CSIRO

DIVISION OF FISHERIES

CRUISE REPORT

SS3/92

HOBART TO HOBART
15 JULY – 13 AUGUST 1992

FRV
SOUTHERN SURVEYOR

CSIRO
AUSTRALIA

Itinerary

Departed Hobart: 0830 h Wednesday, 15 July 1992
Arrived Hobart: 1700 h Friday, 24 July 1992
Departed Hobart: 0830 h Saturday, 25 July 1992
Arrived Hobart: 0500 h Thursday, 13 August 1992

Cruise Objectives

Leg 1

Leg 1 of the cruise made the third in a series of annual acoustic surveys of the biomass of orange roughy *(Hoplostethus atlanticus)* on their major spawning ground off northeastern Tasmania. In addition to making echo-integration surveys of orange roughy, the survey focussed on assessing the target strength (TS) of orange roughy and the proportion of orange roughy in the acoustic plumes around the spawning hill. Ancillary information was also obtained to assess the biomass of orange roughy based upon an egg survey, which was carried out from a chartered fishing vessel. This is the final year of two FIRDC grants in support of these projects. The specific objectives were:

1 To conduct two echo-integration acoustic surveys of the orange roughy on their spawning ground off northeastern Tasmania (St Helens area) with repeated transects to quantify sampling variance.

2 To obtain *in situ* target strength (TS) measurements of orange roughy on these grounds.

3 To assess the proportion of orange roughy and other fishes in acoustic marks on the spawning ground from TS measurements.

4 To calibrate the hull-mounted and towed transducers at the surface and to calibrate the towed transducer at depth.

5 To sample acoustic marks with the Engels demersal trawl to assess the size and species composition of fish in the area, and to sample fish that can be captured in the water column with the pelagic trawl.

6 To incubate orange roughy eggs at three temperatures at sea-level pressure and at one temperature at mid-water pressure to determine the rate of development.

7 To establish the dead zone height and density of fish within the dead zone by comparing hull-mounted and towed transducer returns.

8 To examine the feasibility of tagging orange roughy with the Deepwater Automated Fish Tagging device.

9 To obtain flesh and liver samples of orange roughy at reproductive Stage IV to examine the relationship of body condition to fecundity.

10 To determine the buoyancy of orange roughy eggs through use of a graded density series of Ficoll solutions (C. Crossley, Sydney University).

11 To determine the vertical distribution of orange roughy eggs from 0–900 m through use of the EZ opening–closing plankton net.

12 To obtain water column profiles of temperature and salinity with the CTD to determine sound velocity and absorption profiles.

Leg 2

Leg 2 of the cruise made an initial acoustic survey of the blue grenadier (*Macruronus novaezelandiae)* stock that spawns during June–August off western Tasmania. This survey was conducted in conjunction with two chartered fishing vessels, which fished on acoustic marks to determine their size- and species-composition. The trawling results were compared with those from the split-beam echo sounder. Egg sampling carried out from the commercial vessels will be used to assess the feasibility of using egg surveys to estimate blue grenadier stock biomass. Plankton samples collected this year will be used by Ms C Chong (University of Tasmania) to examine the growth of blue grenadier larvae in relation to food availability and competitors. It is anticipated that the acoustic survey will need to be repeated in 1993 and 1994 to obtain a reliable biomass estimate. The specific objectives were:

1 To carry out an echo -acoustic survey of blue grenadier off the west coast of Tasmania between the shelf break and 700 m, replicating transects day and night to assess diurnal variability.

2 To obtain day/night *in situ* TS measurements of blue grenadier.

3 To assess the proportion of blue grenadier in acoustic marks off western Tasmania as a function of depth between the shelf break and 700 m using *in situ* TS sampling.

4 To direct the sampling of two chartered commercial fishing vessels to assess the size and species composition and swim bladder-type of fish in acoustic targets both on the bottom and in midwater.

5 To incubate blue grenadier eggs at three temperatures to determine their rate of development.

6 To collect ichthyoplankton and microzooplankton samples from the chartered commercial vessel offshore, at the shelf break, and on the shelf on 5–10 transects to assess the distribution of blue grenadier eggs and larvae, and to obtain samples of blue grenadier larvae and microzooplankton to examine the feeding and growth of the larvae in relation to larval density and food availability (C. Chong, University of Tasmania) .

7 To collect samples of orange roughy and other major species for heavy-metal analysis on an opportunistic basis.

8 To obtain water column profiles of temperature and salinity with the CTD to determine sound velocity and absorption profiles.

9 To determine the vertical distribution of blue grenadier eggs from 0–600 m above bottom with the EZ opening/closing plankton net.

10 Over a 48-hour period, to determine the day/night vertical distribution of midwater fishes off Pedra Branca, southern Tasmania, using replicated, midwater tows with the midwater opening/closing (MIDOC) net.

Area of Operation

The acoustic survey of the orange roughy spawning ground (Leg 1) covered an area of approximately 5 nm^2 known as St Helens Hill on the east coast of Tasmania with centre position 41°13.9'S, 148°45.5'E (Fig. 1). The acoustic survey of the blue grenadier (Leg 2) was carried out off the west coast of Tasmania at depths of 200–700 m from Low Rocky Point (Lat. 43° 00') to southwest of King Island (Lat. 40° 20') (Fig. 1).

Results

Overall, the cruise was highly successful. The objectives of both legs were generally substantially achieved.

Leg 1

1 Two echo-integration acoustic surveys of the orange roughy were completed on their spawning ground off northeastern Tasmania (St Helens area). A central transect was surveyed three times on both surveys to quantify sampling variance.

2 Target strength (TS) measurements were obtained on several drifts and tows over orange roughy aggregations. Considerable avoidance was apparent, so fewer data on orange roughy were obtained than expected. However, the data appear sufficient from this cruise and others, as well as from alternative methods of assessment, to define the TS of orange roughy.

3 Due to avoidance of the towed body, TS measurements alone will not be sufficient to assess the proportion of orange roughy and other fishes in acoustic marks on the spawning ground. However, as an alternative, the proportion of orange roughy may be estimated from the difference in biomass along a transect as measured by the hull-mounted transducer prior to passage of the towed body over the mark, and by the towed body itself.

4 The towed transducer was calibrated at the surface in Hobart before the survey, and calibrated at depth on the orange roughy survey site. The hull-mounted transducers were calibrated at Port Arthur at the surface before the survey. The pole-mounted transducer was calibrated at the end of the survey in Great Taylor Bay, Bruny Island.

5 To assess the size and species composition of fish in the area, eight demersal tows were carried out with the Engels trawl. Three were successful, while five were aborted due to hook-ups, torn gear, and unsuitable ground. Eight shots were made with the midwater opening–closing (MIDOC) net to sample the fish that can be captured in the water column; all were successful.

6 Orange roughy eggs were successfully fertilised and incubated to the yolk-sac larval stage at 7°C (C. Bulman, CSIRO). One yolk-sac larva survived 12 d post-hatch. Eggs incubated at 9° did not survive. Experiments at 5° and with a pressurised system were terminated due to equipment malfunction. The eggs required 13 d to hatch at 7°C. Orange roughy eggs have not previously been successfully incubated, and only a single *H. atlanticus* larva has been positively identified from the wild.

7 Measurements were taken over the same tracks with the hull-mounted and towed transducer systems to establish the dead zone height and density of fish within the dead zones.

8 Due to severe damage to the trawl outfitted for the Deepwater Automated Fish Tagging device, trials of this system were not carried out.

9 Nine samples were obtained of flesh, liver, gonads, and otoliths from 36 cm orange roughy at reproductive Stage IV to examine the relationship of body condition to fecundity.

10 Experiments to determine the buoyancy of orange roughy eggs through a graded density series of Ficoll solutions were carried out (C. Crossley, University of Sydney).

11 Two successful tows were carried out with the EZ opening–closing plankton net within a radius of the spawning hill of ~5 nm to determine the vertical distribution of orange roughy eggs from 0–900 m. Several hundred eggs were observed in some of the samples. These results will be combined with those from Objective 10 to assess the vertical distribution (and hence the incubation temperature) of orange roughy eggs as they develop.

12 A water-column profile of temperature and salinity was obtained with the CTD in the vicinity of the spawning area. This information will be used as part of the egg survey to estimate *in situ* incubation temperature and development rate, and to determine the sound velocity and absorption profile for the acoustic signals.

Leg 2

1 A two-phase echo integration acoustic survey of blue grenadier was completed off the west coast of Tasmania between Low Rocky Point (Lat. 43° 00') to southwest of King Island (Lat. 40° 20'). During the first phase, transects were made every 5 nm throughout the survey area between the shelf break and 700 m (33 transects in all). During the second, phase, areas were re-surveyed at a finer scale where significant grenadier concentrations had been found during the first phase, and areas that were identified by the fishermen as particularly productive fishing areas. Transects were replicated day and night to assess diurnal variability. Two of the largest grenadier concentrations were surveyed over a 24-hour period to assess diurnal variability in grenadier distributions and our estimates of their biomass.

2 *In situ* TS measurements were made of blue grenadier in most areas where they were found in significant quantity. Blue grenadier did not appear to avoid

the towed body, and their TS appeared considerably higher than that of other abundant species in the area.

3 Transects were made in most areas of grenadier concentration to measure the TS distribution of fishes there. These data will be used, together with the trawl data, to assess the proportion of blue grenadier in the echo-integration survey.

4 The fishing operations of two chartered commercial fishing vessels, the *Petuna Endeavour* and *Petuna Explorer* were directed to assess the size and species composition of fish in acoustic targets both on the bottom and in midwater.

5 Blue grenadier eggs were successfully fertilised and incubated at ~11.5° to determine development rate through to yolk-sac larvae.

6 Ichthyoplankton and microzooplankton samples were collected by the chartered commercial vessels at three sites (offshore, at the shelf break, and on the shelf) on 11 onshore-offshore transects. These samples will provide preliminary data on the distribution of blue grenadier eggs and larvae to aid in planning a possible future egg survey of the blue grenadier. C. Chong (University of Tasmania) will use samples of blue grenadier larvae and microzooplankton to examine the feeding and growth of the larvae in relation to larval density and food availability.

7 No orange roughy were obtained in the trawls, so no samples were obtained for heavy-metal analysis.

8 Water-column profiles of temperature and salinity were obtained with the CTD at three sites in the northern, central and southern sectors of the survey area. These data will be used, as above, to determine sound velocity and absorption profiles for the acoustic system, and to provide data on the physical environment of the blue grenadier adults, eggs and larvae.

9 Two tows were carried out offshore of a grenadier aggregation with the EZ opening–closing plankton net to determine the vertical distribution of blue grenadier eggs from 0 to 600 m depth.

Cruise Narrative

Leg 1

Southern Surveyor sailed from Hobart on schedule at 0830 h on 15 July. At mid-day, the vessel anchored at Port Arthur in 30 m depth and calibrated the hull-mounted and transducer with the standard copper sphere, and the towed-body transducer with a tungsten-carbide sphere. This was completed at 2300 h, and the vessel steamed to the spawning ground of the orange roughy off St Helens, Tasmania.

The following morning (16 July), en route, two of four transects were carried out off St Patrick's Head, where R. Harden Jones had requested a re-survey of knob-like features. The towed body was deployed, but the EK500 continually 'locked up'. While the faulty EPROM software was being attended to, the demersal trawl was deployed. However, it hung up on touching bottom and was extensively damaged (a broken headline and a torn wing). Only 4 orange roughy were caught. After the net was replaced in the early hours of 17 July, 2 more demersal tows were carried out but with little success (6 roughy and 2 squid in one tow). However, 2 of the roughy in the tow were in spawning condition and were stripped for the incubation experiment. In the evening, with weather conditions holding, a full acoustic survey was carried out with the hull-mounted transducer.

The following day (18 July), water was found to have leaked up into the towed-body cable, so ~15 m of the cable was cut off and it was re-terminated. Demersal tows continued to yield only a few roughy. At mid-day, the towed body was put back in the water to carry out TS measurements, which were conducted along the S and S- central portions of the hill. The first run was carried out by towing the body at ~2 kt and then drifting (wind from the NW generally). Several passes were carried out before midnight.

On 19 July, 3 midwater trawls were carried out between midnight and early afternoon. There was little catch in the first trawl, but fairly typical catches in the next two: *Photichthys* in the upper layers and several species of *Lampanyctus* in the deeper trawls.

In the afternoon, we began a survey with the towed body over the hill, which was completed by early morning (20 July). We then re-surveyed the central transect with the towed body closer to the bottom to examine both the TS distribution and the residual biomass after the roughy dispersed to avoid the towed body. Four passes over the central transect were carried out in this way, and good TS results were achieved. A good mode of roughy-sized targets were seen south of the hill in ~1000 m depth. In the subsequent trawl, the catch consisted almost entirely of roughy and

Coryphaenoides subserrulatus, which was consistent with the TS distribution. A pelagic trawl carried out 100 m above bottom came up with a good catch of *C. subserrulatus* and *Halargyreus johnsonii*, again consistent with TS measurements. In night trawls, there were, interestingly, few myctophids at depth, but abundant myctophids in the net used to ascend and descend, indicating they were migrating vertically into the near-surface layers. Comparison of acoustic plumes recorded from the hull-mounted transducer with that observed subsequently with the towed-body indicated that the roughy descended to the bottom as the towed body passed through, leaving behind a thin cloud of small scatterers.

Conditions were calm on the morning of 21 July and provided an opportunity to calibrate the towed-body transducer, both descending and ascending, as a function of depth to 1000 m. The calibration was carried out with the towed body . A possible slight termperature-related hysteresis effect was indicated. Two opening–closing EZ net tows were completed from 900 m to the surface at 100 m depth intervals to examine the depth distribution of orange roughy eggs. The tows were carried out along a semi-circular path around the spawning hill, radius ~5 nm. This tow path proved far more effective than the conventional straight path used the previous year, and a number of eggs were obtained.

In the early hours of the morning of 22 July, work resumed on defining the composition of acoustic marks in the area. Two passes were made with the towed body over the east side of the hill, followed by a MIDOC net tow targetting layers at 850 and 900 m. This seemed to miss the mark at 850 m and may have fished at 900 m at the tail end of the layer. However a second MIDOC tow through an extensive layer at 850 m passed directly over the hill and through this layer. The catch was predominantly composed of the morid cod *Halargyreus johnsonii*, and the macrourid *Coryphaenoides subserrulatus*, together with the myctophids, *Lampanyctus* spp. A demersal trawl was planned to determine whether there were any orange roughy at all in this area (the midwater layer seemed to intersect directly with the hill without evidence of a further body of other fish). However, as sea conditions had worsened (Force 6/7; 30 kt wind), and it was decided to make towed-body transects instead. When the towed body was lowered through the water column, the signal was found to be excessively noisy, indicating the presence of salt water in the underwater connections.

Work on the cable continued through the night and morning of 23 July. The termination was re-done with a special chemical bonding kit designed to exclude water. Conditions were poor—Force 8—so we decided to return to Hobart early. However, an hour after turning back, we received a report from the *Dell Richey* (under CSIRO charter to carry out the orange roughy egg survey in the area) that conditions had improved markedly. After completing two transects in the area of coral-covered 'knobs', we returned to the spawning hill and trawled demersally in the NE sector on a mark at 800–900 m. The catch was reasonable: ~300 kg roughy and small quantities of other species, including *Halargyreus johnsonii* and several species of sharks.

After completing the trawl, we headed back to Hobart, where we docked at 1200 h on 24 July. Due to bad weather, we postponed our departure the following day (25 July) to 1700 h.

Leg 2

Conditions were poor when the vessel left Hobart, so we headed for Recherche Bay, planning to head out to Main Maatsuyker hill the following morning, where a large aggregation of orange roughy in spawning condition had been reported. The following day (26 July), conditions remained poor, and since the towed body did not function properly when tested, we returned to Recherche Bay to make repairs while the weather was poor. On 27 July, a storm was forecast for the afternoon, but we headed out in the morning to examine conditions at first hand and to test the towed body. The towed body was noisy when used next to the ship. With continuing poor weather, acoustic tests were concluded inshore, and the vessel then anchored in Great Taylors Bay on the south end of Bruny Island. The repairs continued through the day, with little success. On 28 July, an underwater connector sent from Hobart was picked up at Recherche Bay, and the vessel then steamed to Maatsuyker.

The acoustic survey of Maatsuyker began late on 28 July and continued into the morning of the next day. The towed body continued to exhibit excessive noise. Initially, neither the pole-mounted nor the hull-mounted transducers performed well enough to be of use for a quantitative survey, a problem that was traced to water in an interconnecting cable 'loom'. Acoustic marks on Main Maatsuyker hill were sparse and according to John Peterson, skipper of *Petuna Explorer*, unlike those observed during the previous week. We surveyed this hill thoroughly and then made two transects each (N–S and E–W) over NW Maat, Fang Tooth and Monitor (other hills nearby). Small marks were noted on all but nothing significant was seen. Two shots made by *Petuna Explorer*. Catches indicated recent spawning but the fish were mostly spent. Many had full stomachs, perhaps indicating a resumption of feeding.

The vessel proceeded to the west coast to begin the blue grenadier survey. The vessel zig-zagged between 400–700 m looking for potential grenadier marks, but little of interest was noted. The survey proper began on lat 43°00′ S. Approximately five transects were carried out through the night of 30 July. The echo-integration survey was carried out with the pole-mounted transducer, almost 4 m beneath the vessel (and 9 m beneath the sea surface), which now provided a good signal. By surveying with the pole-mounted transducer and taking only TS measurements with the towed body, a greater area could be covered. The grenadier marks were becoming more numerous and more pronounced further to the north. The marks were mostly in the water column or on untrawlable ground, so *Petuna Explorer* switched to pelagic gear. *Petuna Explorer* reported that Ms Chong was extremely seasick.

Transects were carried out with the pole-mounted transducer and TS measurements were made with the towed body. However, the wind came up through the day, and *Petuna Explorer* had difficulty with their pelagic net. It was not ready to fish until 1800 h, by which time conditions were unworkable. *Petuna Explorer* proceeded to Strahan to put Ms Chong ashore.

Acoustic transects continued with the pole-mounted transducer throughout 31 July. Both chartered fishing boats came out in the morning and worked north and south of latitude 42°00', during which time *Southern Surveyor* reached the northern portion of the survey area. In the early hours of 1 August, the fishing boats steamed north, but additional acoustic and TS transects continued to indicate little evidence of blue grenadier. Through the day, *Petuna Explorer* fished various midwater layers without significant catches. By midnight, all but the last two northern transects had been completed. There was no evidence of fish in the northern area, so the fishing boats were instructed to head south to find better ground, while *Southern Surveyor* completed the last northern transects during the night.

By the morning of 2 August, the northern transects and a CTD profile of the water column had been completed. The Petuna boats had located grenadier off Sandy Cape. *Southern Surveyor* steamed south searching for fish and logging the EK500 output between 350 and 650 m. Nothing of significance was found until the vessel arrived at the ground off Sandy Cape in the evening. The main body of fish formed large, intense marks in a canyon-like feature, in which *Petuna Endeavour* was working; *Petuna Explorer* was fishing on ground around the feature. *Petuna Endeavour* had fished the marks at 1900 h and caught 2.5 t of grenadier. *Petuna Explorer* had fished the area outside in a long 2 h tow and caught a similar quantity, of which 75% was grenadier. Initial acoustic transects were followed by towed-body back transects to measure the TS distribution, which was obtained without difficulty.

The area was surveyed over 24 h to examine changes in fish distribution and our estimates of biomass. In the day, the marks dissipated. The larger area was surveyed several times and several tows were carried out. Marks were present but none of the size and intensity of those initially observed at the head of the canyon. At the end of the 24-hour period (3 August), the schools within the canyon did not reappear.

Southern Surveyor proceeded south to an area 15–20 nm off the Pieman River where *Petuna Explorer* had reported even larger marks and an 8 t catch. When we reached the area near midnight, very large intense marks were observed in an area that was surveyed through the rest of the night; two TS transects were also undertaken with considerable success. Although the marks were quite intense, the fish did not appear to be very densely aggregated, which facilitated our measurements of the TS of individual fish. In the morning (4 August), as in the previous area, the marks came to the bottom and largely dissipated. We carried out transects through a larger area (10 nm N–S and 7 nm E–W). The survey was completed by the end of the day and repeated at night until 0030 h. At this time the ship's engine was stopped due to seawater leaking in from the cooling system. *Petuna Endeavour* had fished through the day with the midwater trawl (the bottom was too rough to be trawled successfully). Results were variable, ranging from 150 kg to several tonnes per trawl, but grenadier predominated in the trawls.

The ship remained without power throughout 5 August while the leak was patched. On the morning of 6 August, the cruise resumed. We carried out a fine-scale survey, based on zig-zag transects with ~1 nm spacing, over an area from 42°05' to 42°15'. No large marks were seen, but grenadier marks were seen reasonably consistently at ~450–520 m depth. The echo-integration transects were followed by several transects with the towed body to measure the TS distribution of marks in the area. This indicated a mixed species composition, with many targets in a range corresponding to small fishes (e.g. myctophids) (-45 to -50 dB) and others in the range of -30 to -40 dB. At the appropriate depth we consistently crossed blue grenadier patches, which stood out clearly in the TS range of ~-30.

The EZ net was deployed to examine the vertical distribution of blue grenadier eggs in the vicinity of the major grenadier aggregation off Pieman River. Replicate EZ net tows were carried out at 750 m depth.

The ship then steamed north to an area between 41°27' and 41°35' S, where sizeable concentrations of grenadier were known to occur. The marks in the area were similar to those of the previous night, which indicated a variety of fish species, with relatively small grenadier marks within a narrow depth range (~450–500 m). *Petuna Explorer* trawled 8 t comprised almost exclusively of adult grenadier. In the evening, we headed back south after transferring A. Williams from *Petuna Explorer* to *Southern Surveyor* in a sheltered area south of the Pieman River. *Petuna Explorer* returned to Strahan the next day, leaving *Petuna Endeavour* to complete the remaining plankton stations for the remaining period of its charter.

On 8 August a series of zig-zag transects were carried out to the south. Fish marks were seen at latitudes 42° 15' and 42° 30', but further south, where the slope became steeper (with little ground from 300–600 m), no further marks were seen. We entered Port Davey to examine its potential as a shelter and an area to calibrate the acoustics. Although there was a deep channel in sheltered water, it was exceedingly narrow and unsuitable for an extended anchorage. Leaving Port Davey, we examined a canyon due south at 43° 30' but no acoustic marks were evident.

Southern Surveyor reached the trophodynamics study area off Pedra Branca early on 9 August, where a 48-hour series of stratified midwater tows with the MIDOC system was planned. Gear problems and worsening sea conditions led to several aborted tows. On the final attempt, the net tore badly, and MIDOC sampling was terminated. Conditions soon deteriorated to Force 8, and the ship was directed to the inside of Bruny Island for two days of maintenance and testing of the towed-body acoustics and to calibrate the transducers. The pole-mounted transducer was calibrated by mid-afternoon of 10 August. The ship picked up a spectrum analyser in Recherche Bay that had been brought down from the CSIRO Marine Laboratories in Hobart. On 11 August the towed body was calibrated and measurements taken of the towed body transducer output in shallow water. At midday, the vessel put out to sea but conditions were too rough to deploy and retrieve the towed body, so the vessel returned to its Bruny Island anchorage.

At midnight, however, winds off Maatsuyker were reported to have dropped to 25 kt, so the vessel proceeded to deeper water. The audio output from the towed body indicated that the noise problems were probably induced by strumming of the towed body cable and vibrations in the towed body; in shallow water, noise was picked up from the vessel. The EK500 receiver does not filter high-level noise outside its frequency band of interest. On retrieving the towed body, the cable was found to be severely abraded, as if from a wire, and the cover over the electronics was dented. A re-examination of the track of the vessel suggested that the body had caught on the CSIRO current meter and sediment trap mooring that had been deployed on SS1/92. The mooring may have been towed due west, but its disposition is not known. The MIDOC net was deployed at mid-day, but the net was badly torn upon retrieval. and the vessel was directed to Hobart. The vessel arrived in Hobart at 0500 h.

Summary

The scientific achievements of the cruise fell generally into the following three areas: acoustic biomass assessments of orange roughy and blue grenadier, and development of the egg survey method for the orange roughy.

This was the third year that orange roughy have been successfully surveyed on the spawning ground off St Helens, Tasmania. However, this was the first time that species diversity in the spawning area, particularly within the water column, was examined. Acoustic plumes that can extend >100 m above bottom account for most of the presumed orange roughy biomass, but it is now clear from TS measurements and sampling with opening–closing nets that there are reasonable quantities of other fish species in the area. Data from this cruise can be used to begin assessing the proportion of the different species in the plumes.

One of the main uncertainties in carrying out the egg survey of the orange roughy over the past several years has been the development rate of the eggs. Incubation of orange roughy eggs on this cruise fills an important gap in our use of this method.

This initial attempt to survey blue grenadier acoustically in Australian waters provided sufficient data to generate a first-order biomass estimate, and in addition it provided several interesting insights. First, blue grenadier TS can be readily defined *in situ*; and due to the high and characteristic TS, the proportion of these fish in an area can be ascertained acoustically. However, blue grenadier are highly dynamic. The configuration and depth range of schools were observed to change rapidly, and the movements of fish into and out of the spawning area are not known. The effects of short-term behavioural variability on biomass estimation can begin to be examined with data from this cruise. To obtain an absolute biomass estimate of blue grenadier acoustically, it will be necessary estimate the flux of these fish through their spawning area.

Personnel

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

T. Koslow (Cruise Leader)
A. Williams (Leg 1, part Leg 2)
R. Kloser
M. Sherlock (Leg 1)
J. Cordell (Leg 2)
L. MacDonald
C. Bulman
C. Crossley (U. Sydney) (Leg 1)

Acknowledgements

We are pleased to acknowledge the contribution of the Master, Ian Taylor, and crew of the *Southern Surveyor* to an amiable and successful cruise. We are also grateful to Chris Shearer and John Peterson, skippers of the *Petuna Endeavour* and *Petuna Explorer,* and their crews, for their cooperation and guidance, which contributed immeasurably to the success of the blue grenadier cruise. We gratefully acknowledge funding from the Fisheries Research Development Council (grants 90/25 and 90/9) and the charter granted by the Australian Fisheries Management Authority which made this research possible.

Tony Koslow
Cruise Leader

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Date: 25/1/93

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Distribution

Normal circulation
Cruise participants
P. Rockcliffe (Petuna Seafoods)
C. Shearer (Petuna Seafoods)
J. Peterson (Petuna Seafoods)

Appendix 1

Table 1. Stations occupied by the *Southern Surveyor* during Cruise SS3/92.

Station no	Date	Type	Start position	End position	Min depth	Max depth
SS 1	16.7.92	CTD station	41°14'S 148°47'E.	—	—	—
SS 2	16.7.92	Towed Body	41°15'S 148°44'E.	—	—	—
SS 3	16.7.92	Demersal trawl	41°13'S 148°46'E	41°13'S 148°46'E.	720	720
SS 4	17.7.92	Demersal trawl	41°15'S 148°46'E.	41°15'S 148°46'E.	790	790
SS 5	17.7.92	Demersal trawl	41°13'S 148°45'E.	41°00'S 148°00'E.	820	850
SS 6	17.7.92	Demersal trawl	41°16'S 148°45'E.	41°16'S 148°15'E.	780	800
SS 7	17.7.92	Demersal trawl	41°17'S 148°46'E.	41°17'S 148°46'E.	1023	1042
SS 8	17.7.92	Towed Body	41°18'S 148°49'E.	41°14'S 148°45'E.	—	—
SS 9	17.7.92	Towed Body	—	—	—	—
SS 10	18.7.92	Demersal trawl	41°15'S 148°46'E.	41°16'S 148°46'E.	750	1040
SS 11	18.7.92	Towed Body	41°14'S 148°46'E.	—	—	—
SS 12	18.7.92	Towed Body	41°14'S 148°45'E.	—	—	—
SS 13	19.7.92	Pelagic trawl	41°14'S 148°45'E.	41°14'S 148°48'E.	614	790
SS 14	19.7.92	Pelagic trawl	41°14'S 148°43'E.	41°13'S 148°47'E.	566	808
SS 15	19.7.92	Pelagic trawl	41°14'S 148°43'E.	41°13'S 148°47'E.	1000	1000
SS 16	19.7.92	Towed Body	41°19'S 148°44'E.	—	—	—
SS 17	20.7.92	Demersal trawl	41°15'S 148°45'E.	41°18'S 148°45'E.	938	975
SS 18	20.7.92	Pelagic trawl	41°15'S 148°45'E.	41°19'S 148°46'E.	850	939
SS 19	21.7.92	Pelagic trawl	41°17'S 148°45'E.	41°12'S 148°45'E.	600	650
SS 20	21.7.92	Pelagic trawl	41°12'S 148°45'E.	41°17'S 148°46'E.	650	900
SS 21	21.7.92	Towed Body	41°14'S 148°49'E.	41°14'S 148°45'E.	—	—
SS 22	21.7.92	Demersal trawl	41°17'S 148°43'E.	41°12'S 148°50'E.	0	850
SS 23	22.7.92	Towed Body	41°11'S 148°45'E.	41°14'S 148°49'E.	0	900
SS 24	22.7.92	Pelagic trawl	41°12'S 148°46'E.	41°16'S 148°46'E.	0	918
SS 25	22.7.92	Pelagic trawl	41°14'S 148°46'E.	41°17'S 148°46'E.	—	—
SS 26*	22.7.92	Towed Body	41°08'S 148°45'E.	—	—	—
SS 27	22.7.92	Sounding	41°23'S 148°44'E.	—	—	—
SS 28*	23.7.92	Demersal trawl	41°16'S 148°46'E.	41°13'S 148°46'E.	861	900
SS 29	28.7.92	Towed Body	44°16'S 146°13'E.	—	—	—
SS 30	29.7.92	Towed Body	43°06'S 145°10'E.	—	—	—
SS 31	31.7.92	Towed Body	41°58'S 144°31'E.	—	—	—
SS 32	31.7.92	Sounding	41°55'S 144°32'E.	—	—	—
SS 33	1.8.92	Towed Body	41°02'S 144°46'E.	—	—	—

Station no	Date	Type	Start position	End position
SS 34	2.8.92	CTD	40°20'S 143°20'E.	—
SS 35	2.8.92	Towed Body	41°22'S 144°24'E.	—
SS 36	3.8.92	Towed Body	41°24'S 144°16'E.	—
SS 37	4.8.92	CTD	41°48'S 144°33'E.	—
SS 38	6.8.92	Towed Body	42°11'S 144°45'E.	—
SS 39	7.8.92	Demersal trawl	41°53'S 144°31'E.	41°48'S 144°27'E.
SS 40	7.8.92	Demersal trawl	41°48'S 144°27'E.	41°54'S 144°35'E.
SS 41	7.8.92	Towed Body	41°37'S 144°25'E.	—
SS 42	8.8.92	Towed Body	42°22'S 144°49'E.	—
SS 43	8.8.92	CTD	43°33'S 145°45'E.	—
SS 44	9.8.92	Pelagic trawl	44°13'S 147°04'E.	44°11'S 147°12'E.
SS 45	9.8.92	Pelagic trawl	44°12'S 147°07'E.	44°11'S 147°09'E.
SS 46	9.8.92	Pelagic trawl	44°11'S 147°08'E.	44°10'S 147°20'E.
SS 47	9.8.92	Towed Body	43°33'S 147°08'E.	—
SS 48	12.8.92	Towed Body	44°07'S 147°16'E.	—
SS 49	12.8.92	Pelagic trawl	44°14'S 147°05'E.	44°14'S 147°18'E.
SS 50	12.8.92	Pelagic trawl	44°12'S 147°07'E.	44°12'S 147°16'E.

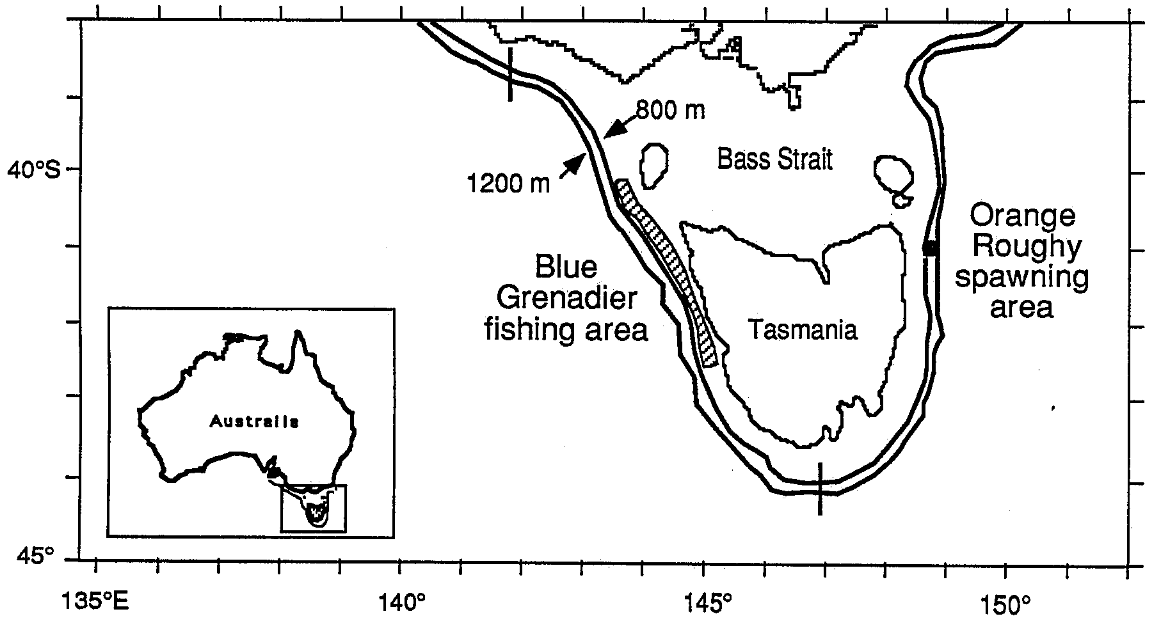

Fig 1. Area of operation

Appendix 2

Table 2. Commercial vessel stations (Blue grenadier survey) during Cruise SS3/92.

Station no	Date	Type	Start position	End position	Start depth	End depth	Trawl time	Catch wt (total)
P. Ex 1	27.9.92	Demersal trawl	44°13'S 146°09'E	14°11'S 146°13'E	822	914	7	3500
P. Ex 2	27.9.92	Demersal trawl	44°12'S 146°10'E	44°12'S 146°10'E	870	960	5	430
P. Ex 3	31.7.92	Plankton drop	42°00'S 145°03'E	—	50	—	—	—
P. Ex 4	31.7.92	Plankton drop	42°00'S 144°50'E	—	150	—	—	—
P. Ex 5	31.7.92	Plankton drop	42°00'S 144°38'E	—	500	—	—	—
P. Ex 6	31.7.92	Midwater trawl	41°58'S 144°36'E	42°02'S 144°36'E	430	470	38	16
P. Ex 7	1.8.92	Midwater trawl	40°55'S 143°47'E	40°55'S 143°46'E	400	500	20	2
P. Ex 8	1.8.92	Midwater trawl	40°50'S 143°42'E	40°50'S 143°40'E	520	620	17	24
P. Ex 9	1.8.92	Plankton drop	40°45'S 143°36'E	—	500	—	—	—
P. Ex 10	1.8.92	Midwater trawl	40°46'S 143°38'E	40°44'S 143°35'E	350	350	62	5
P. Ex 11	2.8.92	Plankton drop	40°30'S 143°24'E	—	520	—	—	—
P. Ex 12	2.8.92	Plankton drop	41°15'S 144°09'E	—	500	—	—	—
P. Ex 13	2.8.92	Midwater trawl	41°22'S 144°19'E	44°23'S 144°21'E	450	500	20	8.5
P. Ex 14	2.8.92	Midwater trawl	41°21'S 144°16'E	41°19'S 144°15'E	440	480	46	360
P. Ex 15	2.8.92	Midwater trawl	21°24'S 144°21'E	41°28'S 144°22'E	440	520	82	2100
P. Ex 16	2.8.92	Plankton drop	41°30'S 144°23'E	—	510	—	—	—
P. Ex 17	2.8.92	Demersal trawl	41°26'S 144°20'E	41°19'S 144°24'E	250	500	128	3570
P. Ex 18	3.8.92	Demersal trawl	41°55'S 144°34'E	41°48'S 144°32'E	450	520	90	8750
P. Ex 19	6.8.92	Demersal trawl	41°56'S 144°33'E	41°46'S 144°34'E	435	600	197	7200
P. Ex 20	6.8.92	Demersal trawl	41°45'S 144°32'E	41°50'S 144°31'E				2200
P. Ex 21	6.8.92	Demersal trawl	42°07'S 144°42'E	41°58'S 144°37'E	400	490	150	650
P. Ex 22	7.8.92	Demersal trawl	41°21'S 144°21'E	41°37'S 144°25'E	420	530	218	2100
P. Ex 23	7.8.92	Demersal trawl	41°34'S 144°24'E	41°39'S 144°26'E	460	500	75	8420
P. Ex 24	7.8.92	Demersal trawl	41°45'S 144°29'E	41°51'S 144°33'E	430	620	120	2400

P.End 1*	31.7.92	Midwater trawl	41°52'S 144°33'E	41°52'S 144°33'E.	380	380	9	10.6
P.End 2	1.8.92	Plankton drop	41°00'S 143°50'E.	—	500	—	6	—
P.End 3	1.8.92	Plankton drop	41°00'S 144°04'E.	—	97	—	—	—
P.End 4	1.8.92	Plankton drop	41°00'S 144°17'E.	—	70	—	—	—
P.End 5	1.8.92	Plankton drop	40°45'S 144°01'E.	—	89	—	—	—
P.End 6	1.8.92	Plankton drop	40°45'S 143°43'E.	—	98	—	—	—
P.End 7	1.8.92	Demersal trawl	40°39'S 143°32'E	40°41'S 143°33'E.	442	461	30	104
P.End 8	1.8.92	Plankton drop	40°39'S 143°39'E.	—	97	—	—	—
P.End 9	2.8.92	Plankton drop	41°15'S 144°23'E.	—	93	—	—	—
P.End 10	2.8.92	Plankton drop	41°23'S 144°20'E.	—	450	—	—	—
P.End 11	2.8.92	Demersal trawl	41°22'S 144°21'E	41°26'S 144°19'E.	412	512	70	5000
P.End 12	2.8.92	Demersal trawl	41°21'S 144°22'E	41°20'S 144°24'E.	329	380	31	750
P.End 13	2.8.92	Plankton drop	41°15'S 143°35'E.	—	81	—	—	—
P.End 14	3.8.92	Demersal trawl	41°22'S 144°21'E	41°23'S 144°21'E.	393	412	25	230
P.End 15	3.8.92	Demersal trawl	41°22'S 144°18'E	41°20'S 144°15'E.	467	512	60	650
P.End 16	3.8.92	Demersal trawl	41°22'S 144°21'E	41°23'S 144°21'E.	380	467	20	750
P.End 17	3.8.92	Plankton drop	41°30'S 144°37'E.	—	91	—	—	—
P.End 18	3.8.92	Plankton drop	41°29'S 144°44'E.	—	50	—	—	—
P.End 19	4.8.92	Plankton drop	41°45'S 144°55'E.	—	54	—	—	—
P.End 20	4.8.92	Plankton drop	41°45'S 144°42'E.	—	109	—	—	—
P.End 21	4.8.92	Pelagic trawl	41°58'S 144°34'E	41°52'S 144°32'E.	458	530	60	38
P.End 22	4.8.92	Pelagic trawl	41°48'S 144°33'E	41°49'S 144°31'E.	515	570	40	4000
P.End 23	4.8.92	Pelagic trawl	41°52'S 144°32'E	44°48'S 144°33'E.	516	613	43	167
P.End 24	4.8.92	Plankton drop	41°45'S 144°28'E.	—	503	—	—	—
P.End 25	5.8.92	Demersal trawl	42°00'S 144°38'E	42°08'S 144°42'E.	467	585	165	500
P.End 26	7.8.92	Plankton drop	42°15'S 145°09'E.	—	50	—	—	—
P.End 27	7.8.92	Plankton drop	42°15'S 145°00'E.	—	128	—	—	—
P.End 28	7.8.92	Plankton drop	41°14'S 144°46'E.	—	495	—	—	—
P.End 29	7.8.92	Demersal trawl	42°24'S 144°49'E	42°24'S 144°49'E.	448	460	17	344
P.End 30	8.8.92	Plankton drop	42°30'S 144°51'E.	—	519	—	—	—
P.End 31	8.8.92	Plankton drop	42°30'S 145°04'E.	—	90	—	—	—
P.End 32	8.8.92	Plankton drop	—	—	49	—	—	—

P.End 33	9.8.92	Demersal trawl	43°06'S 145°11'E	43°10'S 145°16'E.	371	410	108	1500
P.End 34	9.8.92	Plankton drop	43°00'S 145°05'E.	—	566	—	—	—
P.End 35	9.8.92	Plankton drop	43°00'S 145°09'E.	—	139	—	—	—
P.End 36	9.8.92	Plankton drop	43°00'S 145°28'E	—	84	—	—	—
P.End 37	9.8.92	Plankton drop	42°45'S 145°21'E	—	20	—	—	—
P.End 38	9.8.92	Plankton drop	42°45'S 145°07'E	—	111	—	—	—
P.End 39	9.8.92	Plankton drop	42°45'S 144°54'E	—	518	—	—	—
P.End 40	10.8.92	Demersal trawl	42°10'S 144°43'E	42°05'S 144°40'E	452	523	140	2000