

CSIRO

DIVISION OF FISHERIES

CRUISE REPORT

SS4/92

HOBART TO HOBART

3 NOVEMBER – 1 DECEMBER 1992

**FRV
SOUTHERN
SURVEYOR**



Itinerary

Leg 1

Departed Hobart: 0830 h Tuesday, 3 November 1992

Arrived Hobart: 1400 h Tuesday, 17 November 1992

Leg 2

Departed Hobart: 0830 h Wednesday, 18 November 1992

Arrived Hobart: 1200 h Tuesday, 1 December 1992

Cruise Objectives

Leg 1

Leg 1 of the cruise examined the productivity of the mid-slope region off southern Tasmania and the processes supporting the rich fisheries of this area. In particular, the cruise examined near-surface primary productivity, the flux of material from the near-surface to deep water, the vertical migrations of organisms through the water column, advection of material into the area, and the trophic pathways leading from primary producers to commercial fishes. This spring cruise was the third in a series of four cruises to examine these processes on a seasonal basis. The first two cruises (SS2/91 and SS1/92) were completed in winter 1991 and summer 1992, respectively.

Specific objectives:

- 1 To determine the day/night vertical distribution of zooplankton, midwater and demersal nekton at a site off Pedra Branca, southern Tasmania, using replicated, day/night demersal, midwater and plankton tows.
- 2 To examine the diet of the dominant fish and zooplankton species at the study sites through stomach content and stable isotope analyses, as the basis for determining the general trophic structure at mid-slope depths, the vertical distribution of feeding, and the resulting vertical flux of material.
- 3 To carry out three cross-slope CTD transects to determine water mass structure in the sampling area.
- 4 To measure zooplankton biomass, primary productivity and the concentration of chlorophyll *a* at the trawl site and on the cross-slope transects.
- 5 To continue the study of currents at the Pedra Blanca site begun during SS2/91, by retrieving and redeploying two current meters.

- 6 To investigate the flux of detritus through the water column by deploying moored and free-floating sediment traps.
- 7 To estimate daily patterns of the vertical distribution of the biomass by using acoustics in conjunction with net sampling.

Leg 2

Leg 2 of the cruise focussed on developing acoustic and net sampling methods of assessing community composition and biomass with particular reference to the deep-water fisheries off southern Tasmania. The ancillary objectives were to assess the target strength of dominant components of the midslope community; the bias associated with the acoustic dead zone, particularly in deeper parts of the area; and the variability and extent of midwater layers on several scales.

Specific objectives:

- 1 Survey 2–3 hills (Pedra Branca; Maatsuyker; and a deeper, oreo hill) to assess:
 - a) the bias associated with a large acoustic dead zone on deeper portions of the hills; and
 - b) the species composition associated with the hill.
- 2 Assess the biases associated with the acoustic split-beam *in situ* target-strength data in relation to backscattering intensity and depth from the transducer.
- 3 Assess the variability in the density and species composition of midwater layers on the following spatial scales, based upon both acoustic and depth-stratified midwater trawl sampling with a midwater opening-closing (MIDOC) net:
 - a) variability at a single time and place;
 - b) onshore-offshore variability on the nm scale; and
 - c) onshore-offshore variability through comparison of stations on the slope and at a station 60 nm South in 3000 m of water.
- 4 Obtain *in situ* target-strength measurements of orange roughy (*Hoplostethus atlanticus*), oreo dories (Oreosomatidae), myctophids (Myctophidae) and other dominant fishes on these grounds.
- 5 If spawning smooth oreo (*Pseudocyttus maculatus*) and black oreo (*Allocyttus niger*) are caught, to fertilise and incubate the eggs to assess development; to assess the vertical distribution of their eggs with the EZ net.

Area of Operation

The cruise was carried out in the waters south of Tasmania (Figure 1). On the first leg, three onshore-offshore CTD transects were made from the shelf to depths of several thousand metres. Detailed biological sampling was carried out, principally in the vicinity of an orange roughy fishing ground south of Pedra Branca Island. An acoustic transect was carried out for 60 nm south of the biological sampling site (from 44°15' to 45°15' S along 147°00' E), and water column nekton was sampled day and night.

Results

Leg 1:

All objectives were met during the first leg of the cruise.

- 1 The day/night vertical distribution of zooplankton, midwater and demersal nekton was examined at a site off Pedra Branca, southern Tasmania, using replicated day/night demersal, midwater and plankton tows. Seven replicate demersal tows were completed over 24 h. Two sets of vertically stratified day/night midwater tows were completed with the EZ opening-closing plankton net system (1 m² mouth opening, 330 mm mesh).
- 2 Samples were obtained from the day/night tows (Objective 1) to examine the diet of the dominant fish and zooplankton species at the study sites through stomach content and stable isotope analyses. This information is the basis for determining the general trophic structure at mid-slope depths, the vertical distribution of feeding, and resulting vertical flux of material.
- 3 Three cross-slope CTD transects were carried out to determine the structure of the water mass in the sampling area.
- 4 Estimates of zooplankton biomass, primary productivity and the concentration of chlorophyll *a* were obtained at the trawl site over a 24-h period and at all stations on the cross-slope transects.
- 5 The current-meter array with current meters at 200 and 900 m, which was deployed on SS1/92, was retrieved. The top current meter and float assembly were missing. No data were recorded on the current meter that was retrieved. Two current meters and two Honjo traps were redeployed at the Pedra Branca site to continue the study of currents and detrital flux at the trawl site.

- 6 The flux of detritus through the water column was estimated by deploying a free-floating sediment trap for 24 h at the 24 h productivity station. The Honjo trap deployed at 900 m on the current-meter array failed to collect samples due to a faulty chip not rotating the collecting jars.
- 7 Acoustic target-strength sampling was carried out in conjunction with MIDOC net sampling during Leg 2 to compare estimates of the vertical biomass, species, and size-frequency distribution from 0–900 m. A full set of day and night profiles was obtained, as well as trawls targeted in particularly distinct layers.

Leg 2

- 1 Three satellite-tracked drifters were released on 18 November for Dr George Cresswell (Division of Oceanography). They were released in the Pedra Branca area: one at the shelf break, and the others 5 nm inshore and offshore.
- 2 Acoustic surveys, target-strength measurements (TS) and tows with the Engels demersal trawl were carried out on a suspected oreo-hill (one of the “Two Sisters” south of Pedra Branca) and on Pedra Branca. Acoustic measurements were obtained on Maatsuyker, but demersal trawling was not carried out due to deteriorating weather conditions. TS measurements were obtained only when the towed body was allowed to drift across acoustic marks rather than when it was towed—and not always then, because of the compactness of the fish schools. Despite four attempts, trawling was not successful on the “Two Sisters”; the bottom was rough and the fish “flighty”. A commercial vessel was also unable to fish this acoustic mark.
- 3 Data obtained from vertical profiles through the water column with the towed body will be used to assess changes and bias in acoustic TS data as a function of distance from the transducer and the TS distribution.
- 4 Variability in the density and species composition of midwater layers was examined on the following spatial scales, based upon acoustic and midwater trawl sampling:
 - a) TS sampling with the towed body and four MIDOC samples were obtained within an acoustic layer at 600–650 m in both day and night to assess variability at a single time and place. The tows were carried out approximately along a depth contour.
 - b) A set of four MIDOC samples was obtained within an acoustic layer from 650–775 m that was sampled orthogonal to the isobaths, proceeding on a N–S course past Pedra Branca. An acoustic transect was then carried out, beginning along this course and proceeding 60 nm South to ~3000 m depth offshore to examine patterns in the distribution of midwater scatterers.

- c) Onshore-offshore variability in midwater fishes was examined by sampling with the MIDOC system and acoustics for the distribution of organisms from 0–900 m depth at a station 60 nm South in 3000 m of water. These results will be compared with the results from sampling on the slope at ~1200 m.
- 5 TS measurements were obtained from a variety of mesopelagic fishes (see 2 and 3 above). Due to a paucity of acoustic marks and difficulties in obtaining trawl samples, this work will need to be continued. An orange roughy was suspended beneath the towed body transducer and lowered to 750 m to obtain TS measurements. Results confirmed the generally low TS measurements of orange roughy obtained from *in situ* sampling. Unfortunately, this technique cannot be used on organisms with swim bladders (e.g. oreos, macrourids, many myctophids), as the swim bladder distorts when the organism is raised or lowered.
- 6 Aggregations of spawning oreos were not encountered, so no experiments were carried out to incubate or examine the vertical distribution of their eggs.

Cruise Narrative

Leg 1

Southern Surveyor left Hobart at 0830 on 3 November 1992 and headed through D'Entrecasteaux Channel to the site of the current meter and sediment trap mooring. A CTD cast to the salinity minimum was carried out in deep water (>1000 m) to test the Niskin bottles for possible leaks. The mooring was located, with some difficulty, about 5 nm from where it had been deployed. Communication was established, but recovery was postponed until daylight.

The vessel proceeded to the inshore station of the western CTD transect and began CTD casts and productivity work. The sampling proceeded without incident. The first transect was completed early in the morning of 5 November. The vessel then sailed to the outer station of the central transect, which was completed the following day. The eastern and final transect was completed the morning of 7 November.

The mooring was retrieved that afternoon. The upper current meter was lost but other gear was retrieved. It appears the mooring had been hit and moved by an unidentified towed body. The sample jars on the Honjo sediment trap had not rotated so no samples were obtained. The cause of the problem was not apparent, although the batteries were low. The free-floating sediment trap was deployed by 1800 h and the 24-h productivity station was initiated. The productivity work went smoothly, except that retrieving the free-floating sediment trap was complicated by a lack of sufficient

large blocks through which large shackles could pass. Also, the wind had increased to Force 6–7, so it was difficult to maintain the traps vertically. After retrieval, the vessel went to the old mooring site to deploy the Honjo sediment traps and current meters. The mooring was deployed by midnight at 44°12.25'S, 147°05.36'E, at 1040 m depth and will be recovered in April 1993. The vessel proceeded to the trawl site.

Demersal trawling began in the early hours of the morning on 9 November at ~44°11.8'S, 147°08' E. Two trawls were carried out unsuccessfully (the net failing to settle onto the bottom the first time and coming fast the second) before the vessel went to Recherche Bay to pick up the EZ plankton nets, which had just been constructed. By evening, the vessel had returned to the site, where a set of midwater tows with the MIDOC system, followed by an acoustic profile of the water column with the towed body, was carried out through the night. However, sea conditions had worsened by dawn, so further deployment of the MIDOC system was not feasible. A CTD cast was carried out at dawn.

The gear was changed over for demersal trawling on the morning of 10 November. There were some difficulties with demersal trawling over the next 24 h: gear failed to settle on the bottom in time to carry out the trawl between the two hills; doors crossed on two tows; and a line parted. The polyvalent trawl doors were changed over to V-doors, which are commonly used in the commercial fishery. Two tows were thereafter completed successfully, although a large tear down one wing was discovered after the second tow. The V-doors descended more quickly, more evenly and controllably through the water, thereby greatly enhancing control and decreasing the time and distance required for the gear to reach bottom.

Sea conditions had moderated by the morning of 12 November, so the trawl and doors were switched back for MIDOC sampling, which was completed successfully over 48 h during 12–13 November. It included two complete day and night profiles of the nekton, a daytime acoustic profile to 400 m and a CTD cast.

EZ net sampling began shortly after midnight on 14 November; by midnight of 15 November, 48 h of depth-stratified plankton sampling had been completed, resulting in 5 day and 4 night profiles. Two CTD casts were also carried out during this period and the radiometer tested.

Early on 16 November, demersal trawling began again and was carried out successfully for around 24 h. On the last tow of Leg 1, the trawl came fast and was badly damaged. The vessel returned to Hobart and docked at 1330 on 17 November. Overall, weather conditions were good and, barring initial difficulties with demersal trawling, all equipment worked well. The objectives of the first leg of the cruise were fully met.

Leg 2

Southern Surveyor left Hobart at 0830 on 18 November. En route to the first station, three drifters were released for Dr George Cresswell: at the shelf break and 5 nm inshore and offshore of it. As conditions were rough (Force 8), the only operations possible were to survey possible sampling sites with the pole-mounted transducer. The Pedra Branca hills, two dory hills known as the "Sisters", and several other hills in the area were surveyed acoustically with two orthogonal transects each. After completing the work that could be carried out in the rough conditions, the vessel came closer to shore to shelter.

The vessel returned to the survey area on the morning of 19 November. Conditions had moderated somewhat, so the towed body was deployed on Hill 34 (one of the "Sisters"), where an intense mark had been seen. TS measurements were not obtained due to the density of the mark, which was intensely red, possibly due to compaction in reaction to the passage of the towed body. Calm conditions returned, so the towed body was lowered vertically. Difficulty was experienced in manoeuvring the vessel over the mark in the strong currents, but eventually a mark was found and TS measurements successfully made, though possibly not on the mark originally observed.

After retrieval of the towed body, several attempts were made to trawl on the mark during 20 November. These were unsuccessful, apparently because of difficulty in making good contact with the bottom, which was very rough. The Scanmar sensor that indicates height above bottom malfunctioned during one of the tows, possibly due to flooding. In calm conditions, the towed body was calibrated with depth; the initial results were similar to those of the last cruise. Conditions then freshened, so a final tow was carried out with the towed body to obtain TS measurements, but again without success.

The vessel proceeded to the Pedra Branca hills, where surveys were carried out with the pole-mounted transducer, but marks in the area were fairly sparse. Fishermen reported good marks on the untrawlable, west side of Maatsuyker, so the vessel sailed there and surveyed early on 21 November until conditions deteriorated. Unable to deploy any gear, the vessel steamed inshore for shelter, anchoring outside Dover. Mr R. McLoughlin was put ashore: with two work-experience persons aboard, his presence was no longer required.

The vessel weighed anchor in the morning of 22 November. Conditions had improved markedly overnight. A series of replicate midwater tows were carried out alongshore within a layer at 600–650 m depth in the day and at night with the MIDOC gear to examine midwater sampling variability. Acoustic sampling was also carried out day and night to compare the catch with the TS distribution. Salps domi-

nated the catch. On 23–24 November, acoustic and MIDOC profiles of the water column were carried out, followed by a further set of replicate MIDOC tows and TS measurements within an acoustic layer at 650–775 m.

On 25 November, the vessel steamed to Recherche Bay to pick up the new Master, Andrew Forbes, and Jason Wearing, and to let off the two work-experience persons, Melvut Kilinc and Vijay Unnithan. The vessel then returned to the Pedra Branca area, where sampling was undertaken to examine onshore–offshore sampling variability in midwater. After a CTD cast, an onshore–offshore (N–S) MIDOC tow was made between 650 and 775 m, starting several miles north of Pedra Branca. The tow was successful, but the headline parted from the net. The vessel returned to the start of the transect and a long acoustic transect begun from Pedra Branca for 60 nm south. The transect continued throughout the daylight period of 26 November. The vessel then turned to the east, the towed body was lowered to 900 m and an acoustic profile was begun from 900–350 m during dusk. Due to re-spooling problems, the measurements were not completed in the dusk period. The towed body was then lowered back to 900 m to take the TS measurements during the night. However, conditions had deteriorated, so the towed body was retrieved. Conditions remained Force 7–9 throughout the night and morning of 27 November, and the vessel remained hove to. The wind and sea gradually subsided during the late afternoon and evening.

Over the next 24 h, MIDOC samples were obtained from the surface to 900 m at the offshore site for comparison with the slope area. The major species were largely the same, though there appeared to be several new elements, including abundant *Borostomias*. On the final cast of the series, the IYGPT net was torn from the headline, possibly due to excessive speed. An acoustic profile of the water column (0–900 m) was carried out after midnight on 29 November, and the vessel then steamed back to Pedra Branca.

Several demersal trawls were carried out on Pedra Branca, yielding primarily the squalid *Etmopterus baxteri* and orange roughy, followed by a drift over the hill to measure the TS of acoustic marks. Conditions on 30 November were flat calm, and a TS experiment was successfully carried out: an orange roughy was tethered beneath the towed body and lowered to 750 m, so the TS of a known specimen (albeit dead) could be measured under ambient conditions. The experiment confirmed the previous estimates of the low TS of orange roughy. A specimen of *Etmopterus baxteri* was examined next, but sea conditions were less calm and the specimen swung out of the beam. Unfortunately the method cannot be used with species that have swim bladders (e.g. oreos), which are distorted when the animal is raised or lowered through the water column.

In the evening of 30 November, the vessel participated in an acoustic tomography experiment, listening for a sound pulse from an explosion from off South Africa. After several delays due to failed firings, a successful firing was achieved around midnight. It was recorded with a hydrophone lowered to the Sofar channel. The vessel then steamed back to Hobart and docked at 1230 h on 1 December.

Summary

The first leg of SS4/92 successfully completed the third (spring) in a series of four seasonal cruises to examine the productivity of slope waters on the main orange roughy fishing ground south of Tasmania. These cruises will delineate the food web leading to orange roughy and describe the mechanisms whereby this large fishery can be supported at mid-slope depths in an apparently extremely limited area with very low productivity.

The second leg concentrated on the development of acoustic methods and the combined use of acoustics and net sampling at discreet depths to characterise pelagic communities. Sampling during the second leg was hindered by generally poor weather conditions and a lack of trawlable acoustic targets. However, most objectives were achieved. A notable achievement was the measurement at depth (750 m) of the target strength of a tethered orange roughy, which directly confirmed the low values obtained from *in situ* sampling with the split-beam sounder.

Personnel

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

Leg 1

T. Koslow (Cruise Leader)	D. McKenzie
A. Williams	B. Griffiths
R. Kloser	V. Latham
M. Sherlock	D. Terhell
M. Lewis	S. Garland
P. Bonham	C. Bulman

Leg 2

T. Koslow (Cruise Leader)	M. Lewis
A. Williams	R. McLoughlin (to 21 November)
R. Kloser	M. Kilinc (Work experience)
C. Bulman	V. Unnithan (Work experience)
J. Cordell	J. Waring*
L. MacDonald	A. Forbes*

* Joined cruise on 25 November at Recherche Bay

Acknowledgements

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Tony Koslow

Cruise Leader



P. C. Young

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This report may not be cited without reference to the author(s).

Distribution:

Normal circulation, cruise participants

Appendix 1

Stations occupied by FRV *Southern Surveyor* during SS4/92

Station	Date	Time	Latitude °S	Longitude °E	Activity
1	3/11/92	16:35	4412.5	14705.61	CTD
2	3/11/92	23:57	4353.35	14622.03	CTD
3	4/11/92	1:38	4355.97	14618.52	CTD
4	4/11/92	3:17	4358.78	14616.58	CTD
5	4/11/92	5:12	4404.77	14615.3	CTD
6	4/11/92	6:45	4408.94	14615.02	CTD
7	4/11/92	9:58	4413.52	14608.28	Seacat/dropnet
8	4/11/92	9:59	4413.52	14608.29	CTD
9	4/11/92	12:16	4418.8	14607.31	CTD
10	4/11/92	15:54	4424.11	14604.22	CTD
11	4/11/92	18:44	4431.07	14601.95	CTD
12	4/11/92	22:33	4436.53	14600.13	CTD
13	4/11/92	1:54	4443.43	14557.9	CTD
14	5/11/92	4:48	4442.88	14557.62	CTD
15	5/11/92	7:08	4442.24	14558.35	CTD
16	5/11/92	12:50	4436.81	14710.35	CTD
17	5/11/92	16:16	4435.51	14709.79	CTD
18	5/11/92	19:37	4427.21	14709.81	CTD
19	5/11/92	22:33	4419.76	14710.76	CTD
20	6/11/92	0:59	4414.13	14710.33	CTD
21	6/11/92	3:21	4413.51	14708.85	CTD
22	5/11/92	5:40	4408.94	14710.88	CTD
23	6/11/92	7:40	4409.34	14708.84	CTD
24	6/11/92	9:26	4408.36	14710.26	CTD
25	6/11/92	10:05	4404.99	14710.1	CTD
26	6/11/92	11:13	4405.1	14710	CTD
27	6/11/92	12:04	4400.74	14709.99	CTD
28	6/11/92	13:50	4358.89	14709.25	CTD
29	6/11/92	14:58	4357.87	14709.95	CTD
30	6/11/92	17:00	4348.9	14733.15	CTD
31	6/11/92	18:16	4352	14734.99	CTD
31	6/11/92	19:28	4354.94	14736.13	CTD
33	6/11/92	20:47	4357.92	14739.31	CTD
34	6/11/92	22:14	4401.82	14742.19	CTD
35	7/11/92	0:01	4408.12	14746.07	CTD
36	7/11/92	2:21	4410.08	14746.58	CTD
37	7/11/92	5:27	4415.28	14748.7	CTD
38	7/11/92	8:12	4421.11	14750.38	CTD
39	7/11/92	15:15	4412.16	14701.4	Retrieval
40	7/11/92	17:45	4411.5	14701.7	Sed. Trap

41	7/11/92	18:35	4411.36	14702.48	CTD
42	8/11/92	0:16	4411.81	14704.66	CTD
43	8/11/92	6:10	4410.3	14710.14	CTD
44	8/11/92	12:00	4409.5	14713.7	CTD
45	8/11/92	12:04	4409.54	14713.85	CTD
47	8/11/92	16:09	4409.3	14716.91	CTD
48	8/11/92	18:45	4409.3	14718.7	Sed. Trap
49	9/11/92	5:00	4411.57	14709.47	Demersal
50	9/11/92	8:15	4410.99	14707.64	Demersal
51	9/11/92	21:15	4412.55	14704.51	MIDOC
52	10/11/92	2:30	4411.9	14721.9	Towed Body
52	10/11/92	2:30	4411.9	14721.9	Towed Body
53	10/11/92	6:00	4411.7	14704.3	CTD
54	10/11/92	9:42	4411.73	14709.69	Demersal
55	10/11/92	13:18	4411.3	14711.83	Demersal
56	10/11/92	19:40	4411.06	14711.39	Demersal
57	11/11/92	3:41	4411.38	14711.67	Demersal
58	11/11/92	7:00	4411.2	14711.03	Demersal
59	11/11/92	11:15	4410.7	14713.5	Demersal
60	11/11/92	13:30	4411.4	14712.3	Demersal
61	11/11/92	19:25	4411.14	14715.02	Demersal
62	11/11/92	20:20	4411.56	14711.7	Demersal
63	12/11/92	8:48	4412.92	14704.76	MIDOC
64	13/11/92	14:54	4411.99	14718.62	MIDOC
65	12/11/92	19:15	4412.3	14657.4	CTD
66	12/11/92	20:14	4412.3	14657.53	MIDOC
67	13/11/92	1:52	4413	14716.6	MIDOC
68	13/11/92	6:08	4413.29	14706.61	Pelagic
69	13/11/92	9:45	4412.6	14726.4	Towed Body
70	13/11/92	12:55	4412.6	14706.2	Radiometer
71	13/11/92	13:48	4411.89	14740.36	MIDOC
72	13/11/92	20:00	4411.55	14722.89	MIDOC
73	14/11/92	0:57	4411.43	14709.32	EZNet
74	14/11/92	5:20	4411.9	14725.8	CTD
75	14/11/92	7:48	4412.1	14728.9	EZNet
77	14/11/92	13:57	4411.99	14712.7	EZNet
78	14/11/92	18:45	4411.7	14722.7	CTD
79	14/11/92	21:27	4411.89	14725.09	EZNet
80	15/11/92	1:45	4412.3	14714.11	EZNet
81	15/11/92	6:32	4412.05	14724.43	EZNet
82	15/11/92	11:11	4411.68	14724.44	EZNet
83	15/11/92	15:40	4411.38	14717.05	EZNet
84	15/11/92	20:43	4411.23	14731.26	EZNet
85	16/11/92	1:01	4411.04	14717.75	EZNet
86	16/11/92	5:30	4410.24	14711.65	Demersal

87	16/11/92	7:38	4410.02	14711.87	Demersal
88	16/11/92	9:10	4409.6	14712.32	Demersal
89	16/11/92	11:25	4409.1	14712.2	Demersal
90	16/11/92	13:15	4409.29	14712.01	Demersal
91	16/11/92	15:00	4409.2	14712.1	Demersal
92	16/11/92	17:00	4409.85	14711.2	Demersal
93	16/11/92	17:40	4410.2	14711	Demersal
94	16/11/92	21:50	4409.8	14711.88	Demersal
95	17/11/92	2:10	4409.27	14711.49	Demersal
101	20/11/92	1:05	4416.15	14716.91	Demersal
102	20/11/92	3:10	4416.2	14713	TB Calibr.
103	20/11/92	9:53	4416	14715.7	Demersal
104	20/11/92	12:03	4415.74	14715.64	Demersal
105	20/11/92	14:30	4416.14	14713.36	Demersal
106	20/11/92	19:05	4414.8	14717.8	Towed Body
108	22/11/92	15:24	4416.15	14707.37	MIDOC
109	22/11/92	18:30	4415.4	14713.4	Towed Body
110	22/11/92	21:20	4415.9	14707.9	Towed Body
111	22/11/92	23:30	4414.9	14656.6	Towed Body
112	23/11/92	1:50	4415.12	14650.58	MIDOC
113	23/11/92	6:10	4415	14655.1	Towed Body
114	23/11/92	10:35	4421.96	14715.36	MIDOC
115	23/11/92	15:40	4415.57	14706.91	MIDOC
116	23/11/92	21:48	4415.9	14708.5	Towed Body
117	24/11/92	0:10	4419.26	14721.26	MIDOC
118	24/11/92	6:10	4413.4	14703	Towed Body
119	24/11/92	10:19	4420.54	14726.35	MIDOC
120	24/11/92	14:47	4415.59	14712.55	MIDOC
121	24/11/92	19:00	4423.7	14729.5	CTD
122	24/11/92	21:24	4420.16	14726.26	MIDOC
126	25/11/92	20:35	4409.3	14706.35	MIDOC
127	26/11/92	4:30	4420	14705.7	Towed Body
128	27/11/92	21:48	4504.17	14705.12	MIDOC
130	28/11/92	5:53	4455.21	14714.81	MIDOC
131	28/11/92	11:14	4453.4	14657.2	MIDOC
132	28/11/92	16:25	4442.94	14713.11	MIDOC
133	28/11/92	20:48	4450.46	14701.95	MIDOC
134	29/11/92	0:45	4447.4	14719.6	Towed Body
135	29/11/92	12:15	4415.71	14706	demersal
136	29/11/92	14:30	4415.24	14706.4	demersal
137	29/11/92	19:20	4416.1	14706.4	Towed Body
139	30/11/92	6:27	4412.43	14709.97	demersal
140	30/11/92	9:48	4417.6	14703.8	Towed Body

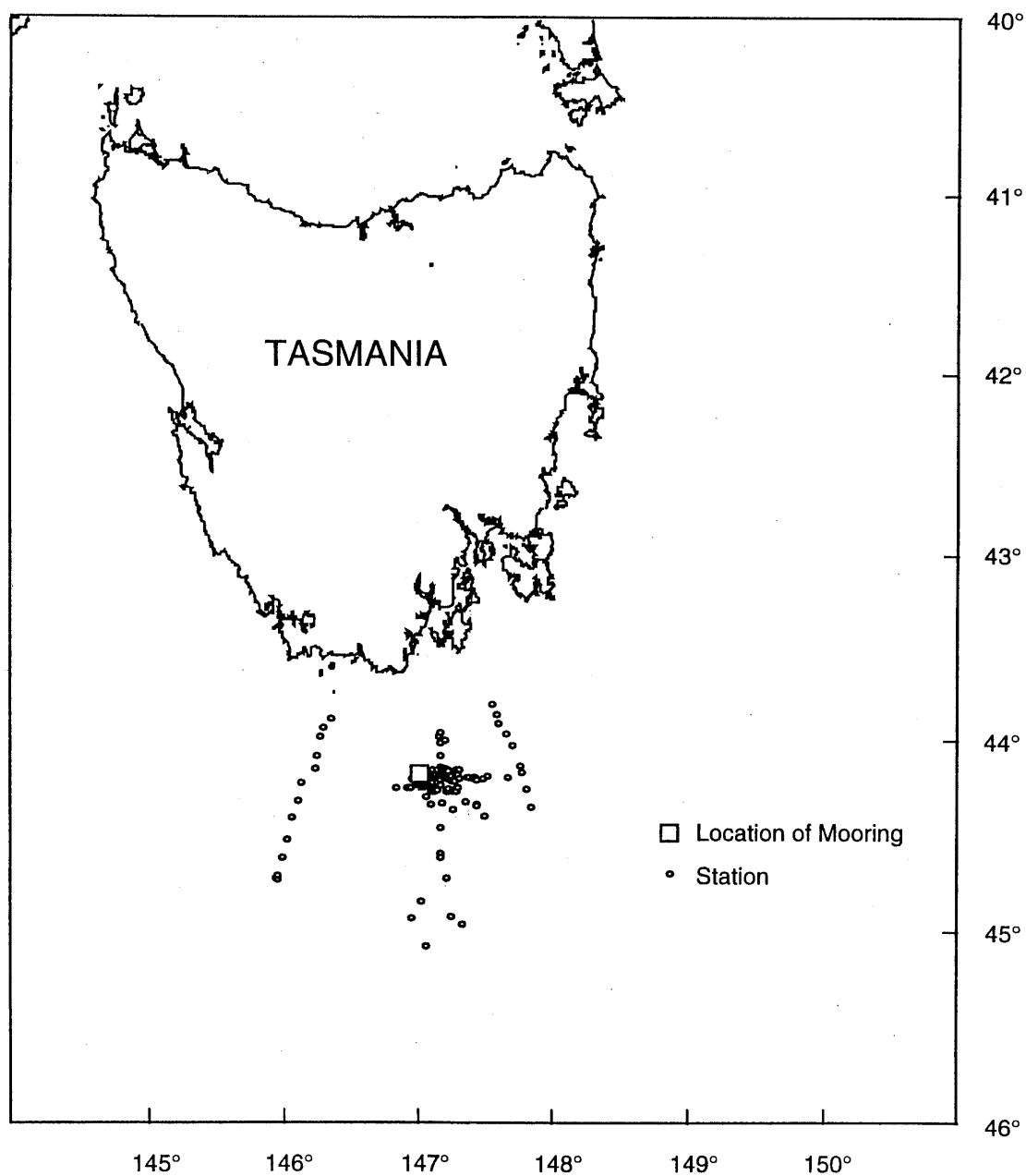


Fig 1. Area of operation

Map showing the area of operations, specifically the CTD transects, current meter and sediment trap mooring, and trawl site.