Resolution of taxonomic problems and preparation of a user-friendly guide to whole fish and fillets for the quota species of the South East Fishery

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Bibliography
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1. Fishes - Australia, Southeastern-identification.
   I. Last, Peter R. (Peter Robert).
   II. Ward, Robert Denston, 1948-.
   III. CSIRO. Division of Marine Research.
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CONTENTS

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Resolution of Taxonomic Problems and Preparation of a User-friendly Guide to Whole Fish and Fillets for the Quota Species of the South East Fishery

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OBJECTIVES:

1. To determine the true species composition of SEF quota species groups, through a combination of classical and genetic taxonomic techniques.

2. To prepare a definitive identification guide to the SEF quota species and their close relatives.

3. To include in this guide a means of identifying fillets of these species based on their protein fingerprints.

NON-TECHNICAL SUMMARY:

An upgraded identification guide to fish and fillets of the South East Fishery (SEF) quota species groups has been compiled from new information. This reference, *South East Fishery Quota Species: an Identification Guide* (Daley *et al.*, 1997) and hereafter referred to as *SEF Species Guide*, was prepared with the joint resources of the CSIRO Division of Marine Research, the Fisheries Research and Development Corporation (FRDC), the Australian Fisheries Management Authority (AFMA) and the Fishing Industry.

The *SEF Species Guide* was based on a thorough taxonomic study of the commercial species of the SEF. It provides an improved means to their identification and also clarifies which species are regulated by quota within each quota species group. The species composition of the fishery, consisting of 13 quota species groups, was found to include a suite of commercial species that are currently not covered by quota regulations. Some are new to science and several are very similar in appearance to the quota species.

The *SEF Species Guide* will be an important tool in the administration of the SEF. Many of the findings of the study have implications for the development of management, including non-trawl sector arrangements. The main findings of the study and their implications for management, are discussed separately for each quota species group in the results section. Results are summarised in Table 1.

In the past, quota regulations have been difficult to enforce because the species identity of the catch was difficult to prove. Genetic examination of seafood can provide strong evidence of species identity. Protein fingerprinting (described more fully in the *SEF Species Guide*) is a simple method of genetic testing that compares muscle proteins of species. It was used in this project for identifying whole fish and fillets of the SEF quota species. For species with very similar or identical protein fingerprints, additional allozyme tests were developed. The main aim of both types of tests is to assist in distinguishing between quota and non-quota species. More sophisticated genetic techniques (e.g. mitochondrial DNA) may provide more definitive identifications but are more expensive and more time-consuming, and require specialised skills and facilities.

Most SEF quota species have different marketing names to their non-quota commercial relatives. Quota species usually command a higher price than the non-quota species. Use of the correct marketing names is likely to increase consumer confidence, by extension their demand for seafood, thereby contributing to the value of the SEF. Protein fingerprinting may be used to check that seafood is not marketed under the name of a different species. In protein fingerprinting, samples to be identified are compared to a protein standard. Some species can be tested cheaply and easily in the market place; other species require additional testing.

The quota species in six of the SEF quota groups (dories, grenadiers, prawns, redfishes, roughies and ocean perches), can be distinguished from the non-quota species by protein fingerprinting alone.

In five groups (gemfishes, lings, morwongs, trevallies and warehous), protein fingerprinting needs to be supplemented with simple allozyme tests. The confirmatory allozyme tests involve comparing muscle tissues from positively identified control specimens. Testing is difficult in the field but can be done in a laboratory by a technician with limited training.

The remaining two groups (whitings and flatheads) need to be tested in a genetics lab, by an expert, using a combination of protein fingerprinting and multiple allozyme tests.

In the event of a legal dispute, field test results (for any of the species) would need to be confirmed in a genetics laboratory. More sophisticated DNA analysis could also be used to provide additional and stronger evidence.

One weakness of similar studies in the past is that no whole fish vouchers were retained. Unless a voucher specimen is retained it is very difficult to prove the identity of a fish from which a tissue sample was taken. Vouchers were retained for all of the species examined during preparation of the *SEF Species Guide*.

FRRF Project No. 92-3/22, FRDC Project No. 94/152

Table 1: Project summary

	Issues highlighted	Distinguishing quota species from non-quota species		Future research
		whole fish	fillets/genetic testing	
Dories	Mirror dory - possibly separate species or stock off WA.	Straightforward for most species.	Market place.	Examination of longfin mirror dory.
Flatheads	May be difficult to monitor quota. Possible stock differences - longspine flathead.	Longspine flathead and rock flathead very similar to the quota species.	Laboratory essential.	Examination of longspine flathead stocks. Family review.
Gemfishes	One minor species is difficult to distinguish from the quota species.	One non-quota species very similar to the quota species.	Laboratory preferred.	No needs identified. Recently reviewed (Paxton and Colgan, 1993).
Grenadiers	One undescribed non-commercial species.	Straightforward with new characters.	Market place.	Examination of silver grenadier .
Lings	Stock/species problems - implications for non-trawl arrangements.	One non-quota species very similar to quota species but different distributions.	Laboratory preferred.	Species/stock structures.
Morwongs	Recently discovered species is not covered by quota.	Newly discovered species very similar to the quota species.	Laboratory preferred.	Australian distribution of new species
Ocean perches	Two species of ocean perch currently covered by one quota.	Quota species very similar to each other but distinct from the non-quota species.	Market place.	Australian review of the genus *Helicolenus*.
Prawns	New distribution records. New species likely.	Straightforward.	Market place (uncooked only).	Examination of new species.
Redfishes	Undescribed species in the GAB. Commercial catch consists of more than one species.	Straightforward with dorsal spine counts.	Market place.	Stock structure of Bight redfish. Description of smalleye redfish.
Roughies	New species - New Caledonia. Further discoveries likely.	Straightforward with new characters.	Market place.	No needs identified.
Trevallies	Silver trevally - possibly two stocks. Possibly two commercial species.	One non-quota species very similar to the quota species.	Laboratory preferred.	Stock structure of silver trevally. Catch composition - skipjack trevally.
Warehous	Ocean blue eye - implications for nontrawl arrangements. New trevalla discovered.	One non-quota species very similar to blue eye. Juveniles of some species similar.	Laboratory preferred.	Catch composition - ocean blue eye. Describe new trevalla. Review family.
Whitings	Non-quota species may comprise up to 10% of the commercial catch.	Difficult, attention to detail required.	Laboratory essential.	Detailed and accurate catch composition - minor species.

1. NON-TECHNICAL SUMMARY

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The *SEF Species Guide* will be an important tool in the administration of the SEF. Many of the findings of the study have implications for the development of management, including non-trawl sector arrangements. The main findings of the study and their implications for management, are discussed separately for each quota species group in the results section. Results are summarised in Table 1.

In the past, quota regulations have been difficult to enforce because the species identity of the catch was difficult to prove. Genetic examination of seafood can provide strong evidence of species identity. Protein fingerprinting (described more fully in the *SEF Species Guide*) is a simple method of genetic testing that compares muscle proteins of species. It was used in this project for identifying whole fish and fillets of the SEF quota species. For species with very similar or identical protein fingerprints, additional allozyme tests were developed. The main aim of both types of tests is to assist in distinguishing between quota and non-quota species. More sophisticated genetic techniques (e.g. mitochondrial DNA) may provide more definitive identifications but are more expensive and more time-consuming, and require specialised skills and facilities.

Most SEF quota species have different marketing names to their non-quota commercial relatives. Quota species usually command a higher price than the non-quota species. Use of the correct marketing names is likely to increase consumer confidence, by extension their demand for seafood, thereby contributing to the value of the SEF. Protein fingerprinting may be used to check that seafood is not marketed under the name of a different species. In protein fingerprinting, samples to be identified are compared to a protein standard. Some species can be tested cheaply and easily in the market place; other species require additional testing.

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In five groups (gemfishes, lings, morwongs, trevallies and warehous), protein fingerprinting needs to be supplemented with simple allozyme tests. The confirmatory allozyme tests involve comparing muscle tissues from positively identified control specimens. Testing is difficult in the field but can be done in a laboratory by a technician with limited training.

The remaining two groups (whitings and flatheads) need to be tested in a genetics lab, by an expert, using a combination of protein fingerprinting and multiple allozyme tests.

In the event of a legal dispute, field test results (for any of the species) would need to be confirmed in a genetics laboratory. More sophisticated DNA analysis could also be used to provide additional and stronger evidence.

One weakness of similar studies in the past is that no whole fish vouchers were retained. Unless a voucher specimen is retained it is very difficult to prove the identity of a fish from which a tissue sample was taken. Vouchers were retained for all of the species examined during preparation of the *SEF Species Guide*.

2. BACKGROUND

The South East Fishery (SEF) is one of Australia's principal fisheries, with an annual commercial catch of over 24 000 tonnes worth more than $55 million (average 93/94 to 95/96, ABARE, 1996). It is a diverse, multispecies fishery that is now managed by an individual transferable quota (ITQ) management system currently based on 21 quota "species" from 13 closely related quota species groups (Table 1).

Each group consists of closely related quota and non-quota species. However, the number of species in each group, their correct scientific names, and the importance of each species within the fishery was not clear. Weaknesses in the understanding of the taxonomy and distribution of the redfish, ling and flathead groups in particular have been highlighted by industry, management and scientists. The need to investigate species composition in, for example, the ocean perch group, was also recognised (Park, 1994).

3. NEED

Knowledge of the species composition of a fishery is essential when preparing unambiguous and enforceable regulations for its management. In quota-managed fisheries, regulations must state clearly which species are covered by quota arrangements. Similarly, a thorough knowledge of species composition is essential for setting appropriate total allowable catch (TAC) limits, which are based on sustainable yield estimates for each species. Yield estimates may be based partly on catch per unit effort (CPUE), calculated from catch data, independent biomass assessments and ecological models, all of which rely on accurate identifications of species.

There is a similar need to ensure that administrators and enforcers can identify species accurately. This is not possible for non-specialists without a good reference source. The issue of SEF quota species identification was raised at a South East Trawl Management Advisory Committee (SETMAC) meeting (January 1993) by Victorian and South Australian Industry members. A "stop gap" guide to the identification of species was prepared from literature by AFMA (Kailola and Grice, 1994). However, many of the quota species groups in the SEF either had never been reviewed in the Australian literature or not for many years. Additional research was needed before an authoritative guide could be prepared.

An authoritative guide is needed to deter and detect quota infringement. In the event of a dispute, it can be used to demonstrate the true species identity of a catch or market product. As not all fish are landed or marketed whole, a method of identifying fillets and fish products is needed. This method (see 1, 5.5 and 5.6) is also useful for checking that cheaper fish fillets are not substituted for more expensive ones in the market.

4. OBJECTIVES

1. To determine the true species composition of SEF quota species groups, through a combination of classical and genetic taxonomic techniques.

2. To prepare a definitive identification guide to the SEF quota species and their close relatives.

3. To include in this guide a means of identifying fillets of these species based on their protein fingerprints.

5. METHODS

5.1 Acquisition and processing of specimens

Frozen specimens of each species (see results section) were obtained from Industry sources and CSIRO field work. Up to ten specimens of each species were partly dissected to remove the right eye, part of the liver, and approximately 2 g of muscle tissue from the right side. One specimen of each species was photographed and retained as a voucher specimen.

5.2 Storage of voucher specimens

Vouchers were preserved in 10% formalin for at least 2 weeks and then stored in 70% ethanol. Fish species vouchers are held by the I. S. R. Munro Ichthyological Collection at the CSIRO Division of Marine Research, Hobart. Prawn vouchers are held by the Tasmanian Museum and Art Gallery, Hobart.

5.3 Storage of voucher and non-voucher tissue samples

All tissue samples were stored at -80°C until analysis, after which they were retained as archive samples, stored at -80°C, at the CSIRO Division of Marine Research, Hobart.

5.4 Morphological examination

Fin rays and vertebrae were counted from radiographs where necessary. For lings and redfishes, proportional body measurements were used to examine body shape of different forms. Meristic and morphological data on species within each quota species group were compared.

Specimens were examined closely for morphological differences that were not evident from the meristic and body measurement data.

5.5 Genetic examination–protein fingerprints (see also *SEF Species Guide*)

Samples of white muscle of fresh and frozen fishes and prawns were placed in 1.5 mL microcentrifuge tubes and a few drops of water were added. The mixture was manually homogenised and then centrifuged at around 12,000 *G* (at room temperature) for two minutes. The supernatant was used for electrophoresis.

For each species, specimens were compared to a protein standard using the Helena Super-Z12 system. The protein standard is a mixture of chicken albumen and the protein extract of white muscle from the redfish (*Centroberyx affinis*).

Samples were run on 76 x 76 mm cellulose acetate plates in a tris glycine buffer system (0.020 M tris and 0.192 M glycine, Hebert and Beaton, 1989) for 25 minutes at 200 V at room temperature. The plates were then stained with Coomassie Blue (0.2% Coomassie Blue in a mixture of 6 parts water to 4 parts methanol to 1 part glacial acetic acid) for 5 minutes and unbound stain removed by washing in a destaining solution (as for the staining solution but without the Coomassie Blue). Proteins present in large amounts stain blue (on a white background).

5.6 Genetic examination–allozyme eletrophoresis
(see also *SEF Species Guide*)

Sample preparation and electrophoresis was as for protein fingerprinting. Histochemical staining followed Hebert and Beaton (1989). The protein standard was not required for allozyme tests.

5.7 Representation of genetic information

After staining and washing, test plates were photographed using 35 mm slide film. Slides were digitised with a Kodak RFS 2035 scanner and then traced using Adobe Photoshop software to produce stylised preliminary figures of the test plates. Some of the final figures are composites of more than one of the preliminary figures.

6. RESULTS

6.1 Dories
Family Zeidae (except where otherwise stated)

Common name	Marketing name*	Scientific name
quota species		
John dory	John dory	*Zeus faber*
Mirror dory	Mirror dory	*Zenopsis nebulosus*
non-quota species		
Silver dory	Silver dory	*Cyttus australis*
New Zealand dory	none assigned (rarely marketed)	*Cyttus novaezealandiae*
King dory	King dory	*Cyttus traversi*
Smooth oreo	Smooth oreo	*Pseudocyttus maculatus* (Oreosomatidae)
Black oreo	Black oreo	*Allocyttus niger* (Oreosomatidae)
Warty oreo	Black oreo	*Allocyttus verrucosus* (Oreosomatidae)
Spikey oreo	Spikey oreo	*Neocyttus rhomboidalis* (Oreosomatidae)
Rough oreo	none assigned (rarely marketed)	*Neocyttus* sp. (Oreosomatidae)

* marketing name assigned by Seafood Marketing Names Working Group (SMNWG)

Species composition

Twelve species of dories and oreos are found in the SEF area. Two of these—the little dory (*Cyttopsis cypho)* and the oxeye oreo (*Oreosoma atlanticum*)—are too small to be important commercially and are unlikely to be confused with the quota species. Therefore only ten species were covered in the Dories section of the *SEF Species Guide*. Only two species are covered by quota arrangements.

Taxonomic problems

The taxonomy of Australian zeids is considered to be well understood. A longfin variety of mirror dory (*Zenopsis* sp.) collected by the CSIRO and the Australian Museum Sydney (AMS) off Western Australia may be a separate stock or species, but it has not been collected from the SEF area.

Identification of whole fish

Distinguishing quota species from non-quota dory species is relatively straightforward. Distinguishing between silver dory and New Zealand dory is still difficult, but reliable characters are described in the *SEF Species Guide*.

Identification of fillets

Dories and oreos were treated in the same section because the fillets of the higher value quota dories and lower valued oreos and non-quota dories are very similar once the skin has been removed. In addition, oreo fillets are often marketed under non-recommended names such as oreo dory, spotted dory, spiky dory *etc.,* which adds to confusion in the market place.

Quota dories were easily distinguished from non-quota dories and oreos by protein fingerprints alone. Most species had unique fingerprints but those of the black oreo and the warty oreo were very similar. Allozyme differences between these two species are described in Lowry *et al.* (1996).

Implications for management

The results are applicable to enforcing management practices as they stand and would contribute to enforcement of quota arrangements for oreos if they are developed in the future.

Future taxonomic research

It may be desirable to examine the longfin form of *Zenopsis*. It has not been recorded in the SEF area and therefore was not examined during this study.

6.2 Flatheads
Family Platycephalidae

Common name	Marketing name*	Scientific name
quota species		
Tiger flathead	Tiger flathead	*Neoplatycephalus richardsoni*
Toothy flathead	Flathead	*Neoplatycephalus aurimaculatus*
Sand flathead	Sand flathead	*Platycephalus bassensis*
Bluespot flathead	Bluespot flathead	*Platycephalus caeruleopunctatus*
Southern flathead	Southern flathead	*Platycephalus speculator*
non-quota species		
Longspine flathead	Flathead	*Platycephalus longispinis*
Rock flathead	Rock flathead	*Platycephalus laevigatus*
Deepwater flathead	Deepwater flathead	*Neoplatycephalus conatus*
Northern sand flathead	Northern sand flathead	*Platycephalus arenarius*
Dusky flathead	Dusky flathead	*Platycephalus fuscus*
Marbled flathead	Flathead	*Platycephalus marmoratus*

* marketing name assigned by SMNWG

Species composition
Eleven quota and non-quota flatheads (from the genera *Neoplatycephalus* and *Platycephalus*) occur commonly in the SEF area and these are described in the *SEF Species Guide*.

Five flathead species are included in a single quota group under the updated SEF management plan. The publication date of the *SEF Species Guide* was delayed to include the new flathead scheme and other possible changes.

The tassel-snouted flathead (*Thysanophrys cirronasus*) is found in the same general area but only on shallow rocky reefs. It is unlikely to be caught by trawlers and is not marketed. Occasionally, when warm currents extend southward, some additional flathead species (which are normally found only in tropical waters) are caught in the SEF area.

Taxonomic problems
Longspine flathead specimens from eastern and western Australia differed slightly in gill raker counts (Table 2). However, as no other morphological or genetic differences were found, these differences may represent stock, rather than species, differences.

Table 2: Gill raker counts* for lower half of first gill arch in longspine flathead

	Western Australia (n=11)	Eastern Australia (n=10)
minimum	15	17
maximum	17	18
average	15.7	17.1
standard deviation	0.647	0.316

* remnants are excluded

Identification of whole fish

The presence of large canine teeth distinguishes *Neoplatycephalus* species from *Platycephalus* species. *Neoplatycephalus* includes tiger flathead, the main commercial species in the SEF.

Identification to species within genera is problematic, even for most biologists. Colouration, especially of the tail, is useful. Distinguishing southern flathead from bluespot flathead, and sand flathead from longspine flathead is particularly difficult.

Identification of fillets

Most flatheads have distinctive protein fingerprints. However, one subgroup of four species (longspine, southern, bluespot and rock flathead) has a common pattern. Under the updated quota arrangements, this difficult subgroup contains both quota (southern and bluespot) and non-quota (longspine and rock flathead) species. Allozyme tests can distinguish fillets of these species.

Implications for management

The species diversity of the flathead catch presents more problems to managers than any other SEF quota species group. Separate quotas for each species would be almost impossible to enforce because of the similarity in appearance of species.

The updated quota arrangement leaves out two species caught commonly in the SEF: longspine flathead and rock flathead. Both are caught within the SEF and both are difficult to distinguish from some quota species. This needs to be considered during catch monitoring, examination of research needs and the development of management arrangements.

Future taxonomic research

The family Platycephalidae contains more than 40 species and is in need of an Australian review (Paxton and Hoese, 1989).

6.3 Gemfishes

Family Gempylidae (except where otherwise stated)

Common name	Marketing name*	Scientific name
quota species		
Gemfish	Gemfish	*Rexea solandri*
non-quota species		
Longfin gemfish	none assigned (rarely marketed)	*Rexea antefurcata*
Barracouta	Barracouta	*Thyrsites atun*
Escolar	Escolar	*Ruvettus pretiosus*
Ribbonfish	Ribbonfish	*Lepidopus caudatus* (Trichiuridae)

* marketing name assigned by SMNWG

Species composition
The taxonomy of Australian gemfishes has been studied previously. Two species (gemfish and longfin gemfish) occur in the SEF area but only the gemfish is covered by quota arrangements.

Colgan and Paxton (1997), on the basis of genetic studies, confirmed the existence of distinct populations of gemfish from the Great Australian Bight and eastern Australia, which they concluded were different stocks. Two more species—prometheus gemfish (*R. prometheoides*) and small gemfish (*R. bengalensis*)—occur only in tropical and sub-tropical waters; they were not examined.

Taxonomic problems
The group was reviewed recently by Parin (1989) and Parin and Paxton (1990). No additional problems were identified.

Identification of whole fish
Gemfish and its non-quota relative the longfin gemfish are difficult to tell apart (see *SEF Species Guide*). Their distributions overlap off New South Wales and southern Queensland, but the longfin gemfish is usually caught further offshore on seamounts as bycatch of a deepwater prawn fishery (Nakamura and Parin, 1993).

Identification of fillets
In addition to protein fingerprinting, a simple allozyme test is required to distinguish between fillets of gemfish, longfin gemfish and barracouta.

Implications for management
Allozyme tests, as well as protein fingerprinting are needed to identify gemfish fillets. The catch location can be used as supportive information.

Future taxonomic research
No future needs identified.

6.4 Grenadiers

Family Merluciidae (except where otherwise stated)

Common name	Marketing name*	Scientific name
quota species		
Blue grenadier	Blue grenadier	*Macruronus novaezelandiae*
non-quota species		
Silver grenadier	none assigned (rarely marketed)	*Lyconus* sp.
Toothed whiptail	none assigned (rarely marketed)	*Lepidorhynchus denticulatus* (Macrouridae)
Southern whiptail	none assigned (rarely marketed)	*Caelorinchus australis* (Macrouridae)
Southern hake	Southern hake	*Merluccius australis*

* marketing name assigned by SMNWG

Species composition

The commercial grenadier catch consists almost entirely of blue grenadier, which is the only quota species in this group. Hake (in fillet form) and silver grenadier are occasionally confused with blue grenadier. Hake, which have been recorded locally from off Victoria and western Tasmania, are occasionally caught and sold with blue grenadier. Silver grenadier are caught in deeper water along with orange roughy.

Taxonomic problems

The nomenclature of the silver grenadier proved to be a difficult taxonomic problem. Australian and New Zealand specimens may represent one or more undescribed species but this was not fully resolved. Australian specimens were compared to the holotypes of the two known species of *Lyconus* and found to be most similar to *L. pinnatus.* However, the holotype was in bad condition and we are uncertain if it is the same as the Australian species. Other comparative specimens that might have helped resolve this issue could not be obtained from museums overseas.

Identification of whole fish

See *SEF Species Guide.*

Identification of fillets

Hake have a similar texture to blue grenadier, and once the head and tail have been removed, the two can be confused. Silver grenadier are paler and softer than other species in this group, and therefore less likely to be marketed. During the study, headed and gutted whiptails, which could have been confused with blue grenadier, were seen at the Melbourne fish market. Fortunately, fillet identification is simple for this quota species group, as each species has a distinct protein fingerprint.

Implications for management

No significant problems identified.

Future taxonomic research

Determine correct scientific name for *Lyconus* sp.

6.5 Lings
Family Ophidiidae (except where otherwise stated)

Common name	Marketing name*	Scientific name
quota species		
Pink ling	Ling	*Genypterus blacodes*
non-quota species		
Rock ling	Ling	*Genypterus tigerinus*
Tusk	Tusk	*Dannevigia tusca*
Violet cuskeel	none assigned (rarely marketed)	*Brotulotaenia crassa*
Ribaldo	Ribaldo	*Mora moro* (Moridae)

* marketing name assigned by SMNWG

Species composition
Two species of ling are caught in the SEF area: pink ling and rock ling. Only pink ling are covered by quota arrangements. Distribution of the two species overlaps on the continental shelf but the commercial catch consists almost entirely of pink ling taken in deeper water (below 200 m). The rock ling is most abundant in coastal waters and estuaries, where it is caught by inshore vessels and then sold in small quantities to local fish markets.

Taxonomic problems
Two distinct colour forms of pink ling, which may or may not be separate species, occur in the SEF. These deepwater (pink) and shallow-water (orange) forms are currently being examined as part of FRDC project 97/117 to resolve stock structure in ling.

Identification of whole fish
Some characters (length of lower jaw and vertebra and fin counts) in the literature for distinguishing between the two ling species are not reliable. Additional characters have been provided (see *SEF Species Guide*) but juvenile ling less than 200 mm total length remain difficult to identify to species.

Identification of fillets
Fillets of the two species of ling are difficult to distinguish. They are usually sold with the skin on but the colour differences seen in freshly caught lings (see *SEF Species Guide*) may fade during storage. Ling fillets need to be compared to known samples of rock and pink ling tissues, using an allozyme test, to identify an unknown muscle tissue sample.

Implications for management
The possibility that the pink and orange forms are separate ling stocks is currently being addressed. Examination of these forms and other possible regional stock difference during FRDC project 97/117 may contribute to future development of trawl and non-trawl quota arrangements.

Future taxonomic research
The pink and orange forms of pink ling, as well as regional stock structure issues, is being examined further.

6.6 Morwongs
Family Cheilodactylidae

Common name	Marketing name*	Scientific name
quota species		
Jackass morwong	Morwong	*Nemadactylus macropterus*
non-quota species		
Grey morwong	Morwong	*Nemadactylus douglasii*
King morwong	none assigned	*Nemadactylus* sp.
Blue morwong	Blue morwong	*Nemadactylus valenciennesi*
Red morwong	none assigned (marketed as red morwong)	*Cheilodactylus fuscus*

* marketing name assigned by SMNWG

Species composition
Jackass morwong comprises over 90% of the commercial morwong catch from the main fishing areas off southern New South Wales and north-eastern Victoria; grey morwong comprises about 7% (Smith, 1994). The remainder of the catch consists of at least three other species. Morwong quota arrangements restrict catches of jackass morwong only.

Taxonomic problems
An additional species, the king morwong (referred to as king tarakihi in New Zealand), was recently discovered off New Zealand (Smith *et al.*, 1996). A few specimens have been found in the Melbourne fish market (Roberts, pers comm) but it is unclear where they were caught. The distribution of king morwong is presently unclear.

Identification of whole fish
Earlier this century, catch data for jackass morwong included grey morwong (Smith, 1994) but these species are distinct and should no longer be confused. The newly identified king morwong is very similar to jackass morwong and may have been overlooked in the SEF (see *SEF Species Guide*).

Identification of fillets
Currently recognised species of Australian morwongs can be distinguished from each other in the market place by simple protein fingerprinting. Jackass morwong and king morwong are difficult to distinguish without allozyme testing.

Implications for management
Catches of king morwong are not at present covered by quota restrictions. Although large catches of this species are unlikely within the SEF, identification disputes would be difficult to resolve without allozyme testing and careful examination of morphological characters.

The proportion of king morwong in commercial catches is expected to be small. However, if king morwong are confirmed to occur in Australian waters it may be desirable to include both king morwong and jackass morwong in quota arrangements to eliminate possible ambiguities.

Future taxonomic research
The presence and abundance of king morwong in Australian waters need to be confirmed. This new species is soon to be described by Clive Roberts (National Museum of New Zealand).

6.7 Ocean Perches
Family Scorpaenidae

Common name	Marketing name*	Scientific name
quota species		
Ocean perch	Ocean perch	*Helicolenus barathri*
Reef ocean perch	Ocean perch	*Helicolenus percoides*
non-quota species		
Thetis fish	none assigned (sometimes marketed)	*Neosebastes thetidis*
Incised gurnard perch	none assigned (sometimes marketed)	*Neosebastes incisipinnis*
Common gurnard perch	none assigned (sometimes marketed)	*Neosebastes scorpaenoides*
Red rock cod	none assigned (sometimes marketed)	*Scorpaena cardinalis*
Cape scorpionfish	none assigned (sometimes marketed)	*Trachyscorpia capensis*
Deepsea scorpionfish	none assigned (sometimes marketed)	*Trachyscorpia* sp.

* marketing name assigned by SMNWG

Species composition
Ocean perch taxonomy in the SEF has not been adequately resolved. Fishermen at Lakes Entrance and Eden have long recognised distinct deep- and shallow-water forms. The main SEF catch comes from deep water, taken as a bycatch of demersal trawling below 200 m. In contrast, the shallow-water form is caught by a variety of gear. Mixed catches of the two species occur mostly near the shelf margin.

Taxonomic problems
Paxton and Colgan (1993) found differences in allele frequencies between deep-and shallow-water forms of ocean perch taken from various sites. They concluded that these forms were reproductively isolated from each other off eastern Australia, with the exception of the western Tasmanian sites. Paxton and Colgan noted that the allele frequencies for 6-PGDH for the deep and shallow water forms at the Tasmanian site were the reverse of all other sites. However given that only 4 Tasmanian deep water and 5 Tasmanian shallow water specimens were tested these results are not conclusive.

Our study indicated that for both southeast Tasmanian and NSW samples the deep and shallow forms were reproductively isolated from each other. Three loci (Tables 3 and 4) showed allele frequency differences in sample sizes of between 11 and 32 animals (Table 4). Four other loci (marked with an asterix in Table 3) showed minor frequency differences but require larger sample sizes to test their significance.

The species composition of the ocean perch fishery was examined by Park (1994) using morphological and other biological techniques. He concluded that the two forms differed in meristics and reproductive biology. Our morphological studies of specimens from New South Wales, Victoria and Tasmania support Park's work (see also "Identification of Whole Fish" below).

We were unable to confirm current scientific names for the two species as we did not have enough resources to examine the holotype of *H. barathri*, which is held in London. The shallow-water species is likely to be *H. percoides*. However, serious doubt exists as to the correct name for the deepwater species. *H. barathri* is used tentatively in this report, but the soft dorsal-fin ray counts for Australian specimens differ significantly from literature counts for the New Zealand holotype and recent material of *H. barathri* (Paulin, 1989). These differences may reflect regional stock differences or alternatively,

the Australian deepwater form (which is the main commercial species) has not been described.

Identification of whole fish

Park (1994) provided characters for distinguishing between the two species of ocean perch including dorsal-fin soft ray counts. However, after examining more than 100 specimens in total, we found these counts to be more variable than Park did and less reliable in distinguishing the two species.

New morphological characters have been provided in the *SEF Species Guide*. Field workers using a draft of the *SEF Species Guide* found that the pattern of markings on the head was the best field character for distinguishing between the two species of ocean perch.

Distinguishing between quota and non-quota species in the ocean perch group is straightforward using the *SEF Species Guide*

Identification of fillets

Protein fingerprints distinguished the true ocean perches from closely related non-quota species that are marketed. Identifying ocean perch to species proved difficult, as no fixed differences were found either in protein or in allozyme loci. However, differences in allele frequencies (Table 4) may allow catches to be identified when 10 or more specimens are available for testing.

Table 3: Loci analysed for ocean perch

Semi-diagnostic polymorphic loci	Polymorphic but not diagnostic loci	Invariant, not diagnostic loci
ADA (L)	@GPDH (L)	AAT-3 (L)
IDH (L)	AAT-1 (L)	ADH (L)
PGM (M)	AAT-2 (L)	CK (M)
	ACON (L)	FUM (M)
	AP LGG (L)*	IDH (L)
	AP PL (L)	LDH-1(L)
	FUM (M)	MDH-1(L)
	G3PDH (M)	ODH (L)
	LDH-2 (M(L))	SOD (L)
	MDH-2 (L)	
	MPI (L)	
	PGI-1 (L)*	
	PGI-2 (L)*	
	SDH (L)*	

tissue types in brackets: L=liver, M=white muscle
* possible semi-diagnostic loci (see text)

Table 4: Allele frequencies for three semi-diagnostic loci in ocean perch

	TAS shallow	NSW shallow	TAS deep	NSW deep
ADA				
(*n*)	19	20	27	17
A	0.026			
B	0.658	0.775	0.185	0.059
C	0.316	0.225	0.815	0.941
IDH				
(*n*)	18	17	19	11
A	0.026			
B	0.944	0.971	0.688	0.545
C	0.053	0.029	0.313	0.455
PGM				
(*n*)	20	20	32	17
A	0.350	0.375	0.203	0.265
B	0.650	0.625	0.781	0.706

Implications for management

As the fishery consists of two species, it may be appropriate to split the quota into reef ocean perch (from the shelf) and ocean perch (caught on the slope). Perhaps quota for reef ocean perch could be linked to inshore species caught in less than 200 m (such as flathead) and quota for deepwater ocean perch could be linked to other demersal species that are caught mainly below 200 m (such as ling and blue grenadier). To split the quota by specifying the scientific names is possible but would be difficult to administer and enforce. Mixed catches in the 200–250 m range, the similar appearance of the two species, and difficulty in separating fillets by genetic techniques make this impractical.

In the past, scientific and logbook data have mostly been pooled for the two species. The revised *SEF Species Guide* provides new field characters for distinguishing between the two species, which should improve the standard of identification and result in better biological and logbook data.

Future taxonomic research

An initial examination of specimens from Western Australia indicated that unrecorded species of *Helicolenus* occur in Australian waters. A regional review of the genus *Helicolenus* is desirable, in particular to resolve the *H. barathri* issue, using a combination of morphological and genetic techniques such as mitochondrial DNA.

6.8 Prawns

Family Solenoceridae (except where otherwise stated)

Common name	Marketing name*	Scientific name
quota species		
Royal red prawn	Royal red prawn	*Haliporoides sibogae*
non-quota species		
Red prawn	Prawn	*Aristaeomorpha foliacea* (Aristaeidae)
Scarlet prawn (Aristaeidae)	Prawn	*Plesiopenaeus edwardsianus*

* marketing name assigned by SMNWG

Species composition

The royal red prawn is the main commercial prawn of the SEF. Red prawns are caught in smaller quantities being more important off northwestern Australia (Wadley and Morris, 1991). Scarlet prawns grow large, but are caught in smaller quantities than the other species. Another prawn species closely related to the quota species (but not covered in the *SEF Species Guide*) is the pink, or whitetail, prawn (*H. cristatus*). No specimens of this species could be obtained during the study and it is presumably rare in the SEF region.

During the study, scarlet prawns were collected from seamounts south of Tasmania. This is further south than previous distribution records for this species. Several other bycatch species of prawns are caught in the SEF but many of these are poorly known and some may be undescribed (Gowlett-Holmes, pers comm).

Identification of whole prawns

Distinguishing between SEF quota prawns and their close relatives in the SEF is straightforward if the heads have not been removed (see *SEF Species Guide*).

Identification of tails

A simple protein fingerprint test can distinguish quota and non-quota prawns. Five species of tropical prawns were also examined; all had protein fingerprints distinct from SEF prawns. Prawns are often marketed as cooked products, which cannot be tested by protein fingerprinting.

Implications for management

Protein fingerprinting is highly effective in identifying fresh prawns but of limited use in the market place if the tails have been cooked.

Future taxonomic research

The prawn catch may include species that are new to science and need to be described.

6.9 Redfishes
Family Berycidae

Common name	Marketing name*	Scientific name
quota species		
Redfish	Redfish	*Centroberyx affinis*
non-quota species		
Bight redfish	Bight redfish	*Centroberyx gerrardi*
Swallowtail	Swallowtail	*Centroberyx lineatus*
Yelloweye redfish	none assigned (marketed as redfish and yelloweye red snapper)	*Centroberyx australis*
Smalleye redfish	none assigned (rarely marketed)	*Centroberyx* sp.
Imperador	Imperador	*Beryx decadactylus*
Alfonsino	Alfonsino	*Beryx splendens*

* marketing name assigned by SMNWG

Species composition
The main commercial species in this group, and the only species covered by quota, is the redfish (*C. affinis*). Five non-quota species caught in the SEF are described in the *SEF Species Guide*, as is yelloweye redfish, which is caught beyond the western limit of the SEF but is sold at the Melbourne and Sydney fish markets.

Taxonomic problems
Taxonomic and distributional problems in this group surround two species—Bight redfish and smalleye redfish.

Bight redfish are thought to live mainly in the Great Australian Bight. However, during this study, small specimens were collected off Tasmania and southern New South Wales. As subsequent attempts to acquire adult specimens from off New South Wales failed, the earlier catches probably represented seasonal movements of juveniles on the fringes of their distribution.

Smalleye redfish, an undescribed species, is reported off southern Australia (Hutchins and Swainston, 1986), but no specimens could be obtained during the study from either New South Wales or South Australia. This species is probably not common in commercial catches but may be caught in the western Bight region.

Identification of whole fish
The most important identifying character for redfishes is the dorsal-fin spine count which quickly distinguishes the quota species from non-quota species (see *SEF Species Guide*).

Identification of fillets
Redfish are often sold headed and gutted, but can still be identified by dorsal-fin spine counts. Fillet identification by protein fingerprinting is straightforward and no additional tests are required to distinguish the quota species from other redfishes.

Implications for management
Assuming that no major catches of Bight redfish are recorded from the SEF, the current quota arrangements are appropriate. If such catches are reported, arrangements should be reviewed.

Catches of redfish should be examined more carefully in future to calculate the proportion of minor species, particularly Bight redfish, in the commercial catch.

Future taxonomic research
Centroberyx sp. needs to be examined, as specimens are acquired, to determine its status and distribution. More than one form of alfonsino lives in Australian waters and this group needs broader regional attention.

6.10 Roughies
Family Trachichthyidae

Common name	Marketing name*	Scientific name
quota species		
Orange roughy	Orange roughy	*Hoplostethus atlanticus*
non-quota species		
Darwins roughy	none assigned (rarely marketed)	*Gephyroberyx darwinii*
Giant sawbelly	none assigned (rarely marketed)	*Hoplostethus gigas*
Blacktip sawbelly	none assigned (rarely marketed)	*Hoplostethus intermedius*
Sandpaperfish	none assigned (rarely marketed)	*Paratrachichthys* sp.

* marketing name assigned by SMNWG

Species composition
The commercial roughy catch consists almost entirely of orange roughy, the only quota species in this group. Although this species is almost always orange-red, a black form is occasionally caught, causing confusion. Four non-quota species could be confused with orange roughy. Of these, only Darwins roughy grows to a commercial size, but it is caught in small numbers only in the SEF. Darwins roughy was recorded off Tasmania (east coast) for the first time during this study.

Taxonomic problems
The taxonomy of this group in the SEF is thought to be well understood. However, as roughies (genus *Hoplostethus*) live at great depths, in waters that are generally poorly known, it is likely that new species will be described (Kotlyar, 1995). A species of roughy recently discovered from New Caledonia has not yet been described (Roberts, 1997).

Identification of whole fish
See *SEF Species Guide.*

Identification of fillets
All species of roughy covered in the *SEF Species Guide* can be quickly distinguished from each other by their protein fingerprints.

Implications for management
Disputed identifications of orange roughy should be easily resolved from either fresh or frozen specimens.

Future taxonomic research
No future needs identified.

6.11 Trevallies
Family Carangidae

Common name	Marketing name*	Scientific name
quota species		
Silver trevally	Silver trevally	*Pseudocaranx dentex*
non-quota species		
Skipjack trevally	none assigned (rarely marketed)	*Pseudocaranx wrighti*
Yellowtail kingfish	Yellowtail kingfish	*Seriola lalandi*
Jack mackerel	Jack mackerel	*Trachurus declivis*
Yellowtail horse mackerel	none assigned (marketed as Yellowtail horse mackerel)	*Trachurus novaezelandiae*

* marketing name assigned by SMNWG

Species composition
Two closely related species of trevally are thought to occur off Southern Australia: silver trevally and skipjack trevally. The commercial SEF catch seems to be dominated by silver trevally, which is the only quota species. No skipjack trevally were found in the many demersal trawl catches from New South Wales, Victoria and South Australia, we examined. However, they were collected off Western Australia. They may also be caught by non-SEF vessels, working inshore, along the southeast Australian coast.

Taxonomic problems
Two colour forms of silver trevally are reported by New South Wales anglers (Hutchins and Swainston, 1986): a yellowfin form from the north and a plain silver form from the south. They may represent separate stocks or even different species.

Identification of whole fish
See *SEF Species Guide*.

Identification of Fillets
Silver trevally and skipjack trevally have very similar protein fingerprints but can be distinguished by an allozyme test.

Implications for management
Catches should be monitored to check for skipjack trevally. If the two colour forms of silver trevally represent two stocks, the SEF would consist almost entirely of the southern stock.

Future taxonomic research
The distribution of skipjack trevally should be examined.

6.12 Warehous, Trevallas
Family Centrolophidae

Common name	Marketing name*	Scientific name
quota species		
Blue eye	Blue eye	*Hyperoglyphe antarctica*
Blue warehou	Blue warehou	*Seriolella brama*
Silver warehou	Silver warehou	*Seriolella punctata*
non-quota species		
White warehou	none assigned (marketed)	*Seriolella caerulea*
Ocean blue eye	none assigned (marketed)	*Schedophilus labyrinthica*
Tasmanian rudderfish	none assigned (marketed)	*Tubbia tasmanica*
Seamount rudderfish	none assigned (rarely marketed)	*Tubbia* sp.
Rudderfish	none assigned (rarely marketed)	*Centrolophus niger*
New Zealand ruffe	none assigned (rarely marketed)	*Schedophilus huttoni*

* marketing name assigned by SMNWG

Species composition
Of the nine species taken in the fishery, three are quota species: blue eye, blue warehou, and silver warehou. Ocean blue eye is a non-quota species caught with blue eye as far south as Tasmania. White warehou, a close relative of silver and blue warehou, is being marketed in increasing quantities.

Taxonomic problems
During the study, an undescribed species of trevalla (*Tubbia* sp.) was discovered on the Pedra Branca Seamount. This species has occasionally been marketed as "rudderfish" but is unlikely to be confused with any of the quota species.

Identification of whole fish
Problems with identifying commercially important silver and blue warehous have been compounded by the use of a wide variety of local common names for these species. The juveniles, in particular, are difficult to identify. Characters used to identify these species have included body form, colour pattern and the presence or absence of a lateral keel on the tail. However we found these characters varied with age within a species, leading to unreliable scientific and logbook data. Other, more reliable, characters have been used in the revised guide. Better characters have also been provided for distinguishing between blue eye and ocean blue eye.

Identification of fillets
Fillet identification of most species in this group requires only a protein fingerprint test that can be completed in the market place. Distinguishing between blue eye and ocean blue eye fillets is more time-consuming and requires testing tissue samples against frozen samples from previously identified laboratory specimens.

Implications for management
Catches of ocean blue eye are not covered by quota. The proportion of ocean blue eye in commercial catches off New South Wales is considered trivial (Kevin Rowling, pers comm) but the known range of ocean blue eye in Australian waters is expanding rapidly. During this study, ocean blue eye were identified in catches from seamounts south of Tasmania, suggesting that the southern seamounts could provide a significant proportion of ocean blue eye catch.

It may be appropriate to include both blue eye species within the non-trawl quota. The proportion of ocean blue eye caught from seamounts off Tasmania needs to be examined by more careful monitoring of catches from this region.

Future taxonomic research
The taxonomy of this group is reasonably clear in the SEF, but needs an Australian review.

6.13 Whitings
Family Sillaginidae

Common name	Marketing name*	Scientific name
quota species		
Eastern school whiting	School whiting	*Sillago flindersi*
non-quota species		
Western school whiting	School whiting	*Sillago bassensis*
Stout school whiting	School whiting	*Sillago robusta*
Sand whiting	Sand whiting	*Sillago ciliata*
Yellowfin whiting	Yellowfin whiting	*Sillago schomburgkii*
Trumpeter whiting	Trumpeter whiting	*Sillago maculata*
King George whiting	King George whiting	*Sillaginodes punctata*

* marketing name assigned by SMNWG

Species composition
The SEF whiting catch is generally considered to consist almost entirely of eastern school whiting, the only quota species. However, several other whitings, may comprise up to 10% of the SEF catch (McKay, 1992). Western school whiting have been caught from Western Australia to Western Port Bay, Victoria, but probably do not extend eastwards to Lakes Entrance. Stout whiting caught in commercial quantities off Queensland may also comprise a substantial component of the commercial catch off New South Wales.

Taxonomic problems
The group has been revised recently by McKay (1992) and no new problems were identified.

Identification of whole fish
Whitings are a group of very closely related species. They are perhaps the most difficult family group in the SEF to identify correctly to species. In the past, diagnosis often required dissection of specimens to examine their swim bladder. The *SEF Species Guide* makes use of more external characters, including colour pattern. These new characters are reliable in the field but can be less useful in fish markets, as some colours fade with storage.

Identification of fillets
The fillets of whiting species are more difficult to distinguish from each other than are those of any other SEF group. Up to three allozyme tests may be required to identify an unknown fillet (see *SEF Species Guide*). Frozen muscle samples from previously identified laboratory specimens are also required, making fillet identification in the field impractical.

Implications for management
The proportion of minor species in the SEF whiting catch is unclear. This may need further investigation. The proportion indicated in historical data is likely to be an underestimate because whitings are difficult to identify correctly.

Future taxonomic research
No future needs identified.

7. BENEFITS

1. Most of the taxonomic problems within the South East Fishery were resolved. The understanding of the fishery composition gained during this study will assist in improving SEF management plans by clarifying which species are covered by quota.

2. The *SEF Species Guide* should result in better logbook data, and hence more detailed and more reliable CPUE data.

3. The *SEF Species Guide* can be used by scientists to obtain more reliable scientific data, which should help our understanding of the ecological sustainability of the SEF region.

4. The *SEF Species Guide* could be used in the detection of quota infringement. The means of genetic identification of quota species included should act as a strong deterrent, but would provide reliable species identifications in the event of a dispute.

5. The ability to identify fillets by protein fingerprinting can be used to deter misuse of marketing names, thereby increasing consumer confidence and demand.

8. INTELLECTUAL PROPERTY AND VALUABLE INFORMATION

Three components of project intellectual property arose from this research:

1. Copyright in the *SEF Species Guide*
2. Protein fingerprinting technique
3. Copyright in this report

With further development, protein fingerprinting may have commercial potential, but is probably not patentable. This issue of protecting the process will be assessed further. The intellectual property arising from the project is the property of both CSIRO and FRDC.

9. FURTHER DEVELOPMENT

The improved knowledge of the taxonomy of the SEF species obtained during the project has highlighted some problems with current regulations that will ultimately need attention. This report also highlighted some potential loopholes in the existing regulations. For some groups (e.g. ocean blue eye), findings may become more relevant in the future as fishing practices change. For other groups (e.g. whitings), more detailed and accurate catch data are required before informed changes to management plans can be considered. The *SEF Species Guide* should improve data recording and collection practices.

The data indicated possible stock differences in several species (e.g. longspine flathead). As stock delineation was not an aim of this project, these differences were not examined further. However, it is likely that more stock differences will be found in the SEF quota

species; some of the techniques used in the present study could be used to delineate stocks.

Whilst most SEF-related taxonomic problems were resolved, the research highlighted broader problems within Australia, which are referred to under the relevant quota group name in the results section.

The principal scientific findings from this project, including descriptions of undescribed species, will be published in scientific journals in the near future. Problems highlighted in the ling fishery are the subject of FRDC project 97/117; the final report will be published in 1999.

10. STAFF

Peter Last	CSOF7	Principal Investigator–Project supervisor
Bob Ward	CSOF7	Genetics supervisor
Ross Daley	CSOF3	Collection and analysis of all genetic and morphological data
Gordon Yearsley	CSOF4	Specimen acquisition, graphic design and book layout

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12. REFERENCES

ABARE (1996). *Australian Fisheries Statistics 1996*. Commonwealth of Australia, Canberra.

Colgan, D. J. and Paxton, J. R. (1997). Biochemical genetics and recognition of a western stock of the common gemfish, *Rexea solandri* (Scombroidea: Gempylidae), in Australia. *Mar. Freshwater Res.* 48:103-118.

Daley, R. K., Last, P. R., Ward, R. D. and Yearsley, G. K. (1997). *South East Fishery Quota Species; an Identification Guide*. CSIRO Division of Marine Research, Australia.

Hebert, P. D. N. and Beaton, M. J. (1989). *Methodologies for Allozyme Analysis using Cellulose Acetate Electrophoresis*. Helena Laboratories, Beaumont, Texas.

Hutchins, B. and Swainston, R. (1986). *Sea Fishes of Southern Australia*. Swainston Publishing, Daglish, WA.

Kailola P. J. and Grice, A. (1994). *Field Guide to South East Fishery Quota Species*. Australian Fisheries Management Authority, Canberra.

Kotlyar, A. N. (1995). *Hoplostethus vniro*, a new species of Trachichthyidae from the East Atlantic. *Vopr. Ikhtiol.* 35(5):702–704.

Lowry, P. S., Elliott, N. G., Yearsley, G. K. and Ward, R. D. (1996). Genetic variation and phylogenetic relationships of seven oreo species (Teleostei, Oreosomatidae) inferred from allozyme analysis. *Fish. Bull.* 94(4):692–706.

McKay, R. J. (1992). FAO Species Catalogue. Vol. 14. Sillaginid fishes of the world (Family Sillaginidae); an Annotated and Illustrated Catalogue of the *Sillago*, Smelt or Indo–Pacific Whiting Species Known to Date. *FAO Fisheries Synopsis* No 125. FAO, Rome.

Nakamura, I. and Parin, N. V. (1993). FAO Species Catalogue. Vol. 15. Snake Mackerels and Cutlassfishes of the world (Families Gempylidae and Trichiuridae); an Annotated and Illustrated Catalogue of the Snake Mackerels, Snoeks, Escolars, Gemfishes, Sackfishes, Domine, Oilfish, Cutlassfishes, Scabbardfishes, Hairtails, and Frostfishes Known to Date. *FAO Fisheries Synopsis* No 125. FAO, Rome.

Parin, N. V. (1989). A review of the genus *Rexea* (Gempylidae) with descriptions of three new species. *Vopr. Ikhtiol.* 29(1):3–23 (in Russian).

Parin, N. V. and Paxton, J. R. (1990). Australia's east coast gemfish. *Aust. Fish.* 49(5):115.

Park, T. J. (1994). Ocean perch, *Helicolenus* sp., in Tilzey, R. D. J. (ed.). *The South East Fishery; a scientific review with particular reference to quota management.* Bureau of Resource Sciences, Canberra.

Paulin, C. D. (1989). Redescription of *Helicolenus percoides* (Richardson) and *H. barathri* (Hector) from New Zealand (Pisces, Scorpaenidae). *J. R. Soc. N. Z.* 19(3):319–325.

Paxton, J. R. and Colgan, D. J. (1993). *Biochemical Genetics and Stock Assessment of Common Gemfish and Ocean Perch.* Final Report FRDC Project 91/35.

Paxton, J. R. and Hoese, D. F. (1989). Platycephalidae (296), in Paxton, J. R., Hoese, D. F., Allen, G. R. and Hanley, J. E. (1989), *Zoological Catalogue of Australia* Vol. 7: Pisces, Petromyzontidae to Carangidae. Australian Government Publishing Service, Canberra.

Roberts, C. (1997). Tropo on Tangaroa off New Caledonia. *Seafood New Zealand.* February 1997:97–99.

Smith, D. C. (1994). Jackass morwong, *Nemadactylus macropterus*, in Tilzey, R. D. J. (ed.). *The South East Fishery; a scientific review with particular reference to quota management.* Bureau of Resource Sciences, Canberra.

Smith, P. J., Roberts, C. D., McVeagh, S. M. and Benson, P. G. (1996). Genetic evidence for two species of tarakihi (Teleostei: Cheilodactylidae: *Nemadactylus*) in New Zealand waters. *N. Z. J. Mar. Freshwater Res.* 30:209–220.

Wadley, V.A. and Morris, S. M. (1991). Deepwater fishery for prawns and carids off Western Australia. Abstract in Proceedings of the 1990 International Crustacean Conference. *Mem. Queensl. Mus.* 31:456.

13. DISTRIBUTION

South East Trawl Management Advisisory Committe

Seafood Marketing Names Working Group

South East Fishery Non-trawl Quota Arrangements Working Group.