wales had a June/July to January reproductive season, with a peak in the number of pregnant males occurring in November. A similar reproductive season has also been recorded for leafy seadragons (*P. eques*) in South Australia (Baker 2000), with the highest incidence of pregnant males occurring in November and January. Potbelly seahorse (*H. bleekeri*), has only recently been separated from *H. abdominalis*, (Kuiter, 2003), and no literature could be found on its reproduction. However, *H. abdominalis* reproduces all year round in New Zealand (Woods, 2000). Sporadic reproduction throughout the year may also be inferred for *H. bleekeri* in Spencer Gulf, given that no distinct size cohorts were evident in our size frequency data.

## 4.2 Stable Isotopes

Gape sizes in Syngnathid fish limit the size of prey that may be consumed, and so smaller fish consume smaller prey. We speculate that the juvenile fish may be consuming smaller crustaceans from the plankton pool (e.g. mysids and other small crustaceans that swarm above the sand), and therefore have lower $\delta\ ^{15}$N values, while larger fish are targeting larger benthic detritivores. Ontogenetic shifts in prey have previously been recorded in Syngnathids. In a New Zealand study, juvenile *H. abdominalis* were found to have more amphipods in their stomachs compared to adult fish that had more decapod crustaceans (Woods 2002). In pipefish, more copepods were found in stomachs of juveniles and more amphipods were found in adults (Tipton and Bell 1988). Seasonal differences in diet are known to occur in *H. abdominalis* (Woods 2002).

The strong latitudinal effect is of interest, even more so because the ranges of the seahorses and seadragons have little overlap, yet both species groups display similar patterns. The reasons for the increase in $\delta^{15}$N values towards the top of the Gulf are unknown, but we speculate that this may be due to increased anthropogenic influences (eg. wastewater nitrogen) from towns and cities located in the north of the gulf. Fernandes et al. (2008) measured $\delta^{15}N$ uptake by seagrasses in Gulf St Vincent and found that the highest values were within 20 km of wastewater treatment plants. While these Nitrogen values generally declined with increasing distance from the source, the observable trends are complicated by the movement of Nitrogen in drifting seagrass. Stable isotope studies have shown that recognition of the movement of nutrients away from the source is an important consideration in understanding trophic pathways (Connolly et al. 2005).

The contradictory patterns in $\delta^{13}C$ values for potbelly seahorse, weedy seadragons and leafy seadragons may be partially explained by differences in the three species distributions in the gulf. The potbelly seahorse was concentrated in the north of the gulf and straddled an area rich in seagrasses, however a small number of individuals from this species were also collected in channel areas to the south that support little seagrass (and likely a reduced carbon pool). Accordingly, it is suggested that the gradient in seagrass biomass is responsible for the latitudinal decline in $\delta^{13}C$ values in potbelly seahorse. In contrast, both the weedy and leafy seadragons have distributions centred further south in the gulf, away from the main seagrass beds and in closer proximity to the oceanic carbon pool. Both these seadragons have broadly overlapping distributions, however weedy seadragons are more common and generally more abundant on the western flank of the gulf. This area of the gulf receives higher nutrient concentrations than the eastern side of the gulf (due to the diurnal influx of oceanic waters), which quite possibly explains why different patterns for $\delta^{13}C$ were obtained for weedy and leafy seadragons.

The effect of seagrass cover on the isotopic signatures of Syngnathids could not be determined with any confidence in this study. This is because the presence of seagrass in the trawls may not accurately reflect plant cover on the seabed. Notably, much of the seagrass material recorded in trawl shots had no rhizome, and may have drifted to the point of capture, rather than having been attached to the seabed at that location.

We found no evidence in this study of any gender related differences in the isotopic signatures in our seahorses. However, stable isotope ratios have been found to differ significantly between male and female pipefish in the Mediterranean (Vizzini and Mazzola 2004). This finding is thought to reflect the limited movement (and therefore prey variability) of males while brooding.

This was an opportunistic study of fish that had already been collected as part of a wider study of bycatch in the Spencer Gulf prawn fishery (Currie et al. 2009). As such this study has several shortcomings that would have been addressed in a pre-planned research project on Syngnathids. In particular, this study provides no data on the relative composition and distribution of Syngnathids in waters shallower than 10 m, as prawn trawling in these inshore areas of the Spencer Gulf is prohibited. Accordingly it is unclear if the inshore waters of the gulf support relatively higher numbers of species and individuals than the offshore waters. This study does not cover any seasonal differences in the distribution and abundances of Syngnathids, something that needs to be addressed to obtain a better understanding of species-specific home ranges and potential migratory behaviours. In addition, survey shots were usually conducted in areas away from reefs to prevent gear hook ups, so they may not fully reflect the habitat use of this fish family. Despite such limitations, the very large overall coverage of the study is unprecedented, and does provide some important insights into the contrasting distributions of several species. For example, potbelly seahorse and tiger pipefish were mainly encountered in the warmer northern waters of the gulf, while the seadragons were generally found in the cooler waters of the central gulf. These meso-scale distributions are broadly consistent with their distributions elsewhere in Australia (i.e. tiger pipefish are generally found in subtropical environments, while seahorses have temperate distributions; see Appendix 1).

Although a total of seven Syngnathid species were collected during the prawn bycatch survey, a further 11 species have been previously recorded for the Spencer Gulf (Appendix 3, South Australian Museum records). The absence of these 11 species from the collections supporting this study may reflect spatial limitations in the survey or the relative rarity of the species themselves. It is also plausible that some species simply swim through the nets and escape or live in shallower waters or are no longer represented in the Spencer Gulf.

While the current study is directed towards a better understanding of the biology of Syngnathids in the Spencer Gulf, it is set in the context of a wider study aimed at mitigating trawling interactions in the Spencer Gulf. Studies in the Australian east coast trawling fishery found a decrease in pipehorses in bycatch over a five year period (Connolly et al. 2001). In the Gulf of Mexico it has been estimated that 72,000 individuals of one Syngnathid species (*Hippocampus erectus*) are taken as bycatch each year (Baum et al. 2003). In both these studies there was not sufficient information on the distribution of fishing effort to unequivocally attribute a decline in fish to trawling. A study of non-target seahorse fisheries in Vietnam, which used a robust measure of effort, estimated a total catch of 36-55,000 fish a year and found numbers were stable over the three years of the study, although fishermen and traders reported a decline in seahorse catches in other trawl fisheries (Meeuwig et al. 2006). More detailed information of the standing stock of Syngnathids as well as their biology is needed in the Spencer Gulf, including the distribution and abundance of Syngnathids in waters shallower than 10 m depth, and the survivorship of Syngnathids collected as bycatch and subsequently returned to the water.

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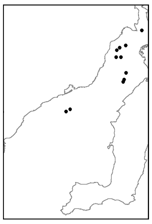
## APPENDIX 1: SPECIES INFOMATION FOR SYNGNATHIDS COLLECTED FROM SPENCER GULF

The following brief information is compiled from various sources to give a comparison of the species found. Maps of Australian distribution are based on Gomon et al. 2008. Maps and data from Spencer Gulf are from the present Spencer Gulf bycatch study. Species information is from the internet site Fishbase (Froese and Pauly, 2009). Codes for Australian Aquatic Biota (CAAB) (Rees, 2009), are given in brackets.

### ***Hippocampus bleekeri*** **Fowler** 1907 Potbelly seahorse (CAAB 37 282010)

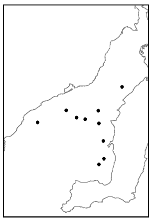


BYCATCH DATA:
Length = to 212 mm
Depth range = 13 - 25.5 m
Average biomass = 1.693 g/ha
Rank biomass = 242
Average abundance = 0.192/ha
Rank abundance = 80
Stations = 23, 26, 32, 50B, 59B, 72, 74, BC3, BC4, Z3/10, Z3/11

FISHBASE DATA:
NB: *H. Bleekeri* data is not listed in Fishbase. This data is for *H. abdominalis.*
Max. size:35.0 cm OT (male/unsexed).
Environment: Demersal; non-migratory; brackish; marine; depth 0-104 m.
Climate: Temperate; 24°S - 50°S, 80°E - 120°W
Importance: Fisheries: of no interest; aquarium: commercial
Resilience: Medium, minimum population doubling time 1.4 - 4.4 years
Vulnerability: Low vulnerability (21.63).
Distribution: Southwest Pacific: Australia and New Zealand. Vulnerable International trade is monitored through a licensing system (CITES II, since 5.15.04) and a minimum size of 10 cm applies.
Biology: Found in large rock pools at low tide. They remain motionless amidst seaweed. Juveniles are pelagic or attached to drifting seaweeds. Feed on minute crustaceans (e.g. copepods and amphipods). Nocturnal. Ovoviviparous. The male carries the eggs in a brood pouch which is found under the tail. Seen in groups at night. Also around jetties and other man-made objects; attached to sponges and colonial hydroids in deeper water. This is the largest seahorse species in southeastern Australia, and has more dorsal fin rays and tail rings than any other seahorse. Sold locally and internationally for the aquarium trade. Dried and sold to the Oriental medicine trade as a tonic and aphrodisiac.
Red List Status: Data deficient (DD).

ADDITIONAL NOTES: Kuiter (2003) separates three species of the bigbelly seahorse. *H. bleekeri*, with a distribution from Lakes Entrance Victoria to the Great Australian Bight and Tasmania, *H. abdominalis* with a distribution in New Zealand only, and *H. cf. abdominalis* with a distribution in NSW and Victoria.

## ***Phyllopteryx taeniolatus*** (Lacepède, 1804) Weedy Seadragon (CAAB 37 282002)

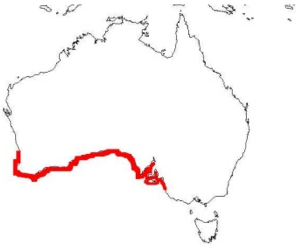


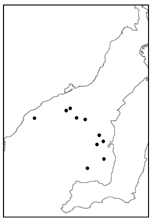
BYCATCH DATA:
Length = to 286 mm Depth range = 14.8 - 25.5 m
Average biomass = 2.472 g/ha Rank biomass = 216
Average abundance = 0.239/ha Rank abundance = 73
Stations = BC11, BC13, BC15, BC17, BC33, BC36, BC9, WD6, Y7, Z3/10

FISHBASE DATA:
Max. size: 46.0 cm TL (male/unsexed)
Environment: Reef-associated; marine; depth range 0 – 50 m
Climate: Temperate
Resilience: Medium, minimum population doubling time 1.4 - 4.4 years
Vulnerability: Moderate vulnerability
Distribution: Eastern Indian Ocean: southern Australia, from southern Western Australia to New South Wales and Tasmania.
Biology: Recorded from the intertidal zone to a depth of 50 m. Frequently among seaweeds and coral reefs. Ovoviviparous. The male carries the eggs in a brood pouch which is found under the tail.
Red List Status: Near Threatened (NT)

ADDITIONAL NOTES: Results from genetic studies that show the degree of gene flow across populations of the two seadragon species in southern Australia, are soon to be published (Wilson and Rouse in prep.).

## ***Phycodurus eques*** (Günther, 1865) Leafy Seadragon (CAAB 37 282001)

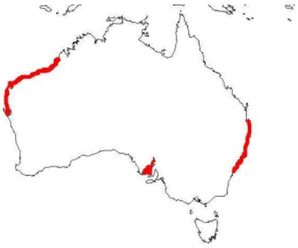


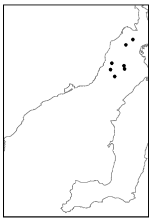


BYCATCH DATA:
Length = to 279 mm Depth range = 14.8 - 26 m
Average biomass = 0.941 g/ha Rank biomass = 268
Average abundance = 0.092/ha Rank abundance = 119
Stations = BC13, BC15, BC20, BC28, BC33, BC40, WD4, WD6, Z3/10, Z3/11

FISHBASE DATA:
Max. size: 35.0 cm TL (male/unsexed; Ref. 9002)
Environment:reef-associated; non-migratory; marine; depth range 4 – 30 m
Climate: subtropical; 32°S - 39°S, 115°e - 140°e
Importance: fisheries: of no interest; aquarium: commercial;
Resilience: Medium, minimum population doubling time 1.4 - 4.4 years
Vulnerability: Low to moderate vulnerability (34.68).
Distribution: Eastern Indian Ocean: endemic to southern Australia.
Biology: Usually occur over sand patches close to reefs with kelp, feeding on mysids and other crustaceans. Ovoviviparous. The male carries the eggs in a brood pouch which is found under the tail. One of the most spectacular examples of camouflage: neither prey nor predators recognize it as a fish.
Red List Status: Near Threatened (NT)

## ***Filicampus tigris*** (Castelnau 1879) Tiger pipefish (CAAB 37 282064)

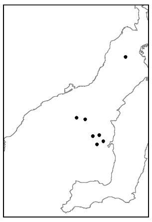




BYCATCH DATA:
Length = to 269 mm
Depth range = 14 - 25 m
Average biomass = 0.298 g/ha
Rank biomass = 317
Average abundance = 0.055/ha
Rank abundance = 152
Stations = 13C, 23, 36, 58C, 61, 70, DK1

FISHBASE DATA:
Max. size: 29.6 cm SL (male/unsexed)
Environment: Demersal; marine; depth range 2 – 27 m
Climate: Subtropical
Resilience: Medium, minimum population doubling time 1.4 - 4.4 years
Vulnerability: Moderate vulnerability (35.65).
Distribution: Eastern Indian Ocean and Western Pacific: Australia (Western Australia, South Australia, Queensland and New South Wales).
Biology: Occurs over mud, sand, rubble and rocky bottoms. Ovoviviparous. The male carries the eggs in a brood pouch which is found under the tail. Males may be brooding at 17.5 cm SL.

## ***Leptoichthys fistularius*** Kaup, 1853 Brushtail pipefish (CAAB 37 282013)

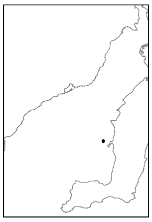


BYCATCH DATA:
Length = to 481 mm
Depth range = 14 - 23.5 m
Average biomass = 0.149 g/ha
Rank biomass = 345
Average abundance = 0.052/ha
Rank abundance = 155
Stations = 20B, BC13, BC15, BC28, WD3, WD4, WD6

FISHBASE DATA:
Max. size: 63.0 cm SL (male/unsexed)
Environment: Demersal; marine
Climate: Subtropical
Resilience: Medium, minimum population doubling time 1.4 - 4.4 years
Vulnerability: Moderate to high vulnerability (54.65).
Distribution: Eastern Indian Ocean: endemic to southern Australia.
Biology: Found in moderate to shallow depths. Largest known pipefish, may well reach 65 cm SL. Ovoviviparous. The male carries the eggs in a brood pouch which is found under the tail. Males may be brooding at 20-21 cm SL.

ADDITIONAL NOTES: The largest known of all pipefish, the Brushtail Pipefish lives in seagrass (especially Zostera) along the southern Australian coast and Tasmania (Kuiter, 2003).

## ***Histiogamphelus cristatus*** (McLeay 1882) Rhino pipefish (CAAB 37 282081)

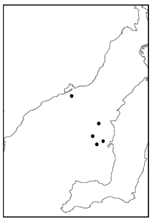


BYCATCH DATA:
Length = to 235 mm
Average biomass = 0.012 g/ha
Average abundance = 0.003/ha
Stations = WD6
Depth range = 18.7 - 18.7 m
Rank biomass = 387
Rank abundance = 326

FISHBASE DATA:
Max. size: 26.5 cm SL
Environment: Demersal; marine
Climate: Subtropical
Resilience: High, minimum population doubling time less than 15 months
Vulnerability: Low to moderate vulnerability (32.16)
Distribution: Eastern Indian Ocean: southern Australia.
Biology: Ovoviviparous. The male carries the eggs in a brood pouch which is found under the tail. Males may be brooding at 13.6 cm SL.

ADDITIONAL NOTES: Occurring in sparse seagrass (Kuiter, 2003).

## ***Stigmatopora argus*** (Richardson, 1840) Spotted pipefish (CAAB 37 282017)



BYCATCH DATA:
Length = to 278 mm
Average biomass = 0.050 g/ha
Average abundance = 0.023/ha
Stations = BC17, BC28, WD3, WD6, Z1/1
Depth range = 15 - 23.5 m
Rank biomass = 370
Rank abundance = 206

FISHBASE DATA:
Max size: 25.4 cm TL (male/unsexed)
Environment: Demersal; brackish; marine; depth range ? – 8 m
Climate: Subtropical
Resilience: High, minimum population doubling time less than 15 months
Vulnerability: Low vulnerability (24.76).
Distribution: Eastern Indian Ocean: endemic to southern Australia, from Rottnest Island and Shark Bay, Western Australia to Hawkesbury River, New South Wales.
Biology: Usually among vegetation in bays and estuaries, but sometimes offshore among floating *Sargassum*. Ovoviviparous. The male carries the eggs in a brood pouch which is found under the tail. Males may be brooding at 11.2 cm TL.

ADDITIONAL NOTES: Occurs in small groups in Zostera beds, mainly estuarine (Kuiter, 2003). In the northern Spencer Gulf this species is highly abundant with 1800 picked up in seagrass trawls (R. Saunders pers. comm.). Near Freemantle in Western Australia large *S. argus* were found in *Posidonia sinuosa* and smaller fish in the narrower leafed *P. coriacea* (Kendrick and Hyndes, 2003).

## APPENDIX 2: MORPHOMETRIC DATA OF SPENCER GULF SYNGNATHIDS

Shaded data were not analysed as they are from pickled specimens. Tail length denoted with * were of damaged tails.

### *H. bleekeri*

| Individual Site_Fish | Wet wt | Snout Length | Head Length | Head/snout ratio | Dorso/ventral depth | Trunk Length | Tail Length | Tail/trunk ratio | Total length | Sex |
|---|---|---|---|---|---|---|---|---|---|---|
| 23_10_F095-A | 21.35 | 18.28 | 36.76 | 2.01 | 36.41 | 64.44 | 113.51 | 1.76 | 214.71 | f |
| 23_F095-A | 13.88 | 17.67 | 35 | 1.98 | 30.25 | 59.94 | 95.87 | 1.60 | 190.81 | f |
| 26_F095-A | 14.69 | 16.48 | 31.56 | 1.92 | 28.31 | 58.78 | 112.59 | 1.92 | 202.93 | f |
| 32_F095-A | 2.47 | 10.09 | 22.37 | 2.22 | 13.27 | 34.45 | 77.6 | 2.25 | 134.42 | m |
| 32_F095-B | 1.68 | 9.83 | 21.98 | 2.24 | 13.23 | 31.79 | 69.22 | 2.18 | 122.99 | f |
| 50B_F095-A | 7.29 | 12.45 | 27.53 | 2.21 | 20.33 | 45.1 | 82.55 | 1.83 | 155.18 | f |
| 50B_F095-B | 10.36 | 12.63 | 28.39 | 2.25 | 24.11 | 44.13 | 102.24 | 2.32 | 174.76 | m |
| 50B_F095-C | 3.24 | 9.33 | 21.18 | 2.27 | 14 | 36.8 | 69.75 | 1.90 | 127.73 | f |
| 50B_F095-D | 2.41 | 8.75 | 20.54 | 2.35 | 14.26 | 29.79 | 69.45 | 2.33 | 119.78 | m |
| 59B_F095-A | 13.11 | 18.26 | 37.21 | 2.04 | 30.54 | 55.94 | 94.74 | 1.69 | 187.89 | f |
| 59B_F095-B | 5.69 | 13.21 | 27.67 | 2.09 | 16.91 | 45.88 | 90.01 | 1.96 | 163.56 | f |
| 59B_F095-C | 3.04 | 10.42 | 23.48 | 2.25 | 15.9 | 38.08 | 72.64 | 1.91 | 134.2 | m |
| 74_F095 | 2.8 | 9.01 | 19.25 | 2.14 | 13.51 | 36.64 | 66.87 | 1.83 | 122.76 | f |
| BC3_F095-A | 11.29 | 15.44 | 30.81 | 2.00 | 26.03 | 45.89 | 105.47 | 2.30 | 182.17 | m |
| BC3_F095-B | 3.67 | 11.12 | 24.72 | 2.22 | 16.04 | 37.92 | 78.62 | 2.07 | 141.26 | f |
| BC4_F095-A | 8.81 | 14.97 | 34.06 | 2.28 | 31.75 | 59.91 | 132.72 | 2.22 | 226.69 | m |
| BC4_F095-B | 5.51 | 10.72 | 22.41 | 2.09 | 17.59 | 34.57 | 86.61 | 2.51 | 143.59 | f |
| BC4_F095-C | 5.5 | 12.68 | 26.95 | 2.13 | 16.7 | 44.21 | 88.57 | 2.00 | 159.73 | f |
| BC4_F095-D | 1.95 | 9.48 | 20.63 | 2.18 | 14.63 | 30.16 | 64.47 | 2.14 | 115.26 | f |
| H72_F095 | 2.62 | 10.69 | 22.89 | 2.14 | 13.44 | 34.88 | 72.25 | 2.07 | 130.02 | f |
| Z3/11_F095 | 6.3 | 10.98 | 26.36 | 2.40 | 19.93 | 36.79 | 83.62 | 2.27 | 146.77 | f |

### *P. taeniolatus*

| Individual Site_Fish | Wet wt | Snout Length | Head Length | Head/snout ratio | Dorso/ventral depth | Trunk Length | Tail Length | Tail/trunk ratio | Total length | Sex |
|---|---|---|---|---|---|---|---|---|---|---|
| 23/10_F046-A | 8.75 | 29.32 | 50.72 | 1.73 | 20.3 | 78.94 | 106.69 | 1.35 | 236.35 | ? |
| BC11_F046-A | 13.51 | 35.4 | 57.57 | 1.63 | 27.87 | 87.44 | 106.58 | 1.22 | 251.59 | ? |
| BC15_F046-A | 11.18 | 38.35 | 60.64 | 1.58 | 28.1 | 88.99 | 108.6 | 1.22 | 258.23 | ? |
| BC15_F046-B | 11.46 | 35.71 | 59.39 | 1.66 | 24.77 | 87.15 | 112.71 | 1.29 | 259.25 | ? |
| BC15_F046-C | 0.67 | 18.05 | 28.86 | 1.60 | 6.76 | 40.68 | 57.42 | 1.41 | 126.96 | ? |
| BC15_F046-D | 13.15 | 37.37 | 61.96 | 1.66 | 29.1 | 88.99 | 108.6 | 1.22 | 259.55 | ? |
| BC15_F046-E | 9.28 | 30.48 | 53.34 | 1.75 | 25.11 | 84.87 | 98.15 | 1.16 | 236.36 | ? |
| BC15_F046-F | 9.38 | 36.54 | 58.55 | 1.60 | 25.47 | 86.72 | 102.39 | 1.18 | 247.66 | ? |
| BC15_F046-G | 4.96 | 26.83 | 46.06 | 1.72 | 16.97 | 70.31 | 91.94 | 1.31 | 208.31 | ? |
| BC15_F046-H | 11.12 | 39.32 | 62.55 | 1.59 | 23.5 | 89.56 | 126.97 | 1.42 | 279.08 | ? |
| BC15_F046-I | 4.94 | 32.79 | 53.07 | 1.62 | 15.38 | 70.47 | 98.45 | 1.40 | 221.99 | ? |
| BC15_F046-J | 7.38 | 33.68 | 51.18 | 1.52 | 22.1 | 77.74 | 104.61 | 1.35 | 233.53 | ? |
| BC15_F046-K | 0.78 | 16.04 | 28.17 | 1.76 | 6.55 | 45.19 | 55.96 | 1.24 | 129.32 | ? |
| BC15_F046-L | 8.29 | 30.98 | 52.78 | 1.70 | 23.38 | 74.31 | 91.26 | 1.23 | 218.35 | ? |
| BC15_F046-M | 4.07 | 32.69 | 51.56 | 1.58 | 18.53 | 70.76 | 79.62 | 1.13 | 201.94 | ? |
| BC15_F046-N | 8.81 | 36.6 | 56.07 | 1.53 | 19.75 | 80.97 | 103.46 | 1.28 | 240.5 | ? |
| BC15_F046-O | 12.49 | 41.8 | 60.98 | 1.46 | 24.8 | 84 | 122.35 | 1.46 | 267.33 | ? |
| BC15_F046-P | 9.41 | 33.67 | 56.82 | 1.69 | 25.71 | 86.64 | 109.3 | 1.26 | 252.76 | ? |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| BC15_F046-Q | 12.52 | 37.86 | 58.93 | 1.56 | 26.99 | 89.57 | 104.19 | 1.16 | 252.69 | ? |
| BC15_F046-R | 13.14 | 35.06 | 60.93 | 1.74 | 26.04 | 89.23 | 106.55 | 1.19 | 256.71 | ? |
| BC15_F046-S | 1.03 | 17.58 | 30.31 | 1.72 | 6.56 | 41.44 | 55.64 | 1.34 | 127.39 | ? |
| BC17_F046-A | 17.16 | 41.88 | 65.88 | 1.57 | 29.44 | 92.86 | 78.8* | 0.85 | 237.54 | ? |
| BC33_F046-A | 7.21 | 27.85 | 47.99 | 1.72 | 21.62 | 77.07 | 94.37 | 1.22 | 219.43 | ? |
| BC33_F046-B | 7.13 | 30.3 | 52.05 | 1.72 | 22.32 | 72.87 | 84.88 | 1.16 | 209.8 | ? |
| BC33_F046-C | 6.93 | 30.75 | 51.05 | 1.66 | 23.76 | 74.11 | 90.49 | 1.22 | 215.65 | ? |
| BC33_F046-D | 9.7 | 32.54 | 54.43 | 1.67 | 22.99 | 84.63 | 113.87 | 1.35 | 252.93 | ? |
| BC36_F046-A | 12.78 | 35.85 | 57.18 | 1.59 | 24.56 | 83.35 | 110.43 | 1.32 | 250.96 | ? |
| BC36_F046-B | 10.66 | 35.21 | 58.49 | 1.66 | 21.57 | 79.32 | 113.16 | 1.43 | 250.97 | ? |
| Y7_F046-1 | 9.3 | 37.56 | 53.94 | 1.44 | 23.4 | 78.9 | 96.43 | 1.22 | 229.27 | f |
| BC13_F046-2 | 12.65 | 42.9 | 62.3 | 1.45 | 21.8 | 81 | 106 | 1.31 | 249.3 | ? |
| BC9_F046-3 | 12.43 | 42.6 | 62 | 1.46 | 22 | 84.6 | 112.8 | 1.33 | 259.4 | ? |
| BC13_F046-4 | 6.66 | 35.5 | 51.5 | 1.45 | 18.2 | 68.2 | 95 | 1.39 | 214.7 | ? |
| BC13_F046-5 | 8.7 | 40.4 | 56.3 | 1.39 | 21.8 | 80.41 | 110.6 | 1.38 | 247.31 | ? |
| BC13_F046-6 | 12.44 | 39.6 | 55.2 | 1.39 | 28.3 | 88.2 | 98.9 | 1.12 | 242.3 | ? |
| BC13_F046-7 | 9.12 | 35.5 | 52.2 | 1.47 | 22.8 | 74.9 | 101.1 | 1.35 | 228.2 | ? |
| BC13_F046-8 | 14.18 | 42.5 | 60.8 | 1.43 | 24 | 87 | 110.4 | 1.27 | 258.2 | ? |
| WD06_F046-A | 15.33 | 39.23 | 62.41 | 1.59 | 32.95 | 92.48 | 82.85* | 0.90 | 237.74 | ? |
| WD06_F046-B | 12.18 | 33.03 | 56.12 | 1.70 | 26.41 | 86.39 | 95.48 | 1.11 | 237.99 | ? |
| WD06_F046-C | 8.08 | 33.14 | 52.18 | 1.57 | 21.55 | 80.32 | 96.17 | 1.20 | 228.67 | ? |
| WD06_F046-D | 16.09 | 43.61 | 66.21 | 1.52 | 25.97 | 87.86 | 121.82 | 1.39 | 275.89 | ? |

## *P. eques*

| Individual Site_Fish | Wet wt | Snout Length | Head Length | Head/snout ratio | Dorso/ventral depth | Trunk Length | Tail Length | Tail/trunk ratio | Total length | Sex |
|---|---|---|---|---|---|---|---|---|---|---|
| Z3/10_F045-A | 2.21 | 16.25 | 30.22 | 1.86 | 7.9 | 38.74 | 68.67 | 1.77 | 137.63 | ? |
| Z3/11_F045-A | 1.49 | 16.15 | 29.95 | 1.85 | 5.55 | 39.22 | 63.24 | 1.61 | 132.41 | ? |
| BC15_F045-A | 11.64 | 26.64 | 47.38 | 1.78 | 22.04 | 71.22 | 111.76 | 1.57 | 230.36 | ? |
| BC15_F045-B | 1.28 | 14.21 | 28.91 | 2.03 | 5.58 | 37.11 | 59.57 | 1.61 | 125.59 | ? |
| BC15_F045-C | 0.71 | 12.73 | 24.55 | 1.93 | 3.63 | 32.85 | 53.25 | 1.62 | 110.65 | ? |
| BC20_F045-A | 1.63 | 14.42 | 29.53 | 2.05 | 6.79 | 38.76 | 55.95 | 1.44 | 124.24 | ? |
| BC28_F045-A | 1.49 | 16.5 | 31.81 | 1.93 | 7.93 | 45.35 | 70.3 | 1.55 | 147.46 | ? |
| BC28_F045-B | 13.56 | 28.65 | 53.05 | 1.85 | 19.13 | 77.07 | 112.15 | 1.46 | 242.27 | ? |
| BC33_F045-A | 27.98 | 32.96 | 58 | 1.76 | 30.76 | 78.03 | 133.61 | 1.71 | 269.64 | ? |
| WD4_F045-1 | 2.38 | 16.8 | 28.5 | 1.70 | 7.4 | 39 | 64.1 | 1.64 | 131.6 | ? |
| BC13_F045-2 | 18.43 | 29.8 | 51.6 | 1.73 | 20.08 | 71.6 | 113.6 | 1.59 | 236.8 | ? |
| BC13_F045-3 | 11.44 | 29.3 | 49.5 | 1.69 | 15.9 | 67.6 | 112 | 1.66 | 229.1 | ? |
| BC40_F045-4 | 1.63 | 16.2 | 27.5 | 1.70 | 7 | 37.6 | 57.4 | 1.53 | 122.5 | ? |
| BC13_F045-5 | 1.25 | 16.8 | 27.8 | 1.65 | 4.6 | 37.9 | 54 | 1.42 | 119.7 | ? |
| WD06_F045-A | 18.46 | 27.93 | 52.93 | 1.90 | 27.22 | 75.72 | 108.28 | 1.43 | 236.93 | ? |
| WD06_F045-B | 1.95 | 15.65 | 28.58 | 1.83 | 5.9 | 36.37 | 62.58 | 1.72 | 127.53 | ? |
| WD06_F045-C | 24.81 | 30.48 | 56.24 | 1.85 | 27.52 | 86.37 | 124 | 1.44 | 266.61 | ? |
| WD06_F045-D | 18.73 | 28.74 | 53.98 | 1.88 | 24.16 | 71.63 | 113.85 | 1.59 | 239.46 | ? |
| WD06_F045-E | 25.7 | 25.08 | 54.03 | 2.15 | 29.74 | 83.96 | 120.3 | 1.43 | 258.29 | ? |
| WD06_F045-F | 19.2 | 28.68 | 53.97 | 1.88 | 23.62 | 74.83 | 112.02 | 1.50 | 240.82 | ? |

### *F. tigris*

| Individual Site_Fish | Wet wt | Snout Length | Head Length | Head/snout ratio | Dorso/ventral depth | Trunk Length | Tail Length | Tail/trunk ratio | Total length | Sex |
|---|---|---|---|---|---|---|---|---|---|---|
| 23_F027 | 5.82 | 11.9 | 27.48 | 2.31 | 5.91 | 68.44 | 143.73 | 2.10 | 239.65 | m |
| 61_F027 | 4.86 | 12.5 | 28.34 | 2.27 | 6.05 | 69.17 | 150.73 | 2.18 | 248.24 | m |
| DK1_FO27 | 4.57 | 11.59 | 14.88 | 1.28 | 6.67 | 65.88 | 140.04 | 2.13 | 220.8 | m |
| 13C_F027-1 | 3.57 | 11.39 | 24.2 | 2.12 | 5.8 | 61 | 132 | 2.16 | 217.2 | f |
| 36_F027-2 | 6.37 | 14 | 29 | 2.07 | 7.6 | 76 | 163 | 2.14 | 268 | f |
| 58C_F027-3 | 4.64 | 11 | 24 | 2.18 | 6.32 | 71.3 | 139 | 1.95 | 234.3 | f |
| 70_F027-4 | 4.94 | 11.6 | 24.9 | 2.15 | 6.4 | 66.3 | 150.6 | 2.27 | 241.8 | m |

### *L. fistularis*

| Individual Site_Fish | Wet wt | Snout Length | Head Length | Head/snout ratio | Dorso/ventral depth | Trunk Length | Tail Length | Tail/trunk ratio | Total length | Sex |
|---|---|---|---|---|---|---|---|---|---|---|
| 20B_F044-A | 2.74 | 32.86 | 46.71 | 1.42 | 5.89 | 90.48 | 96.63 | 1.07 | 233.82 | f |
| BC15_F044-A | 0.96 | 23.7 | 34.9 | 1.47 | 4.27 | 68.42 | 62.16 | 0.91 | 165.48 | f |
| BC15_F044-B | 0.72 | 21.66 | 30.74 | 1.42 | 3.58 | 55.86 | 59.72 | 1.07 | 146.32 | f |
| BC28_F044-A | 0.17 | 11.81 | 19.18 | 1.62 | 2.18 | 36.15 | 39.35 | 1.09 | 94.68 | f |
| BC28_F044-B | 0.78 | 22.92 | 33.92 | 1.48 | 3.52 | 65 | 67.17 | 1.03 | 166.09 | f |
| BC28_F044-C | 1.91 | 28.29 | 39.94 | 1.41 | 5.45 | 90.47 | 84.73 | 0.94 | 215.14 | f |
| BC28_F044-D | 4.98 | 38.53 | 53.4 | 1.39 | 7.6 | 136.96 | 119.05 | 0.87 | 309.41 | f |
| BC28_F044-E | 4.18 | 38.35 | 53.66 | 1.40 | 7.02 | 130.88 | 113.68 | 0.87 | 298.22 | f |
| BC13_F044-1 | 8.43 | 51.5 | 69.8 | 1.36 | 7 | 229 | 198 | 0.86 | 496.8 | f |
| WD3_F044-2 | 3.03 | 36.1 | 49.7 | 1.38 | 4.8 | 107 | 122.5 | 1.14 | 279.2 | f |
| WD3_F044-3 | 0.38 | 17.8 | 26 | 1.46 | 2.1 | 50 | 50 | 1.00 | 126 | f |
| WD4_F044-4 | 1.79 | 29 | 41 | 1.41 | 3.1 | 68 | 151 | 2.22 | 260 | m |
| WD3_F044-5 | 1.86 | 30 | 43 | 1.43 | 3.3 | 71 | 156 | 2.20 | 270 | m |
| WD4_F044-6 | 1.44 | 29 | 38.7 | 1.33 | 2.7 | 60.5 | 141 | 2.33 | 240.2 | m |
| WD6_F044-A | 1.6 | 26.73 | 36.57 | 1.37 | 6.27 | 66.78 | 122.08 | 1.83 | 225.43 | m |
| WD6_F044-B | 3.05 | 39.88 | 53.73 | 1.35 | 7.07 | 130.64 | 115.12 | 0.88 | 299.49 | f |
| WD6_F044-C | 3.5 | 39.54 | 54.28 | 1.37 | 7.55 | 127.02 | 109.92 | 0.87 | 291.22 | f |

### *H. cristatus*

| Individual Site_Fish | Wet wt | Snout Length | Head Length | Head/snout ratio | Dorso/ventral depth | Trunk Length | Tail Length | Tail/trunk ratio | Total length | Sex |
|---|---|---|---|---|---|---|---|---|---|---|
| WD6_F107 | 4.16 | 8.41 | 20.64 | 2.45 | 6.49 | 75.32 | 134.78 | 1.79 | 230.74 | m |

### *S. argus*

| Individual Site_Fish | Wet wt | Snout Length | Head Length | Head/snout ratio | Dorso/ventral depth | Trunk Length | Tail Length | Tail/trunk ratio | Total length | Sex |
|---|---|---|---|---|---|---|---|---|---|---|
| Z1/1_ F078 | 0.94 | 23.23 | 32.46 | 1.40 | 5.43 | 44.37 | 103.8 | 2.34 | 180.63 | m |
| WD6_F078_A | 2.32 | 31.7 | 41.92 | 1.32 | 8.29 | 72.2 | 152.62 | 2.11 | 266.74 | f |
| WD6_F078 | 1.68 | 27.53 | 38.6 | 1.40 | 7.36 | 65.96 | 115.8 | 1.76 | 220.36 | f |
| WD3_F078-1 | 2.03 | 31.1 | 43.83 | 1.41 | 6.18 | 71.22 | 134.15 | 1.88 | 249.2 | f |
| BC17_F078-2 | 1.36 | 26.92 | 37.37 | 1.39 | 5.49 | 63.16 | 131.26 | 2.08 | 231.79 | f |

## APPENDIX 3: SOUTH AUSTRALIAN MUSEUM REGISTER OF SYNGNATHIDS

Summary of distribution of registered South Australian Museum specimens for Syngnathids examined in this study.

| | West Coast & GAB | Spencer Gulf | Gulf St. Vincent/ KI | Victor Harbour/SE | No data | Other states | Total |
|---|---|---|---|---|---|---|---|
| *H. bleekeri* | 1 | 25 | 1 | 1 | 1 | | 30 |
| *P. taeniolatus* | 2 | 4 | 30 | 4 | 11 | 6 | 57 |
| *P. eques* | | 8 | 11 | 2 | 5 | | 27 |
| *F. tigris* | | 8 | | | | | 8 |
| *S. argus* | 14 | 19 | 27 | | 4 | 4 | 68 |
| *H. cristatus* | 1 | 7 | 10 | | 1 | 1 | 20 |
| *L. fistularius* | | 13 | 6 | 1 | 2 | | 22 |

Summary of distribution of other Syngnathids registered at the South Australian Museum.

| | West Coast & GAB | Spencer Gulf | Gulf St. Vincent/ KI | Victor Harbour/SE | No data | Total |
|---|---|---|---|---|---|---|
| *Acentura australe* | | | 3 | | | 3 |
| *Campichthys galei* | | 2 | | | | 2 |
| *C. tryoni* | | | 1 | | | 1 |
| *Heraldia. nocturna* | | | 1 | | 1 | 2 |
| *Hippocampus breviceps* | 1 | 5 | 15 | | 2 | 23 |
| *H. tristus* | | | 1 | | | 1 |
| *Histiogamphelus briggsi* | | | 1 | 1 | | 2 |
| *Hypselognathus horridus* | 4 | | | | | 4 |
| *H. rostratus* | 1 | 2 | 1 | | | 4 |
| *Kaupus costatus* | 2 | 5 | 8 | | | 15 |
| *Lissocampus caudalis* | | | 3 | | 1 | 4 |
| *L. runa* | 1 | | 2 | | | 3 |
| *Maroubra perserrata* | | | 2 | | | 2 |
| *Notiocampus ruber* | | | | 1 | | |
| *Pugnaso curtirostris* | 2 | 10 | 15 | 5 | 1 | 33 |
| *Solegnathus robustus* | 8 | 1 | | | 1 | |
| *Stigmatopora narinosa* | | 5 | 10 | | | 15 |
| *S. nigra* | | 4 | 8 | 1 | | 13 |
| *Urocampus carinirostris* | 2 | | | | | 2 |
| *Vanacampus margatritifer* | | | | 1 | | 1 |
| *V. phillipi* | 4 | 10 | 14 | 1 | | 29 |
| *V. poecilolaemus* | | 9 | 7 | 1 | 1 | 18 |
| *V. vercoi* | | 4 | 4 | | | 8 |