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Fisheries Long Term Monitoring Program

Syngnathids in the East Coast Trawl Fishery: a review and trawl survey

November 2005

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Acronyms

BRD	Bycatch Reduction Device
CFISH	Commercial Fisheries Information System, DPI&F
CITES	Convention on International Trade in Endangered Species
CPUE	Catch Per Unit Effort
DEH	Department of the Environment and Heritage
DPI&F	Department of Primary Industries and Fisheries, Queensland
ECOTF	East Coast Otter Trawl Fishery
ECTF	East Coast Trawl Fishery
EKP	Eastern King Prawn
EPBC	Environment Protection and Biodiversity Conservation
IUCN	International Union for Conservation of Nature and Natural Resources
LTMP	Long Term Monitoring Program, DPI&F
MAFF	Marine Aquarium Fish Fishery
RIBTF	River and Inshore Beam Trawl Fishery
SOCI	Species of Conservation Interest
TCM	Traditional Chinese Medicine
TED	Turtle Excluder Device
VMS	Vessel Monitoring System
WTO	Wildlife Trade Operation

Summary

The Department of Primary Industries and Fisheries (DPI&F), Queensland, manages the state's fish, mollusc and crustacean species and the habitats in which they live. Inherent in this responsibility is a commitment to monitor the condition of, and trends in, fish populations and their associated habitats. This information is used to assess the effectiveness of fisheries management strategies and contributes to ensuring that the fisheries remain ecologically sustainable.

The family Syngnathidae (seahorses, seadragons, pipefish and pipehorses) are harvested incidentally in the Queensland East Coast Trawl Fishery (ECTF) and as a target species in the Marine Aquarium Fish Fishery (MAFF), due to their value as curios, aquarium fish and traditional Asian medicines (Dunning *et al.,* 2001; Vincent, 1996). There is very little information available on the biology or ecology of syngnathid species and as such many are listed as a worldwide conservation concern.

The objectives of this project were to carry out a fishery-independent trawl survey to:

- improve our understanding of the distribution and abundance of syngnathids in shallow water eastern king prawn (EKP) trawl grounds
- collect basic biological information on the syngnathid species within the shallow water EKP trawl grounds
- compare the patterns of syngnathid distribution and abundance using the fishery-independent data collected from the trawl survey to the patterns using fishery-dependent commercial logbook data from the Commerical Fisheries Information System (CFISH)
- investigate the relationship between syngnathid distribution and abundance, and assemblages and habitat characteristics.

During this fishery-independent assessment, 87 trawl shots were undertaken over a 10 night stratified survey in the shallow water EKP trawl grounds. Information was collected on the syngnathids and the entire community composition collected from the trawls. The information collected was statistically compared against the current syngnathid monitoring information.

Over 90% of the total syngnathid catch comprised of pipehorses, *S. dunckeri* and *S. hardwickii*. In addition, there were two species of seahorse and one pipefish collected in the survey area. The highest density of all syngnathids was collected in the 'low effort, zero reported catch' grid east of Noosa. The shallowest depth where pipehorses were caught in the survey area was 50 m, however no trawls were conducted deeper than 85 m and therefore no maximum depth limit was indicated.

There was little correlation in terms of syngnathid abundance between the information gathered from the survey and the daily commercial fishery logbook data used to currently monitor syngnathids. This result indicates that the logbook data alone is not an accurate or comprehensive monitoring tool for fine scale areas of syngnathid distribution and abundance along the Queensland coast. The survey showed that the highest mean abundance of syngnathids occurs in the low trawl effort grids, signifying that syngnathids either prefer habitats not targeted by trawlers or that syngnathid populations in high effort trawl grounds have been reduced due to fishing mortality. Further investigation is required on the biology and preferred habitat of syngnathids to further support either of these potential causal mechanisms.

The data presented in this report is limited to providing information on the first three objectives of the study. The final objective is to be assessed at a later date as the data become available, and will be the subject of a future report.

LTMP Background

The Department of Primary Industries and Fisheries (DPI&F), Queensland, manages the State's fish, mollusc and crustacean species and their habitats. As part of this commitment, DPI&F monitors the condition of, and trends in, fish populations and their associated habitats. This information is used to assess the effectiveness of fisheries management strategies and helps ensure that the fisheries remain ecologically sustainable. DPI&F also uses the information to demonstrate that Queensland's fisheries continue to comply with national sustainability guidelines, so that they may remain exempt from export restrictions under the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999*.

DPI&F initiated a statewide Long Term Monitoring Program (LTMP) in 1999, in response to a need to collect enhanced data for the assessment of Queensland's fisheries resources. The LTMP is managed centrally by a steering committee with operational aspects of the program managed regionally from the Southern and Northern Fisheries Centres located at Deception Bay and Cairns respectively. The regional teams are responsible for organising and undertaking the collection of data to be used for monitoring key commercial and recreational species, and for preparing data summaries and preliminary resource assessments.

A series of stock assessment workshops in 1998 identified the species to include in the LTMP. The workshops used several criteria to evaluate suitability including:

- the need for stock assessment based on fishery-independent data
- the suitability of existing datasets
- the existence of agreed indicators of resource status
- the practical capacity to collect suitable data.

Species currently monitored in the LTMP include saucer scallops, spanner crabs, stout whiting, mullet and tailor in southern Queensland, and tiger prawns and reef fish in northern Queensland. Species with statewide monitoring programs include mud crabs, barramundi, spotted and Spanish mackerel and freshwater fish. Various sampling methodologies are used to study each species. The incorporation of fishery-independent techniques is preferred, with combinations of fishery-dependent and independent techniques being used where appropriate. Data collected in the monitoring program are maintained in a central database in Brisbane.

The primary aim of the LTMP is to collect data for resource assessment (ranging from analyses of trends in stock abundance indices to more complex, quantitative stock assessments) and management strategy evaluations. The greatest value of the growing datasets for each of the species and associated habitats is in the long time series generated by continued sampling, something that is usually required for accurate assessments but is rarely available.

Stock assessment models have already been developed for saucer scallops, spanner crabs, stout whiting, mullet, tailor, barramundi, tiger and endeavour prawns, and spotted and Spanish mackerel. In some cases management strategy evaluations have also been carried out. The data collected in the LTMP have been integral to these activities.

The assessments and evaluations have, in turn, allowed options for improvements to the management of Queensland's fisheries resources to be considered. Enhancements to ongoing monitoring have also been identified, particularly to address the increasing demand for high quality data for dynamic fish population models.

Through the ongoing process of collecting and analysing LTMP data and incorporating these data into regular assessments and refining monitoring protocols as required, DPI&F is enhancing its capacity to ensure that Queensland's fisheries resources are managed on a sustainable basis.

Introduction

The family Syngnathidae (seahorses, seadragons, pipefish and pipehorses) creates much interest throughout the world due to their value as curios, aquarium fish and as an ingredient in traditional Asian medicines (Dunning *et al.,* 2001; Vincent, 1996). It is for these trades that syngnathids are harvested in the Queensland ECTF and MAFF.

The high demand for syngnathids in the traditional Chinese medicine trade has lead to increased fishing pressure and population declines in some areas of the world (Pogonoski *et al.,* 2002; Vincent, 1996). While Australian waters contain approximately half of the world's syngnathid species (Vincent, 1996), there is currently little quantitative evidence of any serious population declines (Pogonoski *et al.,* 2002). However, there is the potential risk that if stocks are depleted in other south-east Asian regions the traditional Chinese medicine trade could focus on Australian species, raising further conservation interest for these syngnathids (Pogonoski *et al.,* 2002).

Objectives

This study was initiated to address requirements of the Commonwealth Department of the Environment and Heritage's (DEH) declaration of an approved Wildlife Trade Operation (WTO) for syngnathids (Appendix 3). The study was specifically concerned with condition 7 of the declaration, which requires DPI&F to design and implement fishery-independent surveys of bycatch in the ECTF in order to improve understanding of syngnathids and their preferred habitats.

To fulfil condition 7 of the WTO declaration it was necessary to carry out research specifically targeting syngnathids. The objectives of this project were to carry out a fishery-independent trawl survey to:

- improve our understanding of the distribution and abundance of syngnathids in shallow water EKP trawl grounds
- collect basic biological information on the syngnathid species within the shallow water EKP trawl grounds
- compare the patterns of syngnathid distribution and abundance using the fishery-independent data collected from the trawl survey to the patterns using fishery-dependent commercial logbook data from CFISH
- investigate the relationship between syngnathid distribution and abundance and assemblages and habitat characteristics.

The shallow water EKP trawl grounds were chosen due to the high numbers of syngnathids reported in the area since 2000 when compared to other areas of the state (Figure 1). The EKP trawl grounds were also chosen to complement the current fishery-independent surveys conducted by LTMP in other Queensland trawl fishery grounds. Surveys are conducted annually for tiger and endeavour prawns in the northern region of the state, north of Townsville (Turnbull *et al.,* 2004), and scallops in the central region of the state, between Bundaberg and Gladstone (Jebreen *et al.,* 2003). There was also a recent survey conducted off the coast of Townsville, between Otter Reef (18.1°S) and Old Reef (19.5°S), in the red spot king prawn trawl grounds (Clive Turnbull, DPI&F, pers. comm. July 2005). While these surveys were not designed specifically to investigate syngnathids, they use gear representative of the ECTF and collect information incidentally on the distribution and abundance of syngnathids.

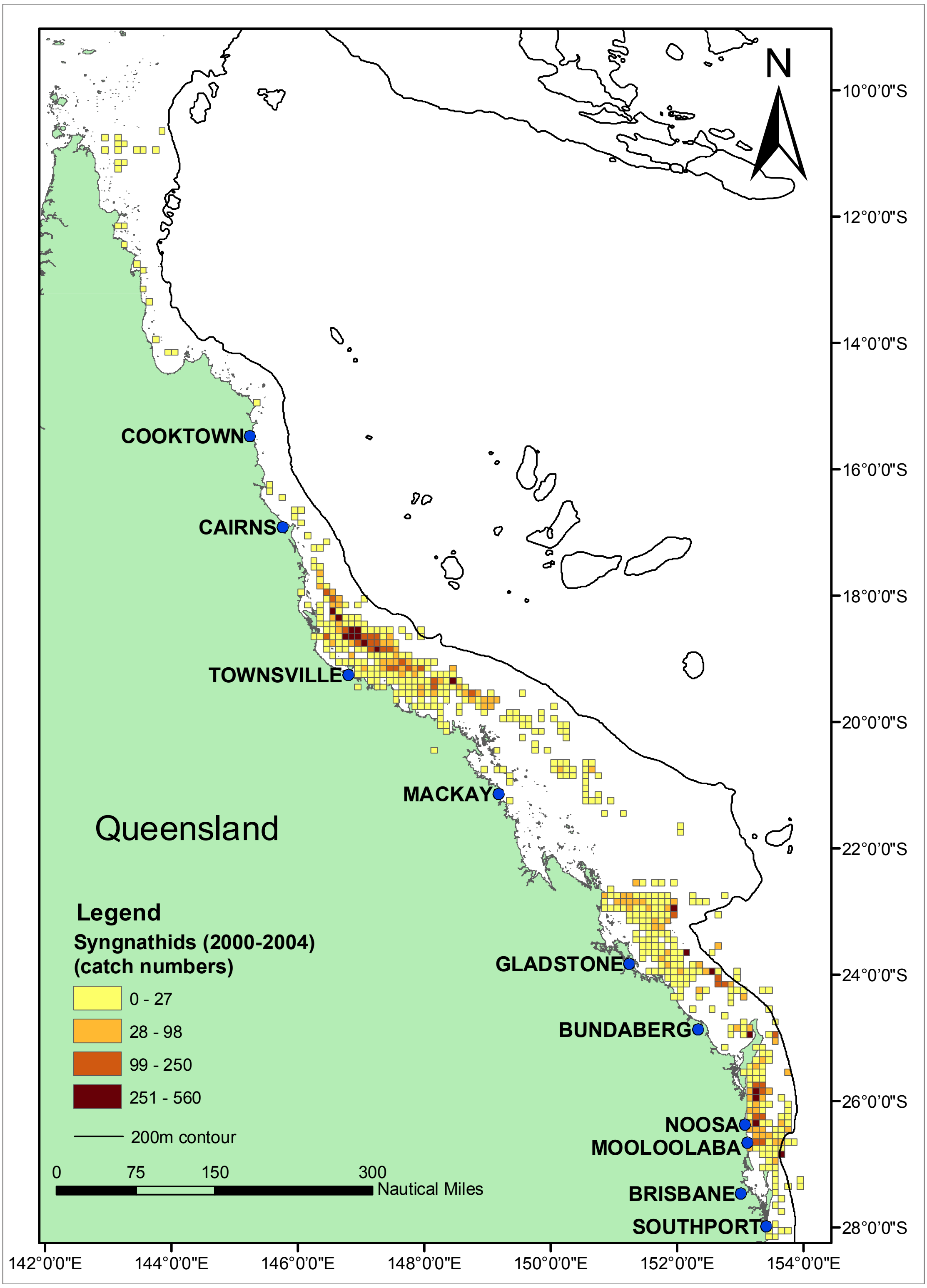

Figure 1. Historical catch (numbers) data for syngnathids along the Queensland coast (2000–2004) (CFISH database February 2005)

This study evaluated the current knowledge of syngnathids within the ECTF. By reviewing the available information it is evident that there is a distinct lack of knowledge about the family and the role it plays in the ECTF. Very little is known of the biology and ecology of syngnathids, their population dynamics and how their populations are potentially affected by the fishery. Surveys such as the one reported in this study provide new information to assist in the sustainable management of syngnathids within Queensland fisheries.

Background

Queensland fisheries

All syngnathid species in Australian waters are protected by Commonwealth legislation under the *Environment Protection and Biodiversity Conservation Act 1999*, where they are listed marine species. It is an offence to take, trade, keep, move, injure or kill a listed marine species without a permit issued by the Commonwealth Minister for the Environment and Heritage. In Queensland, syngnathids are currently permitted to be harvested and exported from both the ECTF and the MAFF. Both of these fisheries are managed by DPI&F under the Queensland *Fisheries Act 1994* and its subordinate legislation the *Fisheries Regulation 1995* and the *Fisheries (East Coast Trawl) Management Plan 1999*.

In order for Queensland fisheries to export syngnathids from Australia, each fishery must undergo an assessment under the *EPBC Act 1999* to ensure that it is being managed sustainably. These assessments are carried out by the Commonwealth DEH, resulting in one of three outcomes—exempt, WTO or prohibition (DEH website, June 2005, www.deh.gov.au/coasts/fisheries/index.html). The export of syngnathids in the ECTF has been assessed as a WTO (Appendix 3), whereas the MAFF is currently under assessment by DEH (August 2005).

In Queensland, all commercial fishers record their daily catch of target and other permitted species in fishery-specific logbooks. They are also required to report any species incidentally collected or interacted with that are listed as species of conservation interest (SOCI) in a separate logbook. The logbook data management system is called CFISH and is managed by DPI&F. The information provided is used to help monitor the status of species and of fisheries along the Queensland coast. The current monitoring of syngnathid catch along the Queensland coast is through CFISH, although there is some variation in the detail of the information recorded on syngnathids between the different Queensland fishery sectors (see www.dpi.qld.gov.au/fishweb/2984.html).

There is currently no routine process in place to validate logbook records of the capture of syngnathids. However, an observer program is being developed by DPI&F which will provide independent validation of the bycatch species (including syngnathids) caught in the trawl fishery (Zeller, 2002). Data collected by the observer program will be used to assess the effectiveness of current management measures aimed at minimising capture of protected species, and for verification of fishery-dependent (logbook) data on protected species, such as syngnathids (McGilvray, 2004).

Queensland East Coast Trawl Fishery

Queensland's ECTF is the largest fishery within the state (Fishweb, April 2005, www.dpi.qld.gov.au/fishweb/12545.html). The fishery consists of two sectors—the East Coast Otter Trawl Fishery (ECOTF) and the River and Inshore Beam Trawl Fishery (RIBTF). The ECOTF is the larger of the two sectors, which in 2004 comprised approximately 480 fishing boats and 61 800 boat days of fishing effort (Gaddes and Bibby, 2005), with the remainder of the ECTF fleet made up of approximately 155 beam trawl operators (CFISH, August 2005). Syngnathids are only harvested from the ECOTF, with no reported catch of syngnathids in the RIBTF to date (Stobutzki *et al.,* 2000).

The main target species for the ECOTF are prawns, scallops and stout whiting (Williams, 2002). Target species vary in their distribution and seasonality and as such most commercial operators in the ECTF travel great distances to target various species along the Queensland coast (Lightowler, 1998; Williams, 2002). Other species that are permitted to be retained as incidental catch, yet are not to be specifically targeted by trawling operations, include Moreton Bay bugs, squid, blue swimmer crabs, red spot crabs, Balmain bugs, barking crayfish, cuttlefish, mantis shrimp, octopuses, pinkies and pipefish[1] (*Fisheries (East Coast Trawl) Management Plan 1999*).

[1] 'pipefish' used in legislation refers to the two syngnathid species of the pipehorses, *S. hardwickii* and *S. dunckeri*. For the remainder of the document these two species will be referred to as 'pipehorses', as this is the accepted common name for *Solegnathus* spp.

The ECTF is further managed by a range of input and output controls stipulated in the Queensland *Fisheries (East Coast Trawl) Management Plan 1999*. These input and output controls include management arrangements such as temporal and spatial closures, gear restrictions, excluder devices, compulsory boat and gear upgrades, effort capping, reduction of fishing days, daily catch limit and a yearly total allowable commercial catch for some species.

The ECTF is currently permitted to retain only two species of Syngnathidae, the pipehorses *Solegnathus hardwickii* (pallid pipehorse) and *Solegnathus dunckeri* (Duncker's pipehorse), with a possession limit of 50 pipehorses in total. The pipehorse catch for the ECTF was not reported as a separate group from other permitted species until 2000 (logbook 'OT07') and was further reported as two separate species from 2003 (logbook 'OT08') (see Fishweb, April 2005, www.dpi.qld.gov.au/fishweb/2984.html).

Marine Aquarium Fish Fishery

Queensland's MAFF occurs in tidal waters south of 10°41′ latitude and east of 142°31′49″ longitude (Lightowler, 1998). The fishery consists of both commercial and recreational fishers that collect marine fish species for display in an aquarium. The fishery is allowed to retain a large variety of fish species from a large number of families, however, approximately 50% of the catch comes from three families—damselfish, wrasses and angelfish (Aquarium Fish and Coral Fisheries Working Group, 1999). The *Fisheries Regulation 1995* stipulates the range of collection and gear restrictions on the fishery.

The MAFF is currently allowed to harvest all species of syngnathid. However, catches are usually restricted by demand and therefore numbers of syngnathids harvested from this fishery are annually very low (Appendix 2). All syngnathids collected by the commercial fishers are recorded in logbooks (logbook 'AQ03') under one category, 'pipefish/seahorses' (i.e. there is no provision to record individual species) (see: Fishweb, April 2005, www.dpi.qld.gov.au/fishweb/2984.html).

Export and trade of syngnathids

Syngnathids are highly valuable on the Asian market for use in traditional medicines (Martin-Smith *et al.,* 2003). The lack of data on syngnathid species and the increase in the traditional Chinese medicine trade has lead to much debate and concern in recent years. Much of the volume, value, sources and trade routes of syngnathids are poorly understood (Martin-Smith *et al.,* 2003). Syngnathids are a high-value commodity due to the demand exceeding the supply; for example, pipehorses have been reported at approximately $US1500 per kg dry weight (Vincent, 1996).

It is believed that the majority of syngnathid international trade revolves around the traditional medicine market and therefore most trade involves dried animals. Traditional medicines using syngnathids are believed to treat a range of ailments including respiratory disorders, sexual dysfunctions, general lethargy and pain (Martin-Smith *et al,*. 2003; Vincent, 1996). For external use syngnathids are ground into a powder and applied topically. When taken internally they are usually only one of several ingredients in a liquid medicine. Seahorses and pipehorses are used for similar medicinal purposes, although pipehorses are perceived to be of a higher value for medicines (Martin-Smith *et al.,* 2003).

Worldwide there are at least 32 nations involved in the syngnathid trade (Vincent, 1996). Martin-Smith *et al*. (2003) indicate that Australia is an important source of pipehorses, providing most of the top quality pipehorses in traditional Chinese medicine. Of the two species retained by the ECTF, *S. hardwickii* is the most common pipehorses used in traditional Chinese medicine worldwide and also the most common exported from Australia. *S. hardwickii* is also exported from other nations within their geographical distribution. This is not the situation for *S. dunkeri* which is endemic to Australia and as such all traditional Chinese medicine specimens would be exported from Australia (Martin-Smith *et al.,* 2003). The Queensland ECOTF retains approximately 5500–11 000 individual syngnathids annually (Appendix 2) with the average fish weighing approximately 62 g wet (27 g dry) (Connolly *et al.,* 2001).

Unlike traditional Chinese medicine very few pipehorses are used in the trade for curios and aquarium fish (Vincent, 1996). Seahorses are popular curios because they retain their shape and morphological characteristics well when dried and are relatively easier to collect than other syngnathid species. Although wild seahorses and other syngnathids are caught for aquaria, very few survive long in captivity. This is mainly due to processes involved with capture and transport of the individuals, which leads to further problems such as disease, stress and malnutrition in captivity (Vincent, 1996).

Biology and ecology of syngnathids

There are several documents that discuss the classification of syngnathids—the two most commonly used are Dawson (1985) and Kuiter (2000) (Appendix 4). Both documents state that the family Syngnathidae is characterised by the presence of lobate gills, a pore-like gill opening located above the opercule, the fins are all soft rayed with all species lacking pelvic fins, the head usually posses a tubular snout with a small mouth at the tip, all without the absence of true jaw-teeth and the body is protected by a ring-like arrangement of dermal plates, rather than scales.

Most syngnathids are characterised by sparse distribution, relatively low mobility, low fecundity and lengthy parental care (Vincent, 1996). Syngnathids are essentially found in coastal marine and estuarine environments. They can occur in depths of a few centimetres up to over 400 m for demersal species (Dawson, 1985). There is a large variation in size of syngnathids, ranging between a few centimetres for the pygmy species to around 650 mm for the pipehorses (Kuiter, 2000). It is generally thought that syngnathids visually feed on zooplankton, preying mainly on small crustaceans that are sucked up whole (Kuiter, 2000; Payne *et al.,* 1998; Woods, 2003).

Due to the lack of information available on the status and biology of Australian syngnathid species, many are listed as vulnerable or data deficient on the International Union for Conservation of Nature and Natural Resources (IUCN) Red List (Appendix 1)—with many seahorse species (*Hippocampus*) also listed in the Convention on International Trade in Endangered Species of Wild Flora and Fauna Appendix II.

The majority of syngnathid research has been focused on characteristic breeding biology of syngnathids (Moreau and Vincent, 2004; Sanchez-Camara and Booth, 2004). It has been widely documented that the males of the syngnathid species exclusively brood and care for the offspring. The female deposits her eggs in a pouch or on a special patch of skin of the male where the sperm is waiting to fertilise the eggs (Kuiter, 2000, 2001). The brood area used by the syngnathid males varies from a fully enclosed pouch in seahorses and some pipefish, a pouch of interlocking skin flaps for most pipefish, and fully exposed eggs attached under the tail for pipehorses and seadragons (Kuiter, 2000; Vincent, 1996; Wilson *et al.,* 2003). The mating system is also varied ranging from monogamy, displayed by most seahorse species and some pipefish, to polygamy, displayed by many pipefish and seadragon species.

Generally syngnathids are poor swimmers with a prehensile tail used to anchor them to the substrate. Syngnathids are commonly associated with vegetated or other structurally complex habitats, however, very little is known on the preferred habitats for individual species (Kendrick and Hyndes, 2003). Anecdotal evidence from the fishing industry suggests pipehorses are generally not associated with open sandy seabeds, preferring rocky reef and sponge areas, which are areas that are not typically trawled (Zeller, 2002). Others have indicated that they may be associated with high current areas that are inhabited by sea pens and sea fans, and that they seem to be more prevalent after or during rough weather (Malcolm Dunning, DPI&F, pers. comm. February 2005). This was supported by fishers in south-eastern Australia who reported that pipehorses were more prevalent with gorgonians, black corals, algae and sponges (Bowles, 2001). Pipehorses have been observed in New Zealand holding on to sponges with their prehensile tails (Martin-Smith *et al.,* 2003).

To help understand the habitats and species associated with pipehorses, Courtney *et al.* (2003) undertook a study aimed at determining associations between pipehorses and other species collected within trawl nets. The study was an exploratory investigation and the conclusions it drew should be utilised with caution. The study utilised data from a fishery-independent DPI&F scallop survey in 2000 and a trawl bycatch survey undertaken in October 2001. The analyses did not show the same species correlations for each survey, yet provided insight into the species with which pipehorses may be associated at various depths.

There is very little known on the biology of the two pipehorse species retained in the ECTF. The little information that is available, such as the known distribution, size and some brooding information is presented in Dawson (1985), Pogonoski (2002) and Connolly *et al.* (2001). Some fishery-independent research that has focused on pipehorses in the Queensland ECTF was conducted during the DPI&F scallop recruitment survey in October 1998. Onboard experiments were conducted to determine the condition of pipehorses when caught in trawls (Dunning *et al.,* 2001). The experiments suggested that very few, if any, syngnathids caught in trawl nets would survive when returned to the water after normal commercial trawl tows of up to 2.5 hours. However, these were limited experiments and should only be used as an indication of pipehorse survival.

Methodology

Survey design

The trawl survey described here was designed using CFISH data to determine areas of reported syngnathid catch and areas of trawl effort in the shallow water EKP trawl grounds. The Queensland EKP trawl grounds extend south from 22°S (Swains Reefs) to the Queensland and New South Wales border. The majority of the effort in this fishery occurs south of Fraser Island targeting eastern king prawns (Williams, 2002). The survey focused on these grounds in depths less than 50 fathoms (90 m) as these are the depths where syngnathids had most frequently been caught in previous surveys (Connolly *et al.,* 2001; Dunning *et al.,* 2003).

The survey was designed by randomly selecting trawl sites within a stratified sampling area. The historical data reported by commercial fishers (CFISH) at 6 minute by 6 minute grids[2] were used to define the strata (Figure 2) (extracted from the CFISH database, February 2005). Six strata were defined based on the trawl effort (high and low effort) and catch per unit effort (CPUE) of syngnathids (high, low and zero CPUE), as shown below:

- high trawl effort, high syngnathid CPUE
- high trawl effort, low syngnathid CPUE
- high trawl effort, zero syngnathid CPUE
- low trawl effort, high syngnathid CPUE
- low trawl effort, low syngnathid CPUE
- low trawl effort, zero syngnathid CPUE.

The annual average number of boat days (2002–2004 data)[3] in each grid defined as high trawl effort was >100 boat days and low trawl effort was <30 boat days. The CPUE of syngnathids (2000–2004) in each grid stratified high catch as >1 syngnathid per 10 boat days and low catch as <1 syngnathid per 10 boat days. Zero catch was defined as a grid that had no historical syngnathid reported catch.

[2] The commercial trawl fishermen report at a 30 minute by 30 minute grid and a 6 minute by 6 minute site resolution. However, as there is no reference to 30 minute by 30 minute grids in this document the word 'grid' will be used to refer to the 6 minute by 6 minute sites.

[3] The effort was based on post 2002 CFISH data because prior to that most of the logbook records were only recorded at the 30 minute by 30 minute grid scale and did not include the 6 minute by 6 minute grid scale.

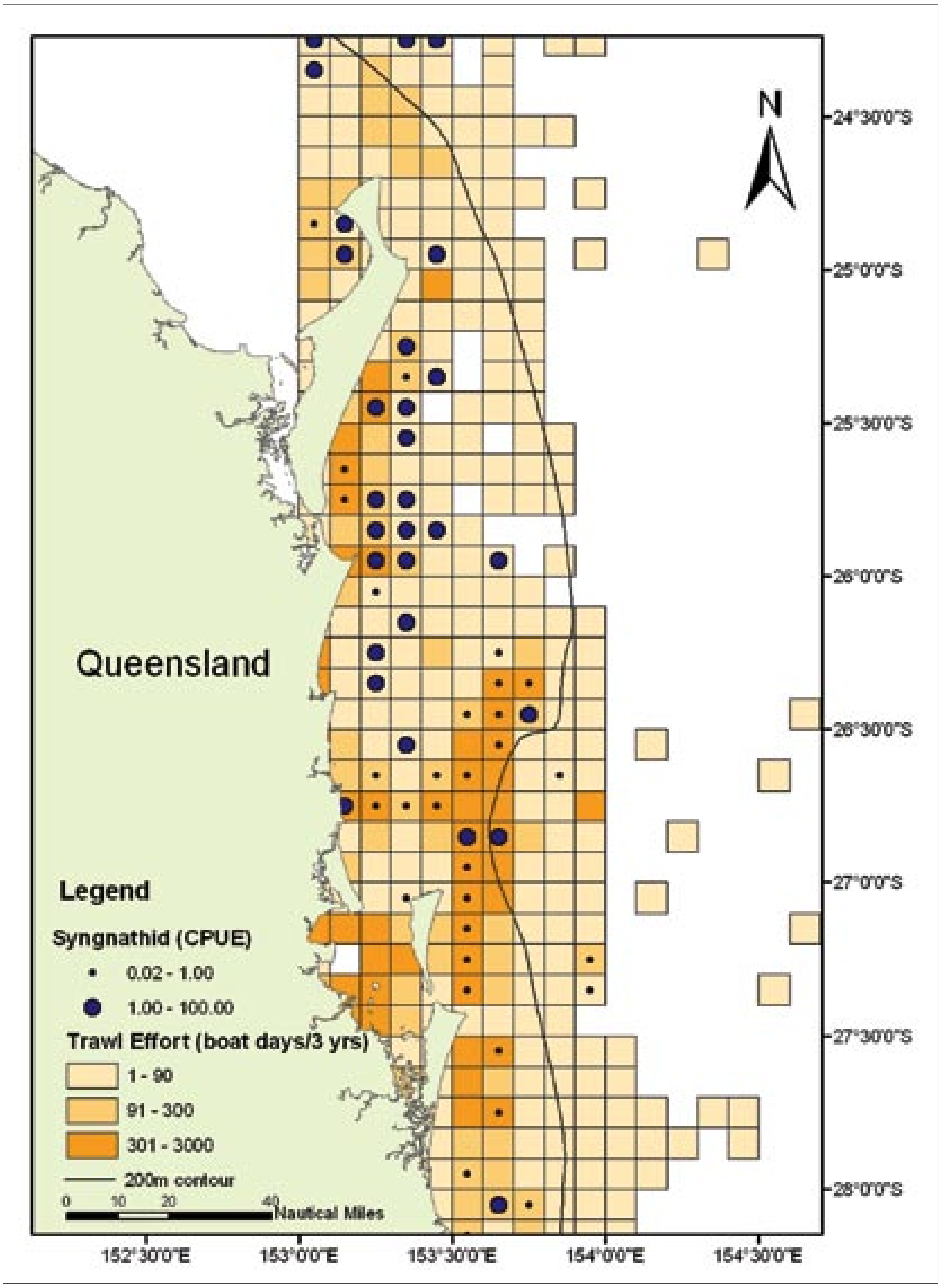

Figure 2. The defined sampling area with the historical data for each 6 minute by 6 minute grid showing the trawl effort (average boat days per year) (2002–2004) and syngnathid CPUE (number of syngnathids caught per 10 boat days) (2000–2004) (CFISH February 2005).

All grids within the survey area were identified as one of the six strata and four grids (three to sample and one reserve) were randomly chosen for each stratum. Each grid selected was divided into 36 evenly spaced 1 minute by 1 minute sub-grids. Eight sub-grids (four to sample and four reserves) were randomly selected within each grid. This was to allow for a 1 nm (nautical mile) survey shot to be undertaken in the selected sub-grids.

Modifications to the sample design were made during the survey, due to the difficulty of trawling some predetermined sub-grids. As such there were survey shots conducted along the border of some grids. Additional sub-grids in some grids and additional grids were trawled opportunistically. Figure 3 shows the grids and survey shots inside the selected sub-grids for the entire survey.

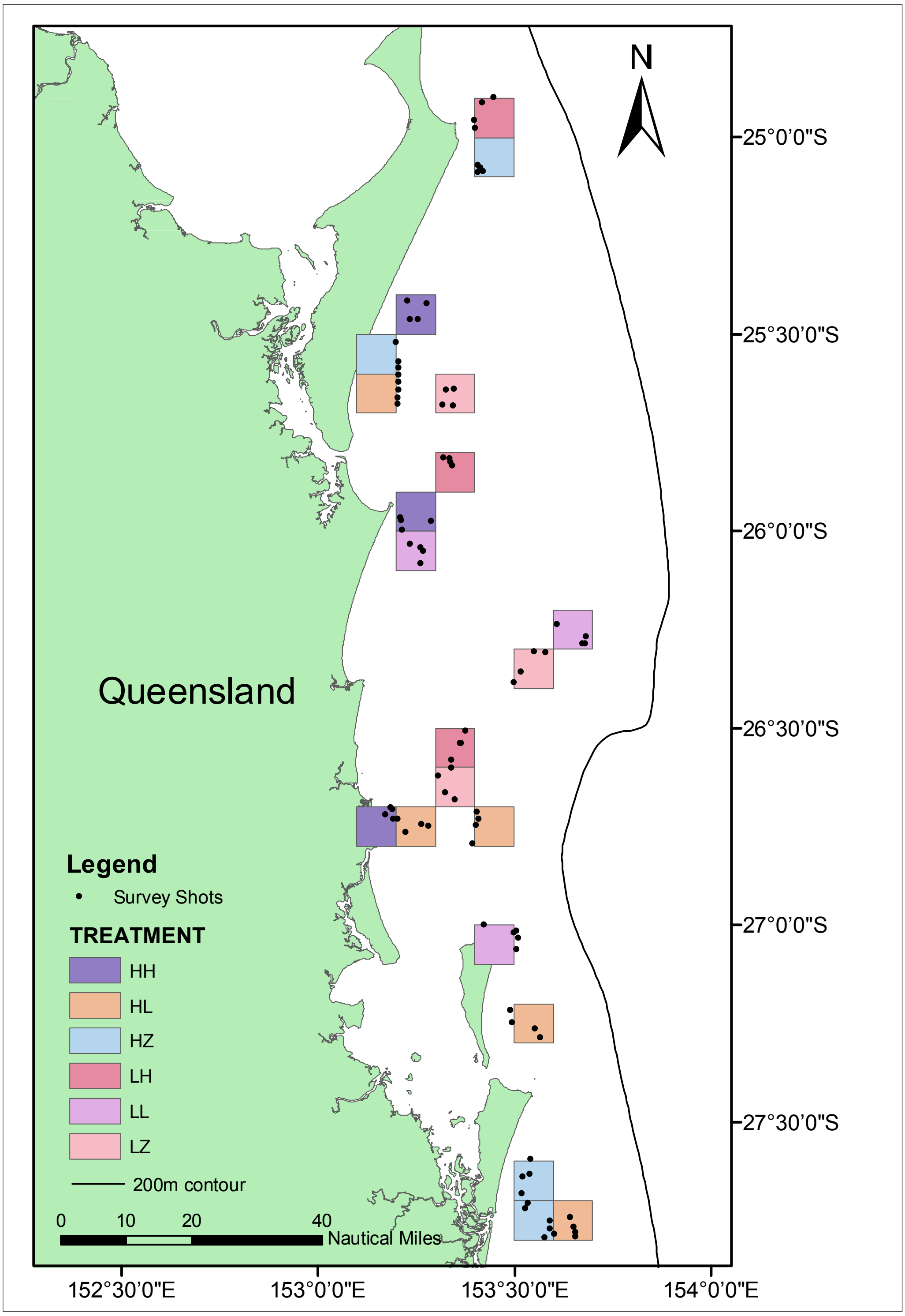

Figure 3. The location of the survey shots (mid-point of trawl) and the stratified grids sampled for the syngnathid survey (April–May 2005). HH = high trawl effort, high syngnathid CPUE; HL = high trawl effort, low syngnathid CPUE; HZ = high trawl effort, zero syngnathid CPUE; LH = low trawl effort, high syngnathid CPUE; LL = low trawl effort, low syngnathid CPUE; LZ = low trawl effort, zero syngnathid CPUE (CFISH February 2005).

Field survey protocols

A ten-night survey was undertaken on board a chartered commercial trawler between 26 April and 13 May 2005 in the shallow water EKP trawl grounds. All trawls were undertaken at night (18:00–06:00 hours) with standard commercial prawn gear representative of the shallow water EKP fishery. The configuration of the trawl nets was triple gear (one port, one starboard and one middle net) with 2 inch (51 mm) mesh, 7 fathom (12.8 m) headline length and 1¾ inch (44 mm) cod end mesh. The two outside nets were fitted with turtle excluder devices (TED) and bycatch reduction devices (BRD). The middle net was used to collect a sample of the community composition[4] and therefore did not have any excluder devices fitted.

The trawl shots were approximately 1 nm in the selected sub-grids. Shot details such as depth, latitude, longitude and time were recorded for the start and finish of each shot and the distance trawled recorded at the finish.

When the nets came on board the vessel the middle net, including catch, was weighed using a load cell meter. After spilling the catch, the middle net, without the catch, was weighed again. The middle net was spilled and sorted separately to the outside nets. Once all nets were spilled a photograph of the total catch was taken prior to sorting any of the nets to confirm catch details at a later date. A 10 kg subsample of community composition was collected from the middle net and snap frozen for laboratory analysis. The carton was weighed on the vessel before freezing.

Any large species (sharks, rays, sponges and corals) caught in the middle net that could not be accurately subsampled were identified, photographed and weighed on the vessel. All syngnathids caught in the survey were retained, labelled (shot number and net) and frozen for analysis in the laboratory.

Laboratory protocols

The frozen syngnathid specimens were brought back to the laboratory, where they were defrosted and identified to species. Pipefish and pipehorses were identified using Dawson (1985) and seahorses were identified using Kuiter (2001). When classifying the *Solegnathus* specimens collected in this survey it became evident that there was a high degree of within species variation in the key characteristic reported by Dawson (1985) for separating Queensland's *S. hardwickii* and *S. dunckeri*. After consultation with the Queensland Museum ichthyologist, a supplementary identification technique was determined, as detailed in Appendix 4.

The wet weight (g), total length (mm), gender and reproductive stage of each specimen were recorded. These measurements were consistent with the techniques used by Kuiter (2001) for seahorses and Connolly (2001) for pipehorses. However, Connolly (2001) measured length with a curled tail, whereas in this survey pipehorse total length was measured, from the tip of the snout to the tip of the tail.

[4] Community composition refers to all catch (including rubble or sediment, yet excluding syngnathids for this survey) trawled by nets without excluder devices such as TEDs and BRDs.

Data analysis

The distribution and abundance of syngnathids caught within the survey was displayed by mapping the density (weight (g) per nautical mile) of syngnathids for each sub-grid location.

To search for any depth preference of pipehorses and seahorses the average number was plotted against the depth. To complement this information the size of syngnathids was plotted against depth and a simple linear regression was carried out to test whether there was a relationship between the size of pipehorses and depth trawled.

To test the similarity of patterns of syngnathid abundance between independent and dependent data, general linear modelling (regressions) was performed using Genstat 7 (2003). Data from both sources (CFISH and the survey) were log-transformed to normalise variances and equalise leverage. The mean logged-abundance for each grid was calculated from the survey, and used in the analysis. The CFISH measure of abundance was the total catch of pipehorses for each grid divided by the total trawl effort for the grid using the data between 1 January 2002 and 31 December 2004.

The complete set of data was analysed, to test for a significant relationship between the CFISH and survey data. The relationships between the two sets of data, for the low and high trawl effort strata, were also examined separately to test whether there were different relationships between the two strata.