

CRUISE REPORT SS 5/94

August 18–September 22, 1994

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DIVISION OF FISHERIES

ITINERARY**LEG 1**

Departure: Hobart 0900 Thursday August 18
Arrival: Devonport 1200 Tuesday August 23

LEG 2

Departure: Devonport 1400 Tuesday August 23
(off Bateman's Bay Wednesday September 7)
Arrival: Eden 1400 Thursday September 8

LEG 3

Departure: Eden 1415 Tuesday September 13
Arrival: Hobart 1400 Thursday September 22

AREA OF OPERATION

The cruise was carried out in waters off the west coast of Tasmania (Leg 1) and off southeastern Victorian, southern New South Wales and the east coast of Tasmania (Legs 2 and 3) between latitudes 36°00'S–44°00'S and longitudes 144°00'E–151°00'E.

RESEARCH BACKGROUND

Leg 1 conducted investigations critical to assessing the biomass of the blue grenadier stock that spawns off western Tasmania in winter. An acoustic survey of the stock was conducted in 1992 and an egg survey was carried out this year with a chartered vessel. The cruise focussed upon determining several parameters that are part of acoustic and egg production assessments.

The acoustic volume backscattering of the grenadier and associated species was assessed using several frequencies, the first time that more than a single frequency has been used in a CSIRO acoustic survey. Because the resonance of organisms is a function of wavelength and frequency, it is expected that greater species discrimination can be achieved through the use of multiple frequencies.

The development rate of fish eggs is largely determined by ambient temperature conditions, so the temperature structure of the water column was assessed along with the vertical distribution of blue grenadier eggs. Experiments must also be carried out to fertilize and incubate blue grenadier eggs at a range of temperatures. Trawls for the blue grenadier adults were carried out to assess their length frequency and state of maturity and to obtain samples to determine fecundity.

Legs 2 and 3 examined ecosystem structure in the South East Fishery region with an emphasis on the relationship of seafloor habitat to fisheries productivity. Sampling was undertaken on the

continental shelf in eastern Bass Strait and southern NSW in the vicinity of several important commercial fishing grounds. This was the second in a series of four cruises which provide seasonal coverage for the study.

Biological samples, information on seafloor topography and oceanographic data were collected from the study area in two phases (Legs 2 and 3). The first phase, a broad scale survey based on seven cross-shelf transects, provided information on the primary patterns of distribution and abundance of fish and invertebrate communities. Demersal trawling, benthic and epibenthic dredging, acoustic profiling and hydrological sampling was undertaken at five sites per transect. Phytoplankton and zooplankton were sampled at two sites per transect. The second phase was directed at intensive sampling on and around a reef area to extend the information gathered in phase one to a smaller scale highly diverse habitat. The range of sampling gears used in this study area was expanded to include a pelagic trawl and a video camera.

In both phases, the physical association of fish and invertebrate assemblages was determined in relation to the physical character of seafloor habitats and overlying water masses. Relationships between biological species and the habitat they occupy will be determined through analysis of diet, trophic position and morphological adaptation.

Subsequent to the sampling undertaken by the *Southern Surveyor*, the same reef area will be sampled with gill nets and traps deployed from commercial fishing vessels.

A related study will examine the effects of ten years of commercial fishing on the benthic composition and associated fish community off Maria Island, eastern Tasmania. This site was first examined by CSIRO fisheries scientists in 1984 before the start of commercial trawling in the area and resampled on SS05/93. A demersal trawl and an underwater camera will be used to replicate the prior surveys.

CRUISE OBJECTIVES

LEG 1:

1. Assess the temperature and salinity (TS) structure at spawning sites and along the shelf and upper slope along the west coast of Tasmania based upon CTD profiles at 1000, 200, and 100 m depth at 41°00', 42°00', and 43°00' S latitudes.
2. Sample the blue grenadier at known areas of concentration along the west coast with a demersal trawl to assess their size and maturity-stage structure, to obtain samples for fecundity analysis, and to obtain running-ripe fish for *in vitro* fertilization and incubation experiments.
3. Carry out replicate vertically-stratified plankton tows using the MIDOC system in each of four areas of potential blue grenadier concentration covering the following depths: bottom- 400 m; 400- 300 m, 300- 200 m, 200- 100 m; and 100 m- surface.
4. Conduct *in vitro* incubation experiments on blue grenadier eggs, raising them from fertilization to hatch at 3 constant temperatures.

5. Obtain acoustic measurements with three frequencies (12, 38, and 120 kHz) of blue grenadier aggregations.

LEGS 2 AND 3:

1. Over a broad area of the continental shelf off eastern Bass Strait and southern NSW:
 - a) determine the late-winter distribution and abundance of demersal fish species by demersal trawling.
 - b) determine the late-winter distribution and abundance of seafloor invertebrate species by benthic/ epibenthic sled sampling.
 - c) identify and determine the distribution of seafloor habitat types through photographic, acoustic and sediment sampling of bottom topography and bottom type, and their associated fish and epibenthic faunas.
 - d) determine the characteristics of the primary water masses in the sampling area during the survey.
2. Obtain samples of fish, plankton and seafloor invertebrates for analysis of stable isotopes to identify their positions in the community food web.
3. Sample stomach contents from commercial and other abundant fish species to determine their immediate feeding links and to compare with stable isotope analyses of trophic structure.
4. Collect water column and benthic sediment samples for analysis of phytoplankton pigments and breakdown products.
5. Through an intensive survey of two offshore (mid-shelf) reef areas:
 - a) determine the composition of the fish and invertebrate communities associated with reef habitats, adjacent flat bottom, and the overlying water mass(es) by sampling with demersal and pelagic trawls, benthic sled or trawl, cameras and acoustics.
 - b) determine the characteristics of the primary water masses over the sampling areas.
 - c) complete and/or repeat 2 and 3 for reef habitat.
6. Determine the species composition of the upper-slope fish community and the distribution of brittle stars off Maria Island for comparison with historical (pre-commercial fishing) catch data.
7. Collect specimens, muscle samples and take photographs of fish and invertebrates for a new CSIRO project: Handbook of Australian seafood.
8. Collect biological material for collaborative studies with other Australian research institutions and stock assessment.

RESULTS

LEG 1:

Objectives for this leg were largely but not fully met due to circumstances beyond our control. More than one of the four sampling days scheduled for Leg 1 was lost due to bad weather and

the need to bring a staff member into shore due to a medical emergency at home. No running ripe blue grenadier were obtained.

1. ASSESS TS STRUCTURE AT GRENADIER SPAWNING SITES

Temperature and salinity profiles were obtained with the CTD at stations (100, 200, and 1000 m depth) on transects along 42° 00' and 43° 00' S latitudes and at the four selected sites where blue grenadier aggregations have previously been observed: off Cape Sorrell, Pieman River, Sandy Cape, and Sandy Ditch (Fig. 1).

2. TRAWL SAMPLING OF GRENADIER

Southern Surveyor trawled demersally for blue grenadier at sites where they have previously been observed to aggregate: off Pieman River, Sandy Cape and Sandy Ditch, and along flat ground between the latter sites. Very few grenadier marks were observed either by ourselves or a commercial vessel (*Petuna Endeavour*) in the region. Marks that were observed were generally well above bottom. Catches of blue grenadier were very poor. None were obtained in running ripe condition (most were spent), so proposed incubation experiments could not be undertaken.

3. PLANKTON NET SAMPLING FOR GRENADIER EGGS

Replicate depth-stratified plankton samples were obtained at 100 m intervals from 400 m to the surface with the MIDOC sampler off Cape Sorell and in the Pieman River canyon.

4. CONDUCT *IN VITRO* INCUBATION EXPERIMENTS ON GRENADIER EGGS

Due to the lack of running ripe fish, the incubation experiments could not be performed.

5. Obtain acoustic measurements of grenadier aggregations.

Acoustic transects using three frequencies (12, 38, and 120 kHz) were carried out at Cape Sorrell, Pieman River, Sandy Cape and Sandy Ditch areas.

LEGS 2 AND 3:

Most objectives were met in full. Due to the loss of time during the MUA dispute, however, only one of two study areas were sampled for objective 5.

1. BROAD-SCALE SURVEY

The distribution and abundance of demersal fishes and benthic invertebrates on the continental shelf off eastern Bass Strait and southern NSW was assessed through a broad-scale sampling program. Stations at 25 m, 40 m, 80 m, 120 m and 200 m were sampled on seven transects, A-F, off Wilsons Promontory, Lakes Entrance, Point Hicks, Gabo Island, Disaster Bay, Merimbula and Bermagui respectively (Fig. 2). At each station a 30 minute demersal trawl was used to collect demersal fishes and a 20 minute sled tow to collect benthic, epibenthic and sediment samples. Samples were processed according to the same protocol at each station. Fish catches were sorted to species, all species represented by 5 or more individuals were measured, and biological data (length, weight, sex, gonad maturation stage) and body tissues (otoliths, muscle and stomachs) were collected from target species. Benthic samples were sorted to separate living material from debris, sieved into size categories and weighed. Subsequently, size

categories were combined and reweighed by taxonomic group at varying levels of discrimination (from species to phylum) depending on the taxon concerned. A 35 mm camera mounted on the sled took photographs at 12 second intervals along each sled transect. Processing of films on board permitted a general assessment of seafloor habitat after each deployment. Water and sediment samples were also taken at each station to characterise the water masses and bottom types across the area at the time of sampling.

All stations were sampled fully except for two: no trawlable bottom was found in 200 m depth on Transect B, and on Transect F a steeply sloping bottom at the 25 m depth contour was dangerously close to shore. Overall, 33 trawls, 34 sled tows and 34 CTD casts were completed. Acoustic data from the EK500 sounder and the RoxAnn seafloor classification software were logged continuously throughout the cruise. A total of about 15.9 tonnes of fish were caught at an average of 466 kg per 30 min trawl (932 kg per hour) during Leg 2.

Species composition changed with both depth and latitude in this region, although many species were distributed throughout. The jack mackerel, *Trachurus declivis*, was the most abundant species and was caught on all transects at most stations. At many stations it accounted for more biomass than any other single species and was often the most numerous species. Similarly, the barracouta, *Thyrsites atun*, was widely distributed and accounted for most biomass at a number of stations. Both species showed a relationship between body length and depth with small fish generally in shallow water and larger fish more abundant offshore.

In the 25 m and 40 m depths, chondrichthyans formed a large fraction of the biomass at all stations: several species of stingarees (*Urolophus* species), swellsharks (*Cephaloscyllium laticeps*) and skates (*Raja* sp. A and *R. whitleyi*) were the most important species. As a family, the Urolophidae was conspicuous in being widespread and abundant in all depths. In 80 m depth, the leatherjacket, *Parika scaber*, ranked at least fourth in biomass at 6 of the 7 stations. The dragonet, *Foetorepus calauropomus*, was abundant at this depth off Lakes Entrance whereas the bellowsfish, *Macrorhamphosus scolopax*, contributed the second highest biomass at this depth at the two northernmost transects. In the 120 m and 200 m depths, the cucumberfish, *Chlorophthalmus nigripinnis*, was widespread and abundant- ranking at least third in biomass at 9 of the 13 trawl stations. The cardinal fish, *Apogonops anomolous*, was also numerous in the deeper water; although a relatively small species, it comprised 54% of the biomass in 200 m off Lakes Entrance. Chondrichthyans comprised a large fraction of the biomass at the deeper stations too. The spurdog, *Squalus megalops*, contributed most biomass at 2 of the deep stations on Transects A and B, while *Urolophus bucculensis*, *U. viridis*, *Raja* sp. A and *C. laticeps* were prominent.

SEF quota species were caught in appreciable numbers at several stations. Redfish (*Centroberyx affinis*) was dominant (19-62% biomass) at three deep northerly stations, while morwong (*Nemadactylus macropterus*), tiger flathead (*Neoplatycephalus richardsoni*), blue warehou (*Seriola lalandi*) and ocean perch (*Helicolenus percoides*), all ranked in the top four species by biomass at a number of stations.

The distribution of invertebrates followed the same pattern as in cruise SS5/93, with bivalves

generally dominating the biomass of inshore samples and gastropods and echinoids (mainly *Peronella peroni*) dominating on the shelf. At the shelf edge, the benthic fauna was generally sparse, and included brachiopods in the deep water off Point Hicks and some large crinoids in the deep water off Disaster Bay; solitary corals and small alcyonarians were common in the shelf edge samples north of Point Hicks.

The photographic records showed that a 'worm turf' was a consistent feature of outer shelf (80 and 120 m station), often with occasional branching sponges, hydroids and bryozoans, and also with larger polychaete tubes. This type of bottom should provide a richer feeding ground for demersal fish than either shallower or deeper shelf areas. Stations inshore of this band between Lakes Entrance and Bermagui had high densities of the imported New Zealand screw shell *Maoricolpus roseus*, at up to 5,000 m⁻². These areas had few or no *Gazameda gunni*, a native screw shell usually occupying this habitat.

2. COLLECTIONS FOR STABLE ISOTOPE ANALYSIS

Tissue samples from a diverse range of fish, plankton and seafloor invertebrates were collected for laboratory analysis of stable isotopes. The fish species sampled and the numbers of samples taken are shown in Table 1; many of the invertebrate species sampled await species level identification. Zooplankton were collected in oblique bongo net tows (500 micron mesh) and drop net samples (100 micron mesh) at the 40 m and 200 m stations. Phytoplankton was collected from filtered water samples at the same stations. Analysis of stable isotope ratios will indicate the relative trophic levels of each organism and therefore their position in the community food web.

3. COLLECTIONS FOR DIETARY ANALYSIS

Stomach contents were collected from a diverse range of commercial and other abundant fish species for dietary analysis (Table 1). This work will determine the immediate feeding links and will compliment the results of stable isotope analyses of trophic structure.

4. COLLECTIONS FOR PIGMENT ANALYSIS

Biological samples for analysis of phytoplankton pigments were taken from the plankton nets and sediment sampler on the benthic sled. Samples were taken from all deployments of both gears and immediately frozen. These samples will be analysed to determine the presence and concentrations of chlorophyll compounds and their breakdown products. This analysis will assist in determining the origin of primary production in the ecosystem, and the herbivores responsible for its decomposition. Additionally, there is a possibility that distinct chemical signatures in sediment samples will be associated with different benthic communities.

5. SURVEY OF REEF AREA

Only one of the two planned study sites, the southern part of Gabo Reef, was sampled (Fig. 2). Gabo Reef was selected for study as it is the largest area of unbroken reef in the Southeastern part of the SEF and is the location of productive trawl and mesh net fisheries. Nearly two of the six days of sampling at Gabo Reef were lost to bad weather and, as a result, fewer mid-water trawls and video transects were undertaken than were planned. A fish trap fitted with a video camera and lights was also unable to be deployed.

Mid-water trawling, seafloor photography and acoustics formed the basis of the reef sampling during this cruise; additional sampling, using fish traps and gill nets fished from commercial vessels, will be undertaken in October. In all, about 6 hours of video footage was taken over the reef and adjacent ground during 6 transects (Fig. 3). Surprisingly, the reef was, for the most part, covered by a fine sandy substrate. Exposed rock was uncommon and macro-invertebrates such as sponges tended to be small to medium in size (<50 cm tall) and sparsely distributed. Reef-top topography was gently undulating over most of the ground surveyed by camera. Sharp relief and exposed rock was mainly seen at the reef edge. Insufficient time prevented camera transects being undertaken in the northern part of the study area where, judging from soundings, there was a higher proportion of rougher bottom. A sample of reef-top invertebrates was taken for identification purposes during a single deployment of the benthic sled. Nine depth-stratified mid-water trawls were completed but generally the catches were disappointing. Very little was caught during the day-time and only small catches were taken at night. Net avoidance appeared to be a problem since appreciably large pelagic marks were evident on and off the reef. However, one shot targetted at a dense part of the scattering layer around 60 m caught a large number of the myctophid, *Lampanyctodes hectoris*, (lantern fish). With the exception of one individual of *Diaphus danae*, this was the only myctophid caught. The main point of interest in catches was the pelagic capture of several tiger flathead (*Neoplatycephalus richardsoni*) and one ling (*Genypterus blacodes*). Utilization of the pelagic realm by these quotoa species was a significant finding since they are regarded as demersal species.

The demersal trawl and the benthic sled were used to sample flat bottom along the inner and outer edges of the reef. Trawling was carried out during day-time and night-time whereas sled sampling had no diel component. As with the sampling undertaken during Leg 2, all fish catches were sorted to species, all species represented by 5 or more individuals were measured and biological data were collected from target species. Benthic samples were sorted by size category and taxa at varying levels of discrimination. A grid of 9 CTD casts was completed during the first day to determine the characteristics of the primary water masses over the sampling area (Fig. 3). Another one or two casts were done each day to monitor any change of water masses during the period of sampling. Plankton samples for stable isotope analysis were taken by 3 bongo net tows over the reef.

6. SURVEY OFF MARIA ISLAND

Six demersal trawl transects with the Engels High Rise net and Photosea-2000 35mm camera were completed on Darcy's Patch off Maria Island at 4-hour intervals. This replicated the sampling design used to sample this area in 1984, although the final, seventh transect was omitted due to time constraints and predicted deteriorating weather. Catches were variable but included several catches greater than 1 tonne, containing many spotted warehou, *Seriotelella punctata*, and ling, *Genypterus blacodes*. Whiptails, including *Caelorinchus parvifasciatus* and *Lepidorhynchus australis*, and the bellowsfish, *Centriscomus humerosus*, were common in most catches. The camera was successfully deployed and provided ample slides of the seabed and the brittle star *Opbiacantha fidelis* to compare their abundance with previous years.

7. COLLECTIONS FOR THE HANDBOOK OF AUSTRALIAN SEAFOOD PROJECT

Specimens were saved from the trawls to provide samples and information for the production of the Handbook of Australian Seafood. Frozen muscle samples were required from ten specimens

of each commercial species (for protein fingerprinting). One specimen of each species was photographed (photos to be published in the Handbook) and preserved in formalin as the voucher specimen; two others were kept frozen for fillet analysis. The table below summarises the number of specimens and samples collected.

Handbook collections	No. of species sampled	No. of species completed	No. of muscle samples	No. of whole fish
Sharks and rays	15	3	60	15
Bony fish	37	20	83	16
Invertebrates	3	0	0	19
TOTAL	55	23	143	50

8. COLLECTIONS FOR COLLABORATIVE STUDIES AND FOR OTHER INSTITUTIONS

A number of miscellaneous specimen collections were made for collaborative studies, to address requests from workers in other institutions and for stock assessment purposes. Specimens saved from trawl or sled samples were as follows:

- Redfish (*Centroberyx affinis*) and tiger flathead (*Neoplatycephalus richardsoni*) for Dr David Smith, Department of Conservation and Natural Resources, Victoria
- Jack mackerels (*Trachurus declivis* and *T. murphyi*) for Mr Grant Pullen, Tasmanian Department of Sea Fisheries
- Trumpeter (*Latidopsis forsteri*) for Dr Jeremy Lyle, Tasmanian Department of Sea Fisheries
- A wide range of invertebrate specimens for Dr Penny Berents of the Australian Museum-including material for current studies of the Australian fauna based at the Museum of Victoria, the Smithsonian Institution and the Zoologisk Museum Copenhagen.
- Octopus (*Octopus* species) for Tim Stranks, Museum of Victoria
- Gurnards (*Lepidotrigla* species) for Dr Martin Gomon, Museum of Victoria
- Squid (*Sepia* species) for Dr C. Lu, Museum of Victoria
- Sawsharks (*Pristiophorus* species) for Dr Geoffrey Waller, British Museum of Natural History, and Matthias Stehmann, ISH, Hamburg
- Gummy and school sharks (*Mustelus antarcticus* and *Galeorhinus galeus*) for Mr Michael Gardner, CSIRO Division of Fisheries
- Miscellaneous taxonomic specimens (particularly Triglidae and Brachionichthyidae) photographed and retained for ongoing taxonomic studies by Dr Peter Last, CSIRO Division of Fisheries.

- Jack mackerel (*Trachurus declivis*) for Dr Nick Elliot, CSIRO Division of Fisheries

ADDITIONAL WORK

i) A cross-shelf photographic transect, requiring 5 deployments of the sled, was completed off Bermagui. This exercise aimed to assess the types and spatial extent of benthic habitats along a complete cross-shelf transect. The sled transect covered many different soft-bottom habitats, with the near-shore habitats particularly changing over short distances. Station 168, the most inshore station, started in an area of confused, short sand waves that soon gave way to regular 1–1.5 m wide sand waves aligned at about 45° to the transect, with oyster and scallop shell in the troughs. The next offshore habitat was one of less-regular, smaller waves of fine sand with probable algal fragments in the troughs and lee of the sand waves. Further offshore still, the wave pattern changed to run approximately at right angles to the transect. Small fish seen included tiger flathead *Neoplatycephalus richardsoni*, a stingaree *Urolophus paucimaculatus*, and an unidentified pufferfish. At the next station (Stn 169), the wave forms changed quickly to include occasional patches of large ripples with shell and stones, followed by a short area of rippled ground with dense polychaete tube cover in the between the ripples. This graded slowly to similar ground with only moderate polychaete cover in the troughs. The fish seen were similar to station 168, with the addition of small ocean perch, *Helicolenus percoides*. At station 170, the sediments slowly changed to an stable area without obvious sand waves, but with a medium to heavy cover of worm tubes, with some alcyonarians included at the deeper end of the station. The only fish seen was a small tiger flathead. At station 171, bottom changed gradually to small ripples running diagonally to the transect, but at 90° to the ripples at the shallower stations. The fauna also changed gradually to relatively sparse worm tubes with no sponge or other megafauna. The fish seen were mainly bellowsfish, *Macrorhamphosus humerosus*. At station 172, the deepest of the five cross-shelf stations, the bottom topography changed gradually to a flat, fine sand bottom with some silt and admixed shell; sediment clouds caused by the tow warp burying in the sediment obscured many frames. The benthic fauna changed from ascidians and small branched sponges initially to include seapens, small crinoids and the ophiuroid *Gorgonocephala*.

ii) Two target trawls were completed to provide additional biological specimens. One was off Disaster Bay for redfish and another on the upper slope off Point Hicks for deeper water species required by the Seafood Handbook project. Both were successful and provided, respectively, a large number of small redfish for length frequency recording and a range of different species for the Handbook.

iii) To enhance the development of species-interaction models CSIRO is undertaking a project to categorise fish species into functional groups based on morphological and functional attributes. A large volume of material to enable the commencement of a pilot study was collected during the cruise (Table 2).

CRUISE NARRATIVE**THURSDAY 18 AUGUST**

Southern Surveyor departed Hobart at 0915 to fanfare as the Communications Group film crew filmed the departure. The vessel steamed to Maatsuyker, arriving there at 1900. The azimuth thruster, which holds the 12 kHz transducer, could not be lowered initially, and the acoustic data were very noisy. There was too much swell to carry out the CTD deepwater bottle test, which Brian Griffiths had requested. The vessel steamed on to the west coast. With 3-4 m swell, everyone was a bit seasick.

FRIDAY 19 AUGUST

CTD stations along 43° lat were carried out during the night. The vessel then proceeded to Cape Sorrell, a 5 hr steam. A CTD station there was followed by acoustic transects that revealed some reasonable fish marks over the bottom during late afternoon. Two MIDOC tows were carried out in the evening. Tow speed was based on the Doppler rather than the GPS sensor, following the advice of the Fishing Master. However, the breakage of 3 wires on the first tow and another wire on the second tow, despite being within ~2.5 kt on the second tow, indicates that the GPS speed should be used. This generally indicated 50-100% higher speeds. A good mark was seen at 2300 hr but it was 30-75 m above bottom, and the vessel proceeded to the next site.

SATURDAY 20 AUGUST

CTD stations were carried out along 42° lat, and the vessel then proceeded to the Pieman River site. A CTD station and acoustic transects were carried out in the morning. Chris Shearer, skipper of *Petuna Endeavour*, was at the site and reported poor catches from further north. A phone call to Mark Lewis from a family friend related that his wife had had a fall, which had affected a recurrent back problem and that she was severely disabled. No relatives were available to help with the baby, and Mark was requested to return home. We steamed 2.5 hr to Strahan, where he was taken in to the nearest road, picked up by the local 'cab,' and taken to Strahan, where he made his way back to Hobart. The vessel returned to the Pieman River site and trawled, catching 1 blue grenadier, a box of ling, 2 boxes of toothed whiptails, some spiky oreos, etc. The vessel proceeded north to the Sandy Cape area.

SUNDAY 21 AUGUST

Three trawls were carried out through the night without success in the Sandy Cape and Sandy Ditch areas and the flat ground between them. Four grenadier were obtained from one shot. Each catch was of one to several boxes of fish with similar catch composition. Several CTD profiles were taken, and the ship headed south toward areas of (hopefully) higher fish abundance. Two MIDOC plankton tows carried out in the Pieman River canyon. At the conclusion of the second tow, the wind had risen to 30 kt and conditions were no longer suitable for plankton towing. The Fishing Master advised that in 1987 in mid-August when no grenadier were found along the west coast from Sandy Cape south that some were found to the north off Cape Grim. Since trawl and plankton samples had already been obtained from the southern area, and in view of the worsening conditions, I opted to head north.

MONDAY 22 AUGUST

Conditions deteriorated through the night. In the morning, it was blowing 40 kt with a worse front on the way. With only 12 hr of working time left I decided to head for shelter and Devonport.

TUESDAY 23 AUGUST

Steaming to Devonport.

WEDNESDAY 24 AUGUST

Southern Surveyor departed Devonport at 1400hr on 23 August and steamed overnight to be on station at the Wilson's Promontory transect for 0400hr. A 'muster stations' drill was completed soon after departure and a briefing of scientific staff took place after tea. Most of the evening of the 23rd was spent preparing sampling gear and laboratories for the start of sampling. This commenced with trial deployments of the combination benthic/ epibenthic sled. Photographic slides from the Photosea camera mounted on the sled were used to check the angle and degree of contact of the sled with the seafloor. Sampling at the two shallow stations (25 and 40 m) on transect A continued with the demersal trawl, CTD, bongo and drop nets and sled. All samples were collected successfully. The first fish catch was around 2 tonnes and comprised mainly barracouta and jack mackerel. The second was smaller but contained a greater variety of species. Sled samples provided large volumes of material in the main nets and small quantities in the internal fine-mesh subsampling nets. Sea conditions were reasonable in the lee of Wilsons Promontory although winds were fresh, around 30-35 knots.

The vessel steamed overnight to the shallow stations on Transect B off Lakes Entrance. We opted to continue working nearshore because the forecast was for continuing strong winds. Acoustic data (EK500 data and Roxanne) were collected whilst underway to characterise seafloor structure. Our course followed the 40 m isobath through an area reported by fishermen to comprise many low relief limestone reefs.

THURSDAY 25 AUGUST

We were at the 25 m station on Transect B for 0530hr. The first benthic sled tow, completed by 0700hr, yielded large samples which required considerable subsampling. Screwshells were dominant in a coarse gravel/ broken shell substrate. CTD casts, drop net and bongo net samples and fish trawls were completed successfully at the 25 and 40 m stations by midday. The first trawl catch was 373kg; among the 24 fishes contained in it, jack mackerel, *Trachurus declivis*, was the most abundant comprising 78% of the total. The small stingaree, *Urolophus cruciatus*, had second highest biomass being 4.9% of total weight. At the 40 m station the trawl catch was 25 species for 580kg; jack mackerel made up 75% and the ray, *Raja* sp. A, 5% of the total. The last sample of the day was a sled tow at 40 m. Sea conditions were favourable for a dingy trip in across the rivermouth sand bar at Lakes Entrance. This permitted us to pick up a set of Niskin bottle clamps by dingy from the Lakes Entrance Co-op. We completed acoustic transects over 10 x 10 Reef (Smithy's Corner), an outer-shelf commercial fishing area, during the night.

FRIDAY 26 AUGUST

Arrived at the 80 m station on Transect B for 0500hr and sampled it successfully with the benthic sled, CTD and trawl. The sled sample contained large quantities of fibrous material (hydroids and worm tubes) which made sorting difficult. A trawl and CTD cast followed at the 120 m station. Both the 80 and 120 m trawls contained medium sized catches of 200-300 kg of mixed species. Species numbers, 33 and 31 respectively, were in the range of total species in shallower stations. A change in species composition was evident in the deeper stations: jack mackerel were scarce and dominant species included dragonets (*Foetorepus calauropomus*), spurdogs (*Squalus megalops*), cucumber fish (*Chlorophthalmus nigripinnis*) and leatherjackets (*Parika scaber*). A large catch in 200 m (540kg) was dominated by the small cardinal fish, *Apogonops anomolous* (54% by weight). The bongo net sample contained a large catch of gelatinous zooplankton. Benthic sled samples from the deep stations were very time consuming to sort and were not finished until 2230. We undertook an acoustic transect over the deep sampling area of Transect B during the night. Weather remains fine with light winds and sunshine; it is reminiscent of a summer cruise! Moved to the outer stations on Transect A in the early morning.

SATURDAY 27 AUGUST

Commenced sampling with the benthic sled at the 200 m station on Transect A at 0530. Because the ground in this area is steep and rough a shorter tow was planned. The gear came fast after 10 minutes anyway but was retrieved safely after some anxious moments. Photographic film from the sled camera showed later that it was only the towing warp that had become bogged. At the time it was decided not to trawl this area and we moved inshore to the 120 m station. The remainder of the day's sampling with the trawl, CTD, drop and bongo nets and benthic sled were completed without problem. The trawl catch at 120 m was small— only 23 species for 147kg, with cucumber fish and the gurnard, *Lepidotrigla mulhalli*, making up 65 and 9% respectively. At 80 m 288kg contained 30 species with *P. scaber* dominant with 37% of total weight. Sled samples were small and contained large quantities of bryozoans and hydroids. Moved eastwards overnight to survey the Everard Reef fishing ground on the way to Transect C off Point Hicks.

SUNDAY 28 AUGUST

Sampling on the Point Hicks transect commenced at the 80 m station around 0500hr. The layered sediment sample indicated the bottom there consisted of patches of fine sand and mud. The trawl catch at this site was fairly diverse: 38 fish species for a total of 315 kg. Stingarees (*Urolophus bucculentus*) and whiting (*Sillago flindersi*) comprised 18% and 17% of weight respectively. In both the 40 m and 25 m trawls, jack mackerel was the dominant species in both weight and numbers. Sled samples at these sites contained large quantities of coarse sand and shell dominated by bivalves. Dog cockles (*Glycimeris* spp.) and *Eucrassatella kingicola* were dominant in 25 m whilst moderate numbers of the NZ screwshell, *Maoricolpus roseus*, occurred in 40 m. We carried out an acoustic survey of the western end of the Big Horseshoe fishing ground during the night.

MONDAY 29 AUGUST

The deep stations on Transect C were sampled today. Both trawl shots were moderate in size, 448 kg and 481kg. The second, in 200 m, was dominated by the dogfish, *Squalus megalops*, in

both weight (41%) and numbers (234) but also contained several boxes of commercial species. Among these were 80 spotted warehou, *Seriola punctata* and 65 morwong, *Nemadactylus macropterus* which comprised 10.7% and 22% of the catch by weight. An additional shot was done on the upper-slope in 400 m for specimens for the Seafood Handbook project. The catch was small but contained several large ling (*Genypterus blacodes*) spotted warehou and two gemfish (*Rexea solandri*). Sled catches were large and time consuming to sort. We steamed eastwards to transect D off Gabo Island and completed three hours acoustic survey over the southern end of Gabo Reef during the night.

TUESDAY 30 AUGUST

Started the day with a sled tow at 80 m. The catch contained large quantities of fine sponge and worm tubes making it difficult to sort. A large number of fish, mostly the scorpion fish, *Scorpaena papillosa*, were present in the large-mesh net samples. The 80 m trawl comprised 35 fish species in the 423 kg catch. Small leather jackets (*P. scaber*), gurnards (*L. mulballi*) and *S. papillosa* were most abundant. A sizeable trawl catch in 40 m (703 kg) was dominated in weight (33%) and numbers (4332) by jack mackerel. Urolophids (*U. paucimaculatus* and *U. bucculensis*) accounted for 27% of the remaining biomass. The inner station proved to be quite different in species composition to any of the previous shallow shots. Two fishes that had not been previously seen, the perch *Caesioperca lepidoptera* and the bullseye *Pempheris multiradiata*, were dominant. That the trawl came fast (but was retrieved without damage) and contained several large sponges and some large fronds of brown alga indicated we may have trawled over some low relief reef. The sled samples at this and the 40 m site were predominantly very coarse sand and broken shell. All samples from the three inner stations were completed successfully. The vessel steamed to the Gabo Reef area for acoustic survey around 2000hr.

WEDNESDAY 31 AUGUST

Two sled samples were completed at the deep stations in 120 and 200 m on Transect D. Both samples were predominantly coarse dead shell substrate containing small numbers of sponges and polychaetes. The small inner net samplers contained large quantities of coarse sand, most of which was retained in a 4 mm sieve. Some warm water species are appearing in the catches on this transect. Trawl catches at the same stations were both dominated in weight by barracouta (*T. atun*) and cucumber fish (*C. nigripinnis*), and in numbers by the small cardinal fish, *A. anomalous*. Bongo and drop net samples contained large quantities of a brown filamentous alga which made samples difficult to sort. Large numbers of pyrosomes were also meshed in the trawl net. Moved north overnight to continue the acoustic survey of Gabo Reef.

THURSDAY 1 SEPTEMBER

Fine weather returned today: clear, sunny conditions with light and variable winds. We sampled the deep stations on the Disaster Bay Transect E starting at 170 m—the greatest depth we could find in this area of steeply sloping shelf. The trawl catch contained 261 kg fish from 24 species. The redfish, *Centroberyx affinis*, comprised 45% of weight and ranked second in abundance. This was our first sizable catch of this important commercial species. A second abundant species, the macrourid, *Caelorinchus mirus*, was also caught in quantity for the first time. The appearance of these fishes indicated the increasing presence of a sub-tropical fauna as we

moved northwards. The trawl catch at 120 m contained 177 *Nemadactylus macropterus*, the commercial morwong, for 28.8% of the total weight. At 80 m, jack mackerel were dominant in weight and numbers. Large catches of algae were taken in the drop and bongo nets; fish larvae and large zooplankton were evident in the catches also.

FRIDAY 2 SEPTEMBER

Fine weather continued and the inshore sampling on Transect E was done against the impressive backdrop of Disaster Bay. At 80 m the sediment sample indicated a different silty mud substrate to the sandy bottom closer inshore. A large catch of the swell shark, *Cephaloscyllium laticeps*, (92 fish for 51% of the weight) was taken at 40 m. In 25 m the catch was dominated in numbers by small jack mackerel, which with 2367 individuals was considerably more abundant than the 152 *Urolophus paucimaculatus* which ranked second. Contrary to expectations, trawls in this area contained very few redfish. The vessel berthed briefly in Eden for the fresh water tanks to be filled. This provided the crew the opportunity for a well earned break before departing at midnight.

SATURDAY 3 SEPTEMBER

Overnight we steamed out on an acoustic transect to the shelf edge just north of Eden before heading north to the next transect. Calm, sunny conditions prevailed for sampling the inshore stations on Transect F off Merimbula. The 25 m station was not attempted because this depth is too close to shore here. Trawl catches at 40 m and 80 m also contained very few redfish. In 40 m, the silver trevally, *Pseudocaranx dentex*, comprised most biomass (22%) and ranked second in numbers to eastern school whiting. Very large quantities of the NZ screwshell, *Maoricolpus*, were taken at this depth; photographs show this mollusc lying in large numbers in channels between ridges of sand. Large quantities of small bryozoans and sponges in the catches indicate the importance of this rich epizootic base. After 20 minutes trawling at the 120 m station the net came fast and was retrieved with a broken headline and extensive damage to the body of the net. It was not repairable on board. Interestingly the catch contained the highest proportion of commercial species in any catch to date, including several boxes of morwong and redfish. We steamed south and completed the acoustic transects over the mid-shelf reef area east of Disaster Bay overnight.

SUNDAY 4 SEPTEMBER

The remaining one and a half deep stations on Transect F were sampled by lunchtime. The early finish allowed us time to steam back to Eden and drop off the damaged trawl net. Arrangements were made for the local net maker, John Reynolds, to meet us at the end of the main wharf. Skillful manoeuvring of the vessel by Ian Taylor enabled the net to be lowered onto the net maker's truck by crane without the vessel having to tie up. Weather remained fine and, with such excellent progress having been made, a barbeque on deck was organised for the evening meal. A targeted shot for redfish was made at 76 m in Disaster Bay to obtain sufficient numbers of juveniles for length frequency analysis. The shot was successful with 1700 kg of fish, 25% of them juvenile redfish. Two acoustic transects were completed over the Green Cape Reef in the early evening before steaming north to the last transect off Bermagui.

MONDAY 5 SEPTEMBER

Sampling commenced with the benthic sled on Transect G at 0530hr. Large quantities of dead shell were taken by the large nets and coarse sand by the inner small mesh nets. The trawl catch at this station was predominantly redfish: about 1050 individuals accounted for 62% (244 kg) of the total weight. Ocean perch made up about 11% of the catch weight and cucumber fish 4.7%. In 120 m the catch was smaller (209 kg) and comprised only 22 species of fish. Stingarees, *U. viridis*, blue warehou, *S. brama* and jack mackerel each comprised between 16 and 19% of the total weight whilst the bellowsfish, *M. scolopax*, was most abundant (805 fish). An acoustic survey of the shelf edge south of Montague Island was undertaken during the night.

TUESDAY 6 SEPTEMBER

The sled catch at 40 m contained a small volume of material overall, but was interesting in containing mostly smooth, river-worn pebbles. The trawl catch at this station was very small, only 40 kg in weight. Half of this was made up by two angel sharks, *Squatina australis*; the stingaree *Urolophus paucimaculatus* and bellowsfish *M. scolopax* were the other primary species in this depth. In 80 m jack mackerel and bellowsfish were the two dominant species in a catch of 25 species for 205 kg.

A cross-shelf photographic transect at Bermagui, requiring a total of 5 benthic sled tows, was scheduled for the sampling time remaining on Leg 2. The first tow, between 25 and 46 m, was done after tea.

WEDNESDAY 7 SEPTEMBER

Two more sled tows were completed before steaming north to Batemans Bay for a rendezvous with people from the South East Fishery Workshop. The morning was spent cleaning the wet lab and other workspaces in readiness for tours of the vessel by workshop delegates. A small ferry, the Redfin, brought two groups of 20 visitors out to *Southern Surveyor* during the afternoon. The groups were very diverse and included fishermen, Fisheries enforcement officers, fishery managers, researchers from State agencies, staff from the fishery monitoring program and two journalists. Each group was split into parties of around five which were taken over the vessel by 'tour leaders' (myself, Nic, Sebastian and Tony Koslow). Several other staff and some of the ship's officers were stationed in labs or at displays and provided information about the Division's research and the vessel itself. A sit down meal was prepared by the catering staff for the first group and light refreshments were provided for the second. There was a high level of interest in the vessel's capabilities and in the work being undertaken. Overall it proved to be a successful exercise. Our mid-cruise staff transfer at Batemans Bay went smoothly.

THURSDAY 8 SEPTEMBER

The last sampling planned for Leg 2, two sled tows between 83 and 277 m to finish the cross-shelf photographic transect, were completed before breakfast. We set course for Eden for the mid-cruise break to take on fuel and supplies. Our arrival at 1200hr was timed to permit refuelling to be finished by nightfall. A briefing for CSIRO staff to discuss the sampling program for Leg 3 was held in the non-smokers lounge at 1330 hr.

Later that afternoon the Maritime Union of Australia (MUA) announced a nation-wide strike (to protest the proposed sale of the Australian National Line). This required a number of the ship's crew to stop work and therefore prevented the vessel sailing. Despite an application by the vessel management company (ASP) to the MUA for exemption from the dispute, none was forthcoming. The scheduled departure time of 2400 hr was postponed.

FRIDAY 9 SEPTEMBER

Alongside in Eden, unable to leave port due to MUA dispute. CSIRO and ASP unsuccessful in attempt to secure exemption for *Southern Surveyor* from strike.

SATURDAY 10 SEPTEMBER

Alongside in Eden, unable to leave port due to MUA dispute. CSIRO staff busy with a variety of tasks on board. An evening barbeque was organised on the ship for all vessel staff and the local fishing industry and their families.

SUNDAY 11 SEPTEMBER

Alongside in Eden, unable to leave port due to MUA dispute.

MONDAY 12 SEPTEMBER

Alongside in Eden, unable to leave port due to MUA dispute.

TUESDAY 13 SEPTEMBER

Eventually departed Eden at 1415 hr. A staff briefing was held at 1530 hr to review the scientific program in light of the time lost. Muster stations were called at 1600 hr and safety procedures and general issues reviewed. Due to the loss of time, one of our two study areas on Gabo Reef was dropped. The 9 days remaining should permit full sampling on one site plus completion of a 24 hr demersal trawling program on Darcy's Patch on the return journey to Hobart. A deep water Niskin bottle test was done on the way to the study area and a test deployment of the MIDOC mid-water trawl undertaken successfully.

WEDNESDAY 14 SEPTEMBER

Winds gusting around 30 knots prevented deployment of the Bongo net during the night. Three more MIDOC trawls were completed, two off the outer margin of Gabo Reef and one over the reef along its outer edge. The trawl catch during darkness comprised mainly myctophids and an unknown species of carid prawn. *Lampanyctodes bectoris* was the dominant myctophid. Of great interest was the pelagic capture of three tiger flathead, *Neoplatycephalus richardsoni*. Daytime catches contained no fish; zooplankton retained by the fine liners in the MIDOC codends was retained for isotope analysis. A grid of 9 CTD casts to characterise the water mass over the study area occupied most of the day watch.

THURSDAY 15 SEPTEMBER

Despite strong westerly winds, which gusted to 50 knots overnight, two depth stratified pelagic trawls were completed before midday. The first, a night-time shot over the reef towards its outside edge, was affected by strong subsurface currents and by the drift of the ship. The gear was very flighty and consequently not fished within 25 m of the bottom. The second tow, in

daylight, fished with the current and was controllable within 5 m of the bottom. During this shot the gear fished through some promising looking marks. However, catches from both tows were very disappointing. Only small numbers of fish and crustaceans were taken by each of the codends during the night-time shot and virtually nothing was caught in the day-time shot. Net avoidance appears to be a problem. We are switching over to demersal trawl and benthic sled sampling under these conditions. The first demersal trawl, outside the outer reef edge, contained only 167 kg of fish. Four species, jack mackerel, barracouta, cucumber fish and burr fish, each comprised between 13 and 19% of the total weight and made up two thirds of the catch. A trawl over the same ground in darkness yielded about 1045 kg, of which 92% was large jack mackerel. The large snatch-block on the rear gantry was changed to permit use of the bongo net under rougher conditions. A relatively large catch of plankton was taken in a bongo tow over the same ground.

FRIDAY 16 SEPTEMBER

Two successful benthic sled tows were made during the night off the outside and inside edges of the reef. A trawl was finished off the inside reef edge in deteriorating weather. The 542 kg catch was dominated by jack mackerel which made up 75 % of weight and more than 50% of numbers. Winds picked up to 40-50 knots by mid-morning making it impossible to fish. We spent the rest of the day dodging the weather.

SATURDAY 17 SEPTEMBER

Decreasing winds early in the morning allowed the resumption of sampling. A demersal trawl was completed inside the inner edge of the reef. The catch of 540 kg was dominated by redfish. A tow over the reef top with the benthic sled yielded a good sample of invertebrates but moderate damage was caused to the sled in the process. One of the main structural members was broken and the nets shredded thereby putting the gear out of action for the remainder of the cruise. Several hours were spent preparing the Osprey video gear for its first deployment during the cruise. Two successful transects were made in a generally northerly direction over the south western region of the study area. The seafloor was gently undulating sandy substrate with sparse sponge cover. Disaster nearly struck during the second retrieval when the towing cable broke. Luckily the gear was near the surface and was lifted by the electrical cables to a point where it was grappled and lifted aboard with the crane. Two or three hours were spent re-rigging the gear so that it could be deployed from the rear deck using the bongo winch. Two more drifts were completed over the south east part of the study area where echo soundings indicated the ground was rougher. No exposed rock was seen apart from at the very edge of the reef where it drops abruptly onto flat ground. Deeply undercut rock outcrops were filmed as the gear drifted over the reef edge.

SUNDAY 18 SEPTEMBER

Two video drifts were done around the centre of the study area where the seafloor appeared similar to the SW part of the study area. Two MIDOC trawls and a CTD were completed before strong winds stopped sampling at 1600 hr. The night-time MIDOC catch contained a variety of species including tiger flathead, jack mackerel and cardinal fish (*A. anomalus*), however, all were present in only in small numbers. Fish were caught in only one codend of the day-time trawl: these were 4 juvenile spotted warehou (*S. punctata*), 1 juvenile jack mackerel and several

specimens of an unidentified centrolophid. The presence of several juvenile arrow squid (*Nototodarus gouldi*) in both catches was noteworthy because of their rare capture in trawls. Fishing resumed again around 1930 hr with a MIDOC shot out beyond the outer reef edge where pelagic scattering layers were most prominent. Unfortunately, the trawl was winched aboard ahead of schedule due to worsening conditions. Reasonable samples were taken however: the myctophid *L. bectoris* dominated catches in all nets. It was the only species taken between ~40 m and 60 m where 321 individuals were caught. A variety of juvenile fish and squid and gelatinous zooplankton were caught in the other nets.

MONDAY 19 SEPTEMBER

A further deterioration in the weather last night, and no forecast change until Tuesday, indicated there would be no further opportunity to sample today. Consequently we departed Gabo Reef for Maria Island at 0030 hr, about 20 hours ahead of schedule. Conditions were poor with 40-50 knot winds in Bass Strait making our headway very slow. Periodic sleet squalls exceeded 60 knots.

TUESDAY 20 SEPTEMBER

We made slow but steady progress on our steam south across Bass Strait. Sea conditions did not abate and we ploughed into 40-50 knot winds and a heavy swell all the way.

WEDNESDAY 21 SEPTEMBER

We commenced fishing on Darcey's Patch at 0630 hr. The wind dropped to around 10-15 knots and conditions were good for fishing. A demersal trawl was completed every four hours with one CTD cast made around mid-day. Catches included a high proportion of commercial species; 1,250 kg of spotted warehou, *S. punctata*, were taken in one 30 minute trawl.

THURSDAY 22 SEPTEMBER

The 24 hour trawling program was completed at 0230 hr this morning. Catch processing was finished as the vessel was underway to Hobart. We were alongside the CSIRO wharf at 1215 hr to complete the cruise.

SUMMARY

LEG 1:

Objectives were met to the extent possible, given the lack of blue grenadier and loss of shiptime due to conditions beyond our control.

CTD stations were carried out on two transects and the four selected areas where grenadier are known to aggregate. Depth-stratified plankton tows were conducted at two of these sites of grenadier aggregation. Multi-frequency acoustic transects were carried out at all grenadier sites, along with demersal trawls. The acoustics indicated that the grenadier were either not present or well off the bottom and unavailable to the fishing gear. Trawl catches were poor, and no running ripe fish were obtained so experiments to fertilize and incubate grenadier eggs could not be performed. Poor fishing conditions were also reported from a commercial vessel operating in the area at this time.

LEGS 2 AND 3:

Most objectives were met in full and additional work was completed. One of two sites at our reef study area was not sampled because of time lost to the Maritime Union strike when the vessel was unable to leave port.

A broad-scale sampling program was completed along seven transects between Wilsons Promontory to the south and Bermagui to the north in depths from 25 m to 200 m. All stations were sampled fully except for two where the bottom was untrawlable. Samples of fish were taken by demersal trawl and a combination benthic sled simultaneously sampled epifaunal and infaunal invertebrates and seafloor sediments. Acoustic data from the EK500 sounder and the RoxAnn seafloor classification software were logged continuously throughout the cruise to provide information on bottom topography and hardness. Data on water column structure were obtained from CTD casts. Overall, 33 trawls, 34 sled tows and 34 CTD casts were completed. A total of about 16 tonnes of fish were caught at an average of 466 kg per 30 min trawl (932 kg per hour) during Leg 2. Sampling on the transects occurred during the day-time permitting acoustic surveys of several important fishing grounds to be completed at night. These areas included Smithy's Corner, Everard Reef, Little Horshoe, Gabo Reef, Howe Reef and Green Cape Reef.

The southern part of Gabo Reef, the largest area of unbroken reef in the southeastern region of the SEF shelf and the location of productive trawl and gill net fisheries, was surveyed during Leg 3. This 'hard ground' was sampled by mid-water trawling, seafloor photography and acoustics during the cruise and will be fished with traps and gill nets from commercial vessels in October. Nine depth-stratified mid-water trawls were completed but generally the catches were disappointing. However, large numbers of the myctophid, *Lampanyctodes hectoris*, were caught in some shots and the capture of several tiger flathead (*Neoplatycephalus richardsoni*) and one ling (*Genypterus blacodes*) some 50 m off the bottom was of particular interest. The topography and invertebrate cover on Gabo Reef was less complex than expected. For the most part it was gently undulating and covered by a fine sandy substrate; exposed rock was uncommon and macro-invertebrates such as sponges tended to be small to medium in size (<50 cm tall) and sparsely distributed.

These extensive data will permit the distribution of fishes, invertebrates and habitat types in this region to be described. The role of different substrates and habitats, and the structure of the community food web, will be assessed in relation to fishery productivity.

Sampling was completed successfully at Darcy's Patch off Maria Island using a design which replicated the survey of this area by CSIRO in 1984. Several large trawl catches (>1 tonne) and successful deployment of an underwater camera provided ample data to compare the abundance of fish and invertebrates with historical records.

Data and biological material were collected for a large number of other collaborative projects and for other agencies. Details are provided in the results section.

PERSONNEL

(Note: unless otherwise indicated, all personnel are staff of the CSIRO Division of Fisheries.)

LEG 1:

Dr Tony Koslow (Cruise Leader)
 Ms Cathy Bulman (Assistant Cruise Leader)
 Ms Claire Fyfe (Tas. State Fisheries Dept)
 Mr Rudi Kloser
 Mr Mark Lewis
 Mr Lyndsay MacDonald
 Mr Douglas Nichols (Tas. State Fisheries Dept)
 Mr James Pirie (Tas. State Fisheries Dept)
 Mr Aleks Terauds
 Mr Jason Waring

LEG 2:

Dr Alan Williams (Cruise leader)
 Dr Nic Bax (Assistant cruise leader)
 Dr Penny Berents (Aust. Museum, Sydney)
 Dr Sebastian Rainer
 Mr Bruce Barker
 Ms Cathy Bulman
 Mr Jeff Cordell
 Ms Stephanie Davenport
 Mr Dave Evans
 Mr Mark Rayner (Division of Oceanography)
 Mr Grant West
 Mr Gordon Yearsley

LEG 3:

Dr Alan Williams (Cruise leader)
 Dr Nic Bax (Assistant cruise leader)
 Dr Vicki Wadley
 Mr Bruce Barker
 Ms Stephanie Davenport
 Mr Dave Evans
 Mr Scott Gordon
 Mr Alastair Graham
 Mr Rudi Kloser
 Mr Craig Proctor
 Mr Mark Rayner (Division of Oceanography)
 Mr Matt Sherlock

SHIP'S COMPANY

Mr Ian Taylor, Master*
 Mr Bruce Wallis, Master*
 Mr Roger Pepper, First Mate
 Mr John Boyes, 2nd Mate
 Mr Pat Gibbons, Chief Engineer*
 Mr Ian McAllister, Chief Engineer*
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 Mr John Hinchcliffe, Electrical Engineer
 Mr Alan Smith
 Mr Don Collins
 Ms Kerry Canham
 Mr Dennis Avey
 Mr Michael Berrell, Bosun
 Mr Steve Bruce
 Mr Kooka Darling
 Mr Colin Haebick
 Mr Geoff Handicott
 Mr Tony Hearne
 Mr Ake Hellberg
 Mr Mal McDougall
 Mr Phil Lee

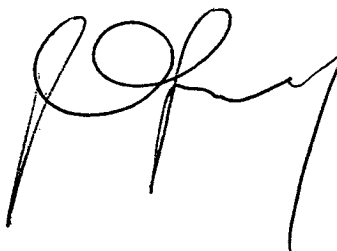
*transferred during mid-cruise break

ACKNOWLEDGEMENTS

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Alan Williams
Cruise Leader

P.C. Young
Chief, CSIRO Division of Fisheries
Date: 24/1/95



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Ship's company	Dr Penny Berents, AMS
John Moore, Dept. Cons. & Nat. Resources,	Richard McLoughlin, Tas. Dept. Sea Fisheries
Lakes Entrance	Dr Jeremy Lyle, Tas. Dept. Sea Fisheries
Steve McCormack, Dept. Cons. & Nat.	Alan Jordan, Tas. Dept. Sea Fisheries
Resources, Melbourne	Jeff North, Tom Davies, Dennis Sheperd,
Dr Dave Smith, Dept. Cons. & Nat. Resources,	Lakes Entrance Fish. Co-op
Queenscliff	John Symonds, Eden Fish. Co-op
Peter Angel, NSW Fisheries, Eden	Jason Cottier, SMP, Lakes Entrance
Mr P. O'Connor, NSW Fisheries, Sydney	Jeff Nemec, SMP, Eden

FIGURE CAPTIONS

Fig. 1 Location of areas sampled during blue grenadier survey (Leg 1)

Fig. 2 Location of transects sampled during broad-scale phase of ecosystem study (Leg 2)

Fig. 3 Sampling positions on Gabo Reef study area (Leg 3)

Table 1 Numbers of fish sampled for dietary and ageing analysis (stomachs, otoliths or vertebrae and muscle tissue for stable isotopes).

SPECIES	COMMON NAME	SPECIES CODE	STOMACHS	AGEING	ISO-TOPIES
Apogonops anomalus	Three-spined cardinalfish	311053	30	31*	20
Caelorinchus australis	Southern whiptail	232001	7	7	6
Caelorinchus mirus	Gargoyle fish	232003	10	10	5
Caesioperca lepidoptera	Butterfly perch	311002	9	14	5
Callorhynchus milii	Elephant fish	043001	1	1	1
Centroberyx affinis	Redfish	258003	104	156	82
Cephaloscyllium laticeps	Swell shark	015001	28	30	16
Cepola australis	Band fish	380001	0	0	1
Chlorophthalmus nigrispinnis	Cucumber fish	120001	43	33*	20
Cyttus australis	Silver dory	264002	49	78*	26
Cyttus novaezelandiae	New Zealand dory	264005	5	10	5
Diodon nichthemerus	Globe fish	469001	20	19	15
Emmelichthys nitidis	Redbait	345001	35	39*	25
Foetorepus calauropomus	Dragonet	427001	31	31*	30
Genypterus blacodes	Pink ling	228002	8	8	9
Helicolenus percoides	Ocean perch	287001	46	56*	25
Heterodontus portusjacksoni	Port Jackson shark	007001	12	13	5
Kathetostoma canaster	Stargazer	400018	0	0	2
Kathetostoma laeve	Stargazer	400003	3	3	3
Lepidotrigla modesta	Grooved gurnard	288007	20	21*	10
Lepidotrigla mulhalli	Round-snouted gurnard	288008	55	54*	15
Macroramphosus scolopax	Bellows fish	279002	25	22	10
Meuschenia freycineti	Six spined leatherjacket	465036	8	8	5
Mustelus antarcticus	Gummy shark	017001	7	7	0
Nemadactylus macropterus	Jackass morwong	377003	40	40*	21
Neoplatycephalus richardsoni	Tiger flathead	296001	48	104*	37
Neoplatycephalus sp.	Flathead	296800	0	10	0
Neosebastes scorpaenoides	Ruddy gurnard perch	287005	8	10	5
Pagrus auratus	Pink snapper	353001	6	7	0
Parika scaber	Velvet leatherjacket	465005	33	40*	21
Pempheris multiradiatus	Common bullseye	357001	10	10	5
Platycephalus bassensis	Sand flathead	296003	5	7	5
Pseudocaranx dentex	Silver trevally	337062	31	24	14
Raja sp. A	Longnose skate	031005	27	37	16
Seriotelella brama	Warehou	445005	56	55	31
Seriotelella punctata	Spotted warehou	445006	25	24	20
Sillago flindersi	Eastern school whiting	330014	16	73*	11
Squalus megalops	Spurdog	020006	30	42	5
Squatina australis	Angel shark	024001	9	9	9
Thyrssites atun	Barracouta	439001	35	79	16
Trachurus declivis	Jack mackerel	337002	52	81*	26
Trygonorrhina sp.	Fiddler ray	027006	5	5	5
Urolophus cruciatus	Banded stingaree	038002	32	32	9
Urolophus paucimaculatus	Sparsely spotted stingaree	038004	30	20	21
Urolophus viridis	Green back stingaree	038007	20	40	21
Zenopsis nebulosus	Mirror dory	264003	3	7	3
Zeus faber	John dory	264004	19	32*	25
TOTAL			1096	726	667

* collected for otolith reference collection

Table 2 Numbers of fish collected for morphometric analysis (small, medium and large specimens)

FAMILY	SPECIES	COMMON NAME	SPECIES CODE	S	M	L
Squalidae	Squalus megalops	Cosmopolitan spurdog	020006	5	5	5
Urolophidae	Urolophus bucculentus	Sandyback stingaree	038001	0	4	4
	Urolophus cruciatus	Banded stingaree	038002	5	5	5
	Urolophus paucimaculatus	Sparsely-spotted stingaree	038004	5	5	1
	Urolophus viridis	Green-back stingaree	038007	5	5	1
Chlorophthalmidae	Chlorophthalmus nigripinnis	Cucumber fish	120001	5	5	5
Brachionichthyidae	Brachionichthys sp. 2	Australian handfish	209005	1	5	5
Ophidiidae	Genypterus blacodes	Pink ling	228002	5	3	1
Macrouridae	Caelorinchus australis	Southern whiptail	232002	2	5	5
Berycidae	Centroberyx affinis	Redfish	258003	5	5	5
Zeidae	Cyttus australis	Silver dory	264002	5	5	5
	Zenopsis nebulosus	Mirror dory	264003	5	5	5
	Zeus faber	John dory	264004	5	5	5
	Cyttus novaezelandiae	New Zealand dory	264005	1	3	0
Macroramphosidae	Macroramphosus scolopax	Common bellowsfish	279002	5	5	5
Scorpaenidae	Helicolenus percoides	Red gurnard perch	287001	5	5	5
Triglidae	Chelidonichthys kumu	Red gurnard	288001	1	5	5
	Lepidotrigla vanessa	Butterfly gurnard	288003	5	5	5
	Pterygotrigla andertoni	Spotted gurnard	288005	0	1	3
	Lepidotrigla modesta	Grooved gurnard	288007	5	5	5
	Lepidotrigla mulhalli	Round-snouted gurnard	288008	5	5	5
Platycephalidae	Neoplatycephalus richardsoni	Tiger flathead	296001	5	5	5
	Platycephalus longispinnis	Long-spined flathead	296000	5	5	0
Hoplichthyidae	Hoplichthys haswelli	Spiny flathead	297001	5	5	5
Serranidae	Apogonops anomalus	Three-spined cardinalfish	311053	5	5	5
Sillaginidae	Sillago flindersi	Eastern school whiting	330014	0	5	5
Carangidae	Trachurus declivis	Jack mackerel	337002	5	5	5
	Pseudocaranx dentex	White trevally	337062	5	4	0
Emmelichthyidae	Emmelichthis nitidus	Redbait	345001	0	5	2
Cheilodactylidae	Nemadactylus macropterus	Jackass morwong	377003	5	5	5
Uranoscopidae	Kathetostoma canaster	Speckled stargazer	400018	0	5	5
Callionymidae	Foetorepus calauropomus	Common stinkfish	427001	5	5	5
Gempylidae	Thyrsites atun	Barracouta	439001	5	5	5
Centrolophidae	Seriotelella brama	Warehou	445005	5	5	5
	Seriotelella punctata	Spotted trevalla	445006	1	5	5
Pleuronectidae	Pseudorhombus jenynsii	Smalltooth flounder	460002	0	3	0
Monacanthidae	Parika scaber	Velvet leatherjacket	465005	5	5	5
	Meuschenia freycineti	Six-spined leatherjacket	465036	5	5	5
Tetraodontidae	Sphoeroides pachygaster	Balloonfish	467004	0	1	1
Diodontidae	Diodon nichthemerus	Globefish	469001	5	5	5
	Allomycterus pilatus	Deepwater burrfish	469002	0	5	5

Figure 1 Location of areas sampled during blue grenadier survey (Leg 1)

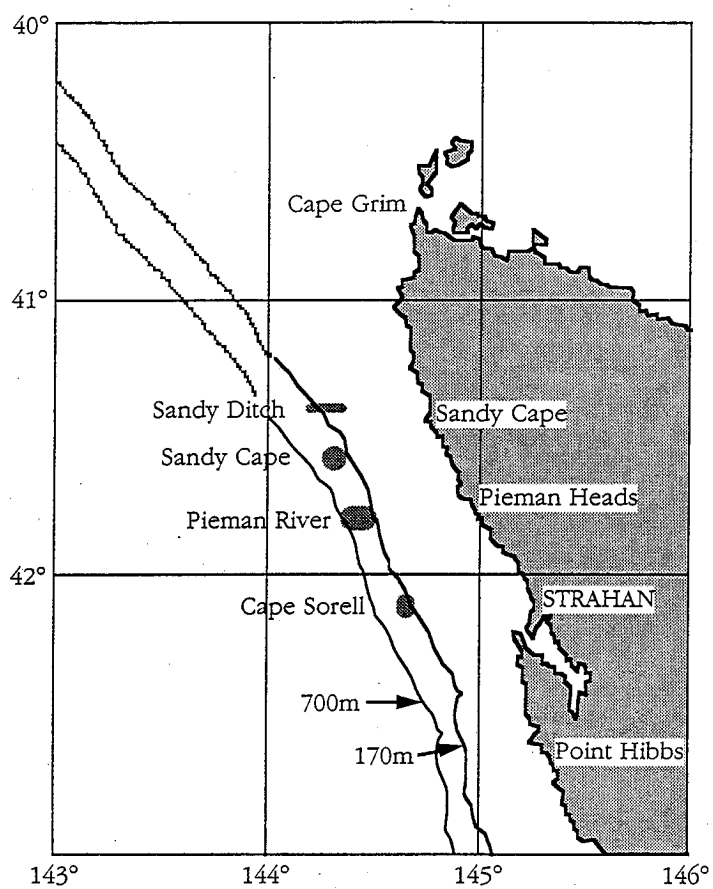


Figure 2 Location of transects sampled during broad-scale phase of ecosystem study (Leg 2)

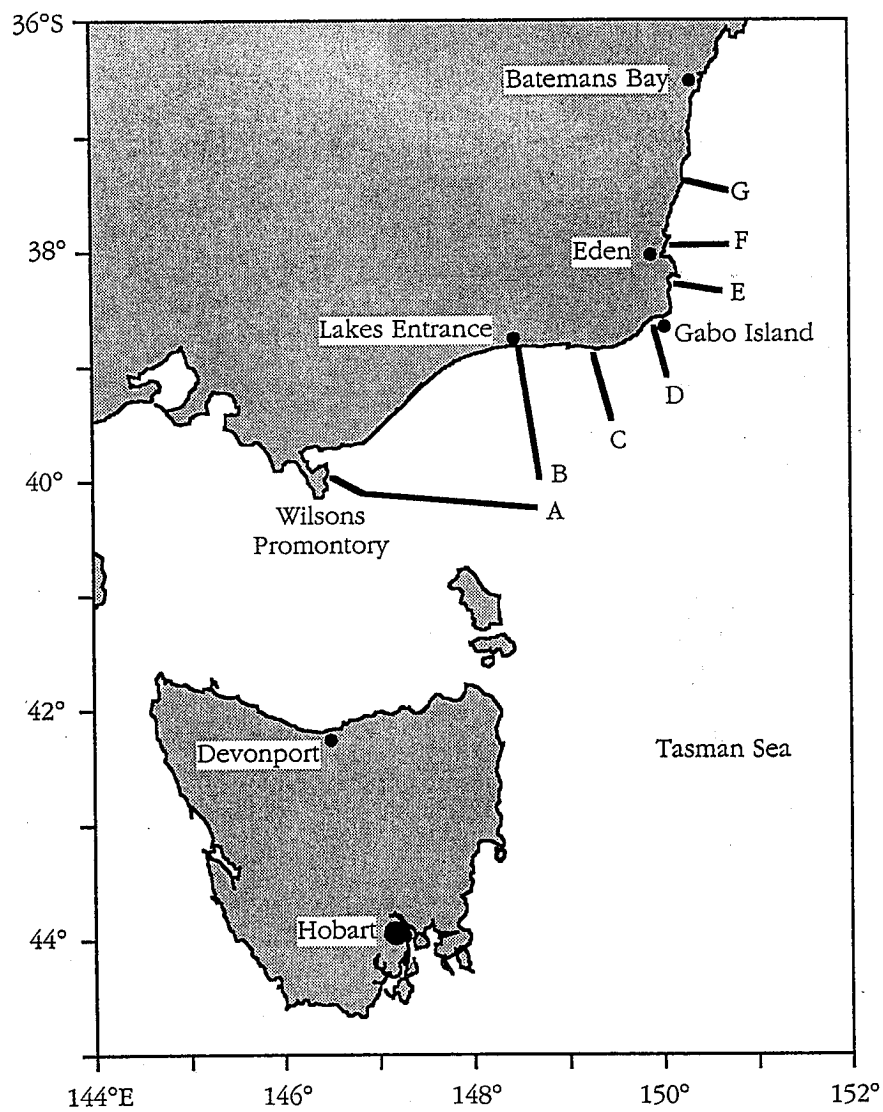
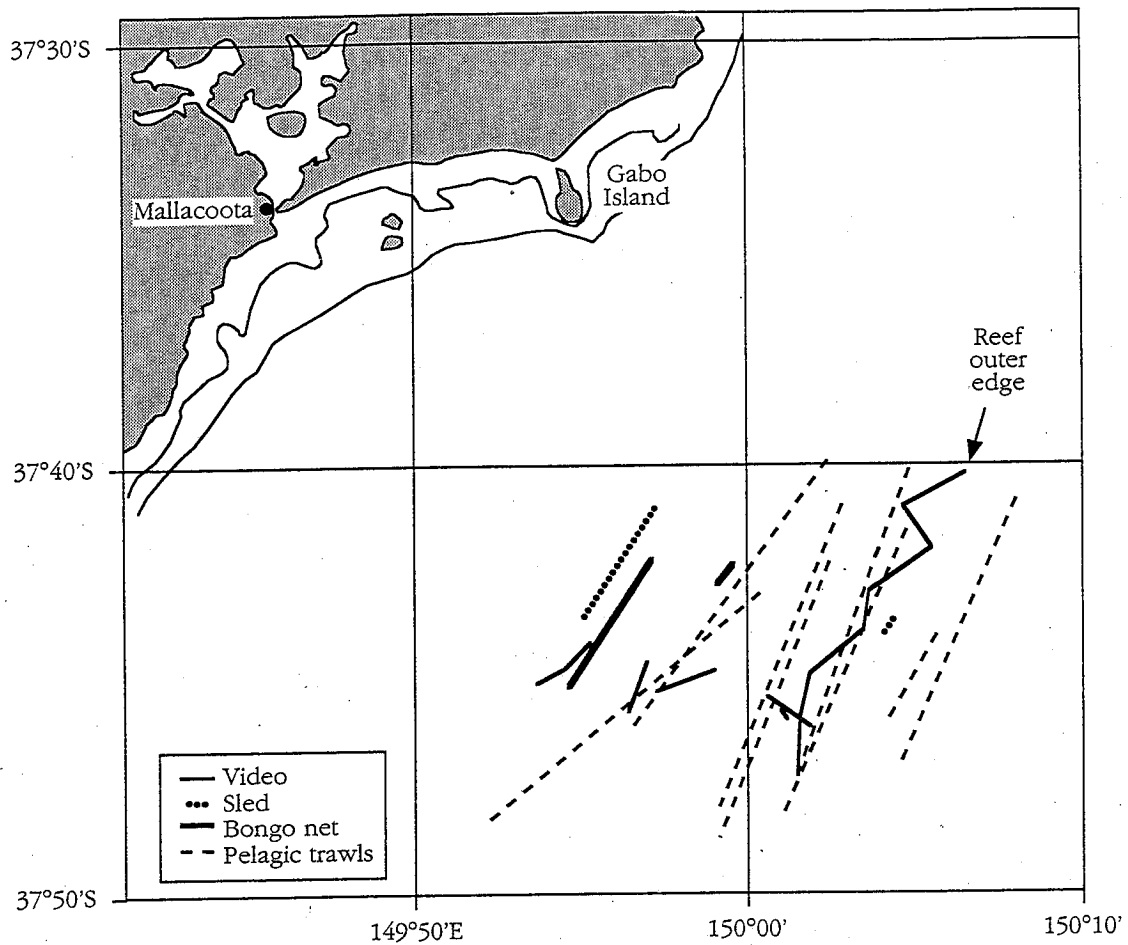


Figure 3 Sampling positions on Gabo Reef study area (Leg 3)



Appendix 1: Details of Sampling Stations, Cruise SS 5/94

Station no.	Lat. (°S.)	Long. (°E.)	Date	Time (h)	Depth (m)	Duration (min)	Sample type								Notes; fishing history		
							Comm'l trawl	Benthic sled	Bongo net	Drop net	MIDOC	Video transect	CTD profile	Engel trawl		RoxAnn	EK500
Leg 1																	
1	42°59.8'	144°58.9'	19.8.94	03:30	1251												
2	42°59.9'	145°06.7'	19.8.94	06:45	176												
3	42°59.6'	145°26.5'	19.8.94	08:25	101												
4	42°05.1'	144°39.8'	19.8.94	16:00	650												
6	42°06.1'	144°39.9'	19.8.94	18:10	653												
7	42°04.2'	144°39.7'	19.8.94	20:40	560												
9	42°00.0'	144°32.8'	20.8.94	01:30	1000												
10	42°00.0'	144°40.4'	20.8.94	03:15	200												
11	42°00.0'	144°55.0'	20.8.94	04:50	100												
12	41°48.6'	144°32.5'	20.8.94	08:45	566												
13	41°47.1'	144°32.5'	20.8.94	09:40	300												
14	41°45.8'	144°33.7'	20.8.94	20:00	500												
15	41°33.1'	144°23.7'	21.8.94	01:30	483												
16	41°28.9'	144°23.2'	21.8.94	03:05	502												
17	41°24.4'	144°19.9'	21.8.94	05:55	509												
18	41°23.0'	144°19.3'	21.8.94	09:20	620												
19	41°33.3'	144°22.9'	21.8.94	12:20	558												
20	41°50.2'	144°31.7'	21.8.94	16:30	661												
21	41°50.0'	144°31.9'	21.8.94	19:05	609												
Leg 2																	
22	38°58.2'	146°34.7'	24.8.94	07:00	32-33	11		X								X	Sled test
23	38°57.4'	146°35.1'	24.8.94	09:01	24-27	11		X								X	Sled test
24	38°57.4'	146°35.4'	24.8.94	09:50	28									X		X	Aborted
25	38°57.7'	146°35.8'	24.8.94	10:15	28									X		X	
26	38°58.2'	146°34.2'	24.8.94	11:05	31-34	30	X									X	
27	39°00.7'	146°35.8'	24.8.94	12:35	45											X	
28	39°00.1'	146°36.6'	24.8.94	13:05	45					X						X	

Station no.	Lat. (°S.)	Long. (°E.)	Date	Time (h)	Depth (m)	Duration (min)	Sample type								Notes, fishing history			
							Comm'l trawl	Benthic sled	Bongo net	Drop net	MIDOC	Video transect	CTD profile	Engel trawl		RoxAnn	EK500	
29	39°00.2'	146°35.5'	24.8.94	13:30	48	20			X							X		
30	39°00.1'	146°35.8'	24.8.94	14:40	43-44	30	X									X	X	
31	39°00.1'	146°36.0'	24.8.94	16:40	40-44	18		X					X			X	X	
32	38°58.3'	146°33.8'	24.8.94	18:05	22-26	20		X					X			X	X	
33	38°56.6'	146°34.2'	24.8.94	20:20	28-30	20		X								X	X	Sediment sample only
34	37°51.9'	148°10.9'	25.8.94	06:20	30-31	20		X					X			X	X	
35	37°51.3'	148°13.6'	25.8.94	07:50	27											X	X	
36	37°51.5'	148°13.2'	25.8.94	08:50	28-29	30	X									X	X	
37	37°55.6'	148°14.7'	25.8.94	09:50	42											X	X	
38	37°55.5'	148°15.0'	25.8.94	10:15	42					X						X	X	
39	37°54.8'	148°17.3'	25.8.94	10:55	43	20			X							X	X	
40	37°55.4'	148°14.9'	25.8.94	12:05	41-42	30	X									X	X	
41	37°55.6'	148°15.1'	25.8.94	14:40	41-41	15		X				X				X	X	
42	38°32.0'	148°24.0'	25.8.94	22:00	160-200								X			X	X	Acoustic survey of Smithy's corner
43	38°43.8'	148°15.7'	26.8.94	06:05	84-85	20		X								X	X	
44	38°42.9'	148°17.7'	26.8.94	07:40	84								X			X	X	
45	38°42.4'	148°16.8'	26.8.94	08:25	86-87	30	X									X	X	
46	38°38.0'	148°20.1'	26.8.94	10:05	111											X	X	
47	38°39.1'	148°19.8'	26.8.94	11:20	104-112	30	X									X	X	
48	38°33.2'	148°17.4'	26.8.94	13:00	210											X	X	
49	38°33.1'	148°17.5'	26.8.94	13:30	205											X	X	
50	38°33.1'	148°24.0'	26.8.94	13:50	205	20			X							X	X	
51	38°32.8'	148°24.8'	26.8.94	15:35	200-220	30	X									X	X	
52	38°33.4'	148°24.7'	26.8.94	17:00	180-190	15		X					X			X	X	
53	38°38.1'	148°20.8'	26.8.94	19:00	118-119	18		X					X			X	X	
54	38°55.6'	148°27.7'	27.8.94	05:35	150-210	10		X					X			X	X	Came fast on retrieval; sled bogged
55	38°59.3'	148°31.7'	27.8.94	07:45	128											X	X	
56	38°59.6'	148°31.2'	27.8.94	08:55	123-125	30	X									X	X	
57	38°56.2'	148°19.9'	27.8.94	10:10	80											X	X	
58	38°55.9'	148°19.2'	27.8.94	11:20	78-83	30	X									X	X	
59	38°56.5'	148°19.3'	27.8.94	12:50	80-85	18									X	X	X	
60	38°59.1'	148°31.6'	27.8.94	15:00	125	20								X	X	X	X	

Station no.	Lat. (°S.)	Long. (°E.)	Date	Time (h)	Duration (min)	Depth (m)	Sample type								Notes, fishing history		
							Comm'l trawl	Benthic sled	Bongo net	Drop net	MIDOC	Video transect	CTD profile	Engel trawl		RoxAnn	EK500
61	38°57.1'	148°30.3'	27.8.94	16:10	20			X							X		
62	38°56.3'	148°29.9'	27.8.94	16:55	190				X						X		
63	38°56.4'	148°30.4'	27.8.94	17:15	200									X	X		
64	37°53.0'	149°05.4'	28.8.94	05:20	76-77						X				X		Acoustic survey of Everard Reef
65	37°53.6'	149°03.5'	28.8.94	07:40	75								X		X		
66	37°53.4'	143°03.9'	28.8.94	08:20	74-75										X		
67	37°49.3'	149°05.9'	28.8.94	09:30	42									X	X		
68	37°49.2'	149°05.6'	28.8.94	09:50	42				X						X		
69	37°49.2'	149°05.4'	28.8.94	10:10	42-46										X		
70	37°49.5'	149°04.2'	28.8.94	11:25	43-47			X							X		
71	37°48.3'	149°01.5'	28.8.94	12:00	28										X		
72	37°48.6'	149°01.1'	28.8.94	13:05	25-30			X							X		
73	37°48.8'	149°03.1'	28.8.94	14:45	27-30						X				X		
74	37°49.3'	149°06.0'	28.8.94	16:30	39-45						X				X		
75			28.8.94												X		Acoustic survey of western Big Horseshoe
76	38°01.9'	149°13.0'	29.8.94	05:30	119-120			X			X				X		
77	38°01.8'	149°05.2'	29.8.94	07:40	118							X			X		
78	38°01.8'	149°07.3'	29.8.94	09:00	118-120										X		
79	38°11.8'	149°16.3'	29.8.94	10:15	236									X	X		
80	38°11.6'	149°16.9'	29.8.94	10:55	247										X		
81	38°11.3'	149°17.7'	29.8.94	11:15	228-276										X		
82	38°11.6'	149°16.6'	29.8.94	14:00	220-220										X		
83	38°11.8'	149°16.0'	29.8.94	16:00	210-220						X				X		
84	38°14.9'	149°18.8'	29.8.94	19:20	390-420										X		
85	37°53.0'	150°01.0'	30.8.94	00:10	124-145										X		Acoustic survey of south Gabo Reef
86	37°39.6'	149°47.4'	30.8.94	05:32	76-85										X		
87	37°36.7'	149°54.8'	30.8.94	07:45	92										X		
88	37°36.7'	149°55.0'	30.8.94	08:20	90-93										X		
89	37°35.4'	149°50.9'	30.8.94	09:50	43										X		
90	37°35.2'	149°51.5'	30.8.94	10:10	44										X		
91	37°35.4'	149°51.4'	30.8.94	11:00	40			X							X		
92	37°35.3'	149°51.0'	30.8.94	11:55	36-38										X		

Station no.	Lat. (°S.)	Long. (°E.)	Date	Time (h)	Depth (m)	Duration (min)	Sample type								Notes, fishing history				
							Comm'l trawl	Benthic sled	Bongo net	Drop net	MIDOC	Video transect	CTD profile	Engel trawl		RoxAnn	EK500		
93	37°34.9'	149°48.2'	30.8.94	13:30	25														
94	37°35.1'	149°43.3'	30.8.94	13:55	24-30	26	X									X			
95	37°35.1'	149°48.5'	30.8.94	15:25	25-32	20		X					X						
96	37°35.9'	149°50.6'	30.8.94	16:30	38-43	20		X					X						
97	37°47.5'	150°04.0'	30.8.94	20:00	100-180	560													Acoustic survey of Gabo Reef
98	37°51.1'	149°50.7'	31.8.94	05:25	130-131	20		X					X						
99	37°48.5'	149°54.0'	31.8.94	07:45	129										X				
100	37°48.9'	149°53.3'	31.8.94	08:25	129-129	30	X												
101	37°54.4'	150°02.8'	31.8.94	10:35	225								X						
102	37°54.4'	150°03.1'	31.8.94	11:10	235				X										
103	37°54.7'	150°03.1'	31.8.94	11:25	0-239	20													
104	37°55.5'	150°02.2'	31.8.94	12:25	220-250	30	X												
105	37°55.3'	150°02.1'	31.8.94	14:30	210	20		X					X						
106	37°39.5'	150°08.5'	31.8.94	20:00	100-180	420									X				Acoustic survey of Gabo Reef
107	37°23.9'	150°17.9'	1.9.94	05:40	161-184	20		X						X					
108	37°27.5'	150°16.4'	1.9.94	07:50	245									X					
109	37°28.1'	150°16.6'	1.9.94	08:45	281				X										
110	37°27.8'	150°16.5'	1.9.94	09:10	0-260	10				X									
111	37°25.9'	150°16.4'	1.9.94	09:50	161-167	30	X												
112	37°18.3'	150°12.0'	1.9.94	11:30	115									X					
113	37°18.9'	150°11.5'	1.9.94	12:00	115-120	30	X												
114	37°17.5'	150°03.6'	1.9.94	13:40	64									X					
115	37°16.7'	150°04.6'	1.9.94	14:35	78-79	30	X												
116	37°19.4'	150°11.3'	1.9.94	17:15	107-110	20									X				
117	37°31.0'	150°11.6'	1.9.94	19:10	100-180	590													Acoustic survey of Gabo Reef
118	37°18.2'	150°12.3'	2.9.94	05:55	108-119	15		X					X						Aborted: wrong station
119	37°18.6'	150°03.9'	2.9.94	07:00	81-82	20		X					X						
120	37°17.5'	150°02.0'	2.9.94	07:50	44														
121	37°17.7'	150°01.9'	2.9.94	08:15	44				X										
122	37°18.2'	150°01.5'	2.9.94	08:35	0-47	20													
123	37°18.7'	150°00.8'	2.9.94	09:05	42-44	20		X						X					
124	37°18.3'	150°01.3'	2.9.94	10:15	44-47	30	X												

Station no.	Lat. (°S.)	Long. (°E.)	Date	Time (h)	Depth (m)	Duration (min)	Sample type								Notes, fishing history			
							Comm'l trawl	Benthic sled	Bongo net	Drop net	MIDOC	Video transect	CTD profile	Engel trawl		RoxAnn	EK500	
125	37°16.5'	149°59.4'	2.9.94	11:30	24											X		
126	37°17.1'	149°59.4'	2.9.94	11:50	26-33	30	X									X	X	
127	37°18.9'	149°59.6'	2.9.94	14:00	24-30	18		X						X		X	X	
128	37°05.0'	149°57.0'	3.9.94	00:30	40	270										X	X	Acoustic transect north of Eden
129	37°00.1'	150°02.9'	3.9.94	05:40	75-75	20		X								X	X	
130	36°55.0'	149°58.0'	3.9.94	07:50	45				X							X	X	
131	36°55.4'	149°58.2'	3.9.94	08:25	45											X	X	
132	36°55.5'	149°58.4'	3.9.94	08:35	0-45	20			X							X	X	
133	36°54.7'	149°57.8'	3.9.94	09:10	41-42	30	X									X	X	
134	36°55.8'	149°58.1'	3.9.94	11:10	43-44	20		X								X	X	
135	36°57.4'	149°02.6'	3.9.94	13:00	68-68	30	X									X	X	
136	36°59.3'	150°02.3'	3.9.94	14:00	68											X	X	
137	36°56.5'	150°12.8'	3.9.94	15:40	120											X	X	
138	36°57.6'	150°12.9'	3.9.94	16:30	120-120	20	X									X	X	Pinned up; net not repairable on board
139	37°19.7'	150°16.0'	3.9.94	20:00	100-200	550										X	X	Acoustic survey of Green Cape Reef
140	36°56.0'	150°12.2'	4.9.94	05:20	115-117	20		X								X	X	
141	36°54.8'	150°17.9'	4.9.94	07:55	152											X	X	
142	36°55.1'	150°18.1'	4.9.94	08:20	151											X	X	
143	36°55.6'	150°18.2'	4.9.94	08:45	0-152	20			X							X	X	
144	36°56.7'	150°18.2'	4.9.94	09:15	150-152	20										X	X	
145	36°52.5'	150°18.1'	4.9.94	10:50	149-152	30	X									X	X	
146	37°22.0'	150°02.4'	4.9.94	16:25	76-76	40	X									X	X	Target shot for juvenile redfish
147	37°19.0'	150°03.2'	4.9.94	21:21	100-180	146										X	X	Acoustic survey of Green Cape Reef
148	36°25.2'	150°18.5'	5.9.94	05:25	220-220	20		X								X	X	
149	36°31.1'	150°17.9'	5.9.94	07:50	201											X	X	
150	36°31.6'	150°17.6'	5.9.94	08:25	179				X							X	X	
151	36°31.4'	150°18.0'	5.9.94	08:45	0-237	20										X	X	
152	36°30.4'	150°18.5'	5.9.94	09:25	247-250	20	X									X	X	
153	36°26.3'	150°13.8'	5.9.94	11:10	122											X	X	
154	36°27.7'	150°13.1'	5.9.94	11:45	123-123	30	X									X	X	
155	36°26.0'	150°14.1'	5.9.94	13:30	119-122	20										X	X	
156	36°23.3'	150°10.6'	5.9.94	14:40	76-79	17										X	X	

Station no.	Lat. (°S.)	Long. (°E.)	Date	Time (h)	Depth (m)	Duration (min)	Sample type							Notes, fishing history			
							Comm'l trawl	Benthic sled	Bongo net	Drop net	MIDOC	Video transect	CTD profile		Engel trawl	RoxAnn	EK500
157	36°15.2'	150°21.5'	5.9.94	21:38	150-300	422										X	Acoustic transect; shelf edge off Bernagui
158	36°23.0'	150°07.7'	6.9.94	05:30	42-43	20		X			X					X	
159	36°24.5'	150°10.6'	6.9.94	07:35	84							X				X	
160	36°24.0'	150°10.5'	6.9.94	08:10	81-85	30	X									X	
161	36°23.3'	150°07.7'	6.9.94	09:50	46							X				X	
162	36°23.4'	150°07.9'	6.9.94	10:15	47				X							X	
163	36°23.4'	150°08.0'	6.9.94	10:30	49	20		X								X	
164	36°21.6'	150°08.6'	6.9.94	11:00	41	30	X									X	
165	36°23.1'	150°06.0'	6.9.94	12:40	26							X				X	
166	36°21.2'	150°07.3'	6.9.94	13:30	25-26	30	X									X	
167	36°22.0'	150°06.7'	6.9.94	14:50	26-26	20		X			X					X	Start of cross shelf sled transect
168	36°21.8'	150°07.0'	6.9.94	18:35	26-28	20		X			X					X	
169	36°22.5'	150°06.5'	7.9.94	05:25	32-46	20		X			X					X	
170	36°22.5'	150°08.5'	7.9.94	06:25	48-83	30		X			X					X	
171	36°22.5'	150°11.4'	8.9.94	05:00	84-123	30		X			X					X	
172	36°22.6'	150°14.9'	8.9.94	06:30	123-277	50		X			X					X	End of cross shelf sled transect
Leg 3																	
173	37°21.1'	150°24.4'	13.9.94	18:00	800							X				X	Niskin bottle check
174	37°47.1'	150°03.6'	13.9.94	23:20	142	60					X					X	Test deployment off reef outer edge
175	37°47.1'	150°01.0'	14.9.94	02:32	132	115					X					X	Outside reef outer edge (night)
176	37°48.6'	150°00.9'	14.9.94	07:45	123	115					X					X	Outside reef outer edge (day)
177	37°48.3'	149°59.1'	14.9.94	11:35	113	115					X					X	Over outer reef edge (day)
178	37°40.0'	149°56.8'	14.9.94	14:35	108							X				X	Start CTD grid over study area; position 1
179	37°43.5'	149°54.6'	14.9.94	15:40	117							X				X	position 4
180	37°47.0'	149°52.0'	14.9.94	16:50	131							X				X	position 7
181	37°47.0'	149°57.9'	14.9.94	18:05	123							X				X	position 8
182	37°43.7'	150°00.1'	14.9.94	19:05	108							X				X	position 5
183	37°39.8'	150°02.6'	14.9.94	12:05	118							X				X	position 2
184	37°40.0'	150°08.0'	14.9.94	21:15	136							X				X	position 3

Station no.	Lat. (°S.)	Long. (°E.)	Date	Time (h)	Depth (m)	Duration (min)	Sample type							Notes, fishing history		
							Comm'l trawl	Benthic sled	Bongo net	Drop net	MIDOC	Video transect	CTD profile		Engel trawl	RoxAnn
185	37°43.8'	150°05.8'	14.9.94	22:15	130							X		X	position 6	
186	37°47.1'	150°02.9'	14.9.94	23:20	134							X		X	End CTD grid over study area; position 9	
187	37°48.5'	149°59.3'	15.9.94	00:36	115	115								X	Over outer reef edge (night)	
188	37°48.7'	149°52.1'	15.9.94	10:35	133	115								X	Over middle of reef (day)	
189	37°43.8'	150°05.5'	15.9.94	14:25	136							X		X	Daily sample position 6	
190	37°45.8'	150°03.4'	15.9.94	15:45	136-139	30	X							X	Outside reef outer edge (day)	
191	37°45.6'	150°03.3'	15.9.94	18:45	138-140	30	X							X	Outside reef outer edge (night)	
192	37°42.9'	150°04.6'	15.9.94	20:45	138-139	20		X						X	Outside reef outer edge (night)	
193	37°43.8'	150°05.5'	15.9.94	21:45	142							X		X	Daily sample position 6	
194	37°44.4'	150°04.2'	16.9.94	00:15	136-136	20		X						X	Outside reef outer edge	
195	37°42.6'	149°56.8'	16.9.94	03:45	101-101	20		X						X	Inside reef inner edge; no photographs	
196	37°44.8'	149°55.0'	16.9.94	04:30	0-107	20			X					X	Inside reef inner edge (night)	
197	37°43.5'	149°55.1'	16.9.94	08:20	108-116	30	X							X	Inside reef inner edge (day)	
198	37°43.3'	149°55.2'	17.9.94	02:30	107-116	30	X							X		
199	37°44.0'	149°58.0'	17.9.94	06:15	108-115	25		X						X	Sled badly damaged; no sediment sample	
200	37°42.9'	149°59.0'	17.9.94	10:25	108	20			X					X		
201	37°46.2'	149°56.1'	17.9.94	15:40	108	90					X			X	SW part of reef heading N	
202	37°46.5'	149°56.2'	17.9.94	18:50	123						X			X	Due south of previous deployment	
203	37°46.0'	149°57.1'	17.9.94	20:45	122							X		X	Close to grid position 7	
204	37°45.8'	150°00.8'	17.9.94	22:50	116-130						X			X	St- study area, drifting St., close to reef edge	
205	37°45.5'	150°00.5'	17.9.94	23:30	116						X			X	Across reef edge and onto trawl ground (no station 206)	
207	37°46.3'	149°56.5'	18.9.94	02:07	49-104	115								X		
208	37°45.4'	149°57.3'	18.9.94	7:15	114-117						X			X		
209	37°45.3'	149°53.4'	18.9.94	08:30	109-116						X			X		
210	37°45.1'	149°57.1'	18.9.94	11:11	43-97	115								X	Shock cords not loaded	
211	37°43.0'	150°00.9'	18.9.94	15:00	116							X		X	Grid position 5	
212	37°47.4'	150°04.3'	18.9.94	19:21	27-90	115								X		
213	42°42.6'	148°24.7'	21.9.94	06:50	451-509	55								X	Maria Island shot #1	
214	42°43.3'	148°24.6'	21.9.94	10:45	490-535	45								X	Maria Island shot #2	

Station no.	Lat. (°S.)	Long. (°E.)	Date	Time (h)	Depth (m)	Duration (min)	Sample type								Notes, fishing history		
							Comm'l trawl	Benthic sled	Bongo net	Drop net	MIDOC	Video transect	CTD profile	Engel trawl		RoxAnn	EK500
215	42°41.7'	148°25.4'	21.9.94	13:05	462						X			X	X		
216	42°41.5'	148°25.5'	21.9.94	15:50	460-475	35							X	X	X		Maria Island shot #3
217	42°41.8'	148°25.1'	21.9.94	19:25	425-450	30							X	X	X		Maria Island shot #4
218	42°41.6'	148°25.9'	21.9.94	23:20	490-580	30							X	X	X		Maria Island shot #5
219	42°42.9'	148°24.7'	22.9.94	02:30	492-573	45								X	X		Maria Island shot #6