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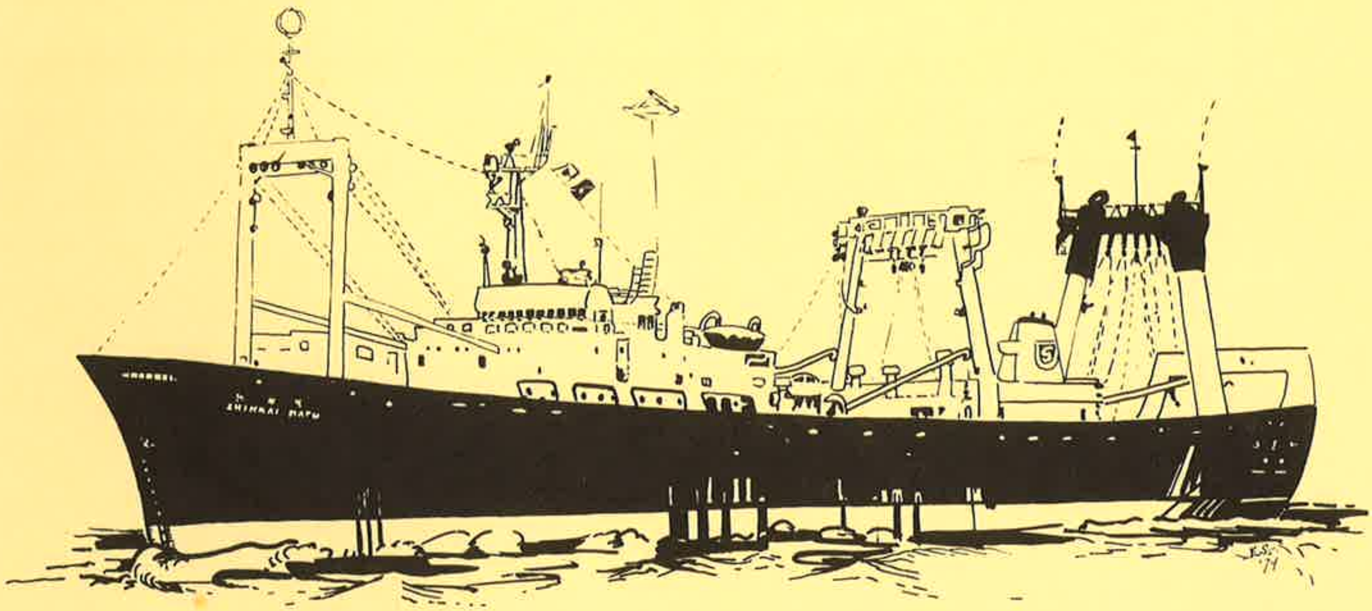

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Introduction

The objective of this work is to provide an immediate crude assessment of the status and potential of the deep-water demersal fishery resource of the New Zealand 200-mile Exclusive Economic Zone (EEZ) (Fig. 1). The reasons for this are twofold. First, New Zealand officially declared jurisdiction over a 200-mile EEZ on 1 April 1978. With this declaration came the responsibility to manage the fisheries of the EEZ to promote optimum use of stocks within the zone (Beeby 1975). Therefore immediate scientific advice had to be provided to enable management of the foreign fishery exploiting the resource. Second, scientific assessments are needed to help plan the future course of the fishery. As will become evident, these two needs require different approaches to scientific assessment.

The direct estimates made here depend entirely on data provided from the activities of Japanese research and commercial vessels fishing in New Zealand waters from October 1975 to February 1977.

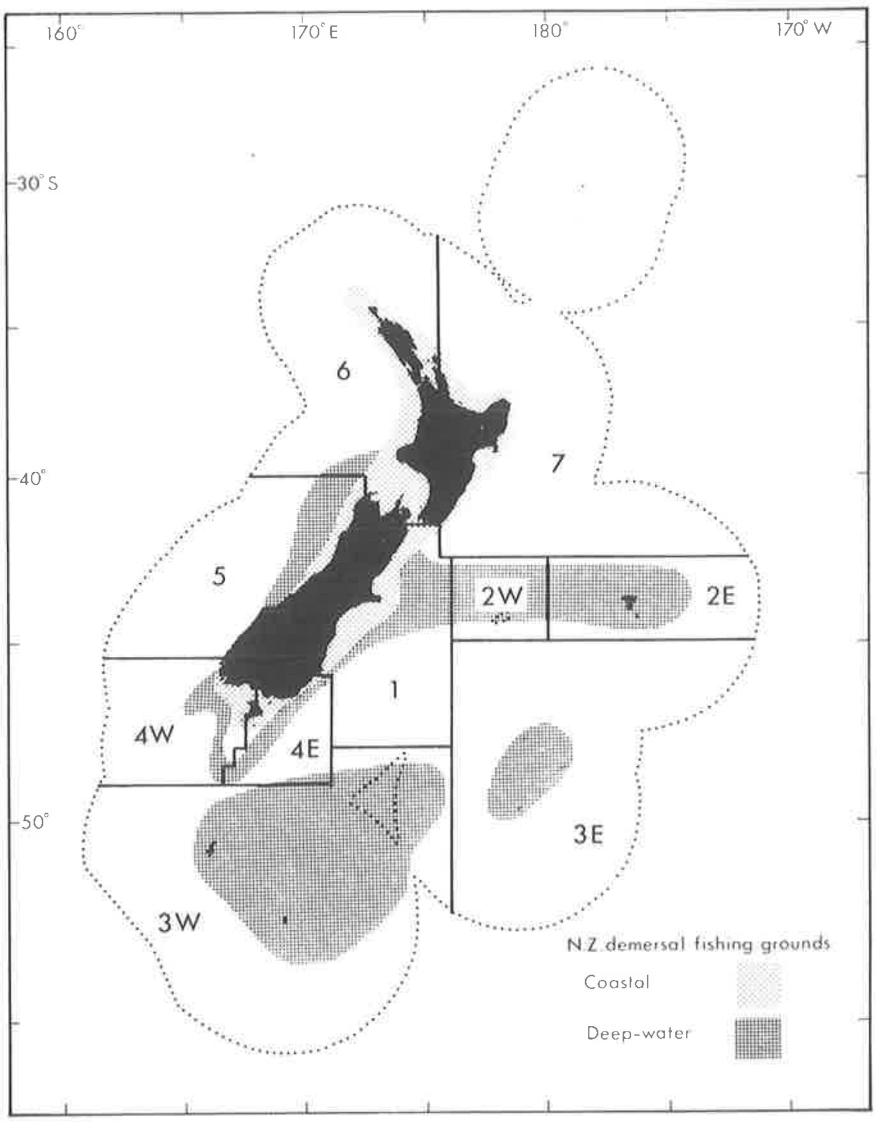


Fig. 1: The New Zealand 200-mile Exclusive Economic Zone and deep-water fishing areas.

Inset 1

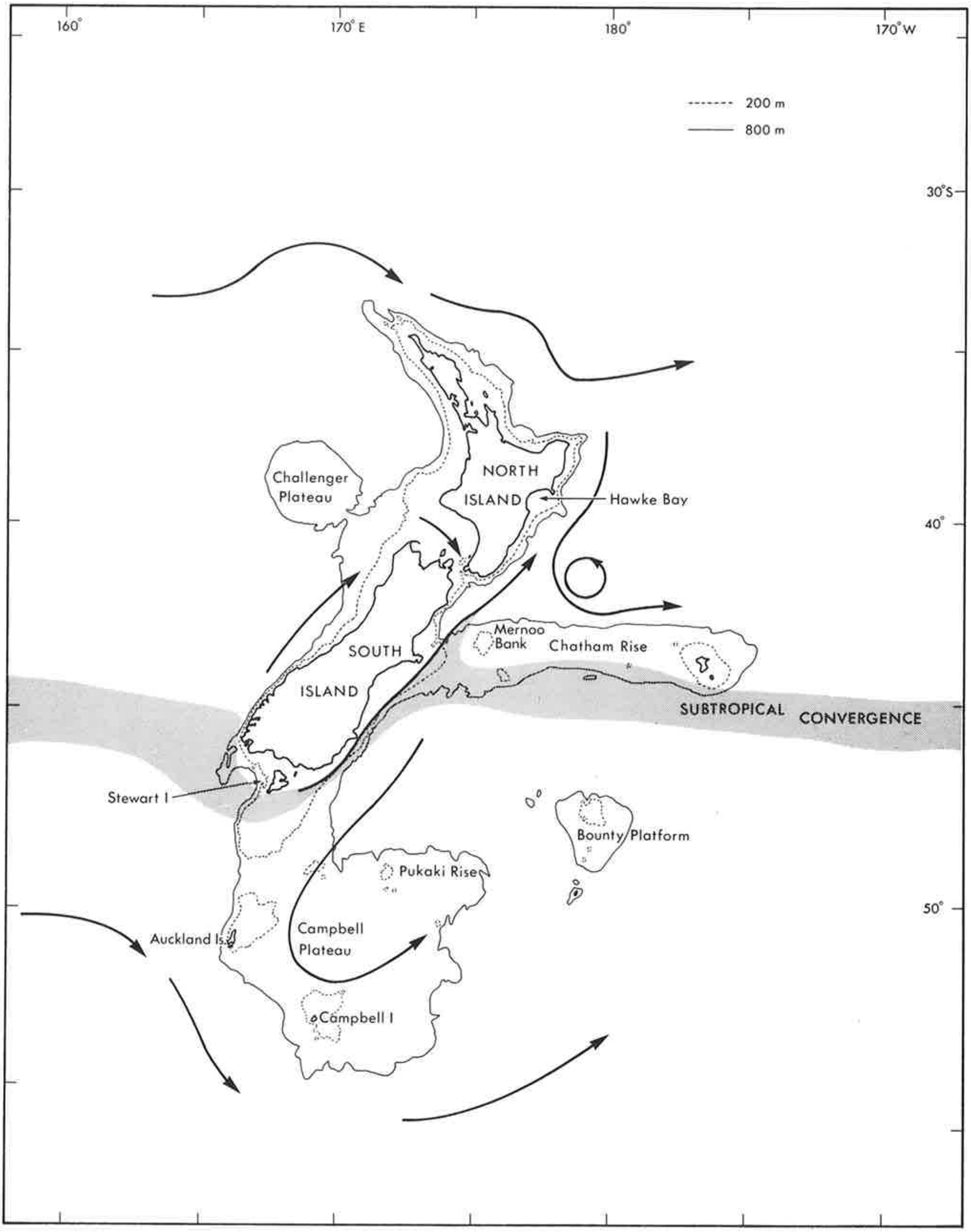


Fig. 2: Major bathymetric features, surface currents, place names, and topographic features of the New Zealand region.

The Fishery

Two distinct demersal fisheries operate inside the New Zealand EEZ (Fig. 1). First, there is the coastal trawl, long-line, and set-net fishery which operates largely around the North Island in depths ranging from 0 to 200 m. Recent annual catches have been about 60 000 t (40 000 New Zealand and 20 000 foreign). The main species are snapper (*Chrysophrys auratus*), tarakihi (*Cheilodactylus macropterus*), trevally (*Caranx georgianus*), barracouta (*Thyrsites atun*), and jack mackerels (*Trachurus declivis* and *T. novaezelandiae*).

Second, there is the deep-water trawl and bottom long-line fishery which operates around the South Island (Areas 1, 4, and 5), on the Chatham Rise (Area 2), and on the Campbell Plateau-Bounty Platform (Area 3) (Fig. 1). This fishery, almost exclusively foreign so far, operates in depths ranging from 200 to 1000 m. Heavy exploitation in this fishery started in the early 1970s when large trawlers from the Soviet Union began fishing the deeper waters along the east coast of the South Island and the vast trawlable expanse of the Campbell Plateau-Bounty Platform. At the same time the Japanese expanded their coastal trawling operations into the deeper waters along the east coast of the South Island and began to explore the potential for bottom long-lining in various areas around New Zealand. The total deep-water demersal catch for 1971–75 averaged about 100 000 t and was evenly divided between Japan and the Soviet Union.

In 1976 the catch rose to about 200 000 t. Part of this increase was due to the establishment of the Japanese bottom long-line fishery on the south side of the Chatham Rise (Area 2) and part was due to the expansion of the Japanese trawl fishery into areas along the edge of the shelf to the east and south of Stewart Island (Area 4) and along the west coast of the South Island (Area 5) (Fig. 1). The Japanese commercial trawlers were guided on to heavy concentrations of silver warehou (*Seriolella punctata*) in the Southland shelf area in December 1975 and January 1976 and hoki (*Macruronus novaezelandiae*), English hake (*Merluccius australis*), and barracouta along the west coast of the South Island from May to September 1976 by the Japan Marine Fishery Resource Research Center (JAMARC) exploratory fishing stern trawler *Shinkai Maru*. The fishing data provided by this vessel served as the basis for the estimates made in this paper. In 1977 the deep-water demersal catch again increased to about 380 000 t as a result of increases in effort by Japan and the Soviet Union and the entrance of South Korean trawlers and bottom long-liners into the fishery.

The main species in the deep-water trawl fishery of recent years has been hoki, a deep-water hake which is caught in both the subtropical waters of Areas 1, 2, and 5 and the subantarctic waters of Area 3. Hoki made up more than 35% of the 1976 deep-water trawl catch. The main species (75% of the 1976 catch) in the bottom long-line fishery is ling (*Genypterus blacodes*). Illustrations and descriptions of the major species exploited in the New Zealand deep-water demersal fishery, as well as species codes used later in this publication, are given in Appendix 1.

Deep-water fishing grounds

The most important deep-water fishing grounds are shown in Fig. 1. Figure 2 shows the major physical features of the region.

East coast, South Island (Area 1)

A significant trawl fishery exists here throughout the year. The major species caught are hoki, barracouta, red cod (*Pseudophycis bacchus*), warehou, jack mackerels, and arrow squid (*Nototodarus sloanii*). The estimated 1977 deep-water catch was 83 000 t.

Chatham Rise (Area 2)

This area supports a year-long trawl fishery along its north and west boundaries as well as most of the bottom long-line fishery along its southern boundary. The major species caught in the trawl fishery are hoki and silver warehou and in the bottom long-line fishery, ling. The estimated 1977 deep-water catch was 52 000 t (32 000 by trawl and 20 000 by bottom long-line).

Campbell Plateau-Bounty Platform (Area 3)

This vast area of subantarctic water has supported a year-long trawl fishery, though recently most of the fishing has been in summer. The major species caught are squid and hoki along the western boundary (in the area of the Auckland Islands) and southern blue whiting (*Micromesistius australis*) in spring and summer on the Campbell Plateau and in winter on the Bounty Platform, where they are reported to spawn (Shpack 1978). The estimated 1977 deep-water catch was 70 000 t.

Southland (Area 4)

This area has supported a sporadic summer trawl fishery. The major species caught are silver warehou and squid along the eastern boundary and ling along the western boundary. The estimated 1977 deep-water catch was 28 000 t.

West coast, South Island (Area 5)

This area supports a winter and spring trawl fishery for spawning concentrations of hoki, hake, and barracouta. Extremely high catch rates of more than 50 t per hour have been recorded. The estimated 1977 deep-water catch was 125 000 t.

Vessels

The most common fishing vessels in the deep-water fishery are 1000- to 4000-GRT factory stern trawlers (up to 120 m in length). Table 1 shows the 1976 Japanese trawl catch and effort by size class. The high catch rate recorded by size class 6 was due to two boats fishing mainly in Area 5 at the height of the winter season with high-opening nets. Unfortunately no comparable records are available for Soviet fishing. In addition to large factory stern trawlers (up to 85 m), the Soviets use smaller (55 m) side trawlers to fish for squid in Area 3 around the Auckland Islands. Most bottom long-line vessels are modified tuna long-liners ranging in length from 45 to 60 m, with a gross tonnage of up to 300 t. Catch rates range from 5 to 15 t per day. Examples of fishing vessels are shown in Figs. 3–6.

TABLE 1: Japanese trawl catch and effort (1976) by size class

GRT	Size class	Days fished	Catch (t)	Catch rate (t/day)
550–1 000	3	5	32	6.40
1 000–1 500	4	977	21 504	22.01
1 500–2 000	5	915	14 583	15.94
2 000–2 500	6	131	12 927	98.68
2 500–3 000	7	785	32 738	41.70
3 000–4 000	8	447	18 663	41.75
Total		3 260	100 447	30.81

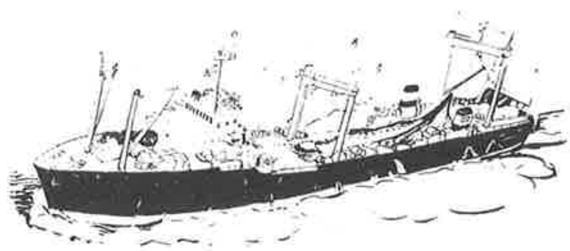


Fig. 3: Japanese stern trawler.

Fig. 4: Japanese bottom long-liner.

Fig. 5: Soviet RTM factory stern trawler.

Fig. 6: Soviet SRTM side trawler.

Estimation

Since the inception of the New Zealand 200-mile EEZ several estimates of deep-water demersal resource potential have been put forward. The Fishery Agency of Japan (Anon. 1978a) estimates the total (coastal and deep-water) demersal biomass to be 8.792 million t with a maximum sustainable yield (MSY) of 879 000 t. Shpack (1978) estimates the southern blue whiting standing stock of the Campbell Plateau-Bounty Platform to be as high as 1.24 million t with a MSY of 250 000 t. Blagodyorov and Nosov (1978) estimate the hoki population to the east and south-east of the South Island to range from 130 000 to 300 000 t with a safe biological yield of 34 000 to 75 000 t. Dudarev (1978) estimates the safe biological yield of deep-water dory (*Neocittus rhomboidalis*) to the east of the South Island to be 60 000 to 70 000 t. Finally, Nosov (1978) estimates the standing stock of jack mackerel (the Soviets recognise only one species, *Trachurus declivis*) to be about 800 000 t with a MSY of 140 000 t.

This is the first attempt to document not only the estimates of deep-water demersal standing stocks and potential catches, but the estimation procedures themselves. The estimates presented here depend entirely on two sources of data: detailed trawl-by-trawl records of the 3400-GRT Japanese research-exploratory fishing stern trawler FRV *Shinkai Maru* and summaries of Japanese commercial trawling activities in New Zealand waters for an overlapping time period.

Shinkai Maru worked the New Zealand deep-water fishing areas from October 1975 until February 1977*. In that time the vessel fished for 300 days, made 1100 trawls, and caught a total of 9063 t of fish. Her characteristics were as follows: length 94.93 m; breadth 16.00 m moulded; tonnage 3393.23 GRT; horsepower 5000 PS; net, a commercial fourseam bottom trawl with headline length 50.00 m; average headline height 7.00 m; groundrope length 70.00 m; net length 89.70 m; doors 28.00 x 40.00 m; distance between wing-ends 39.00 m; cod-end, 100-mm double. Summaries of her four cruises are given in Fig. 7 and Table 2. Records of location, time of day, catch by species, average depth, average speed, time for haul, and surface and bottom temperature were available for each station.

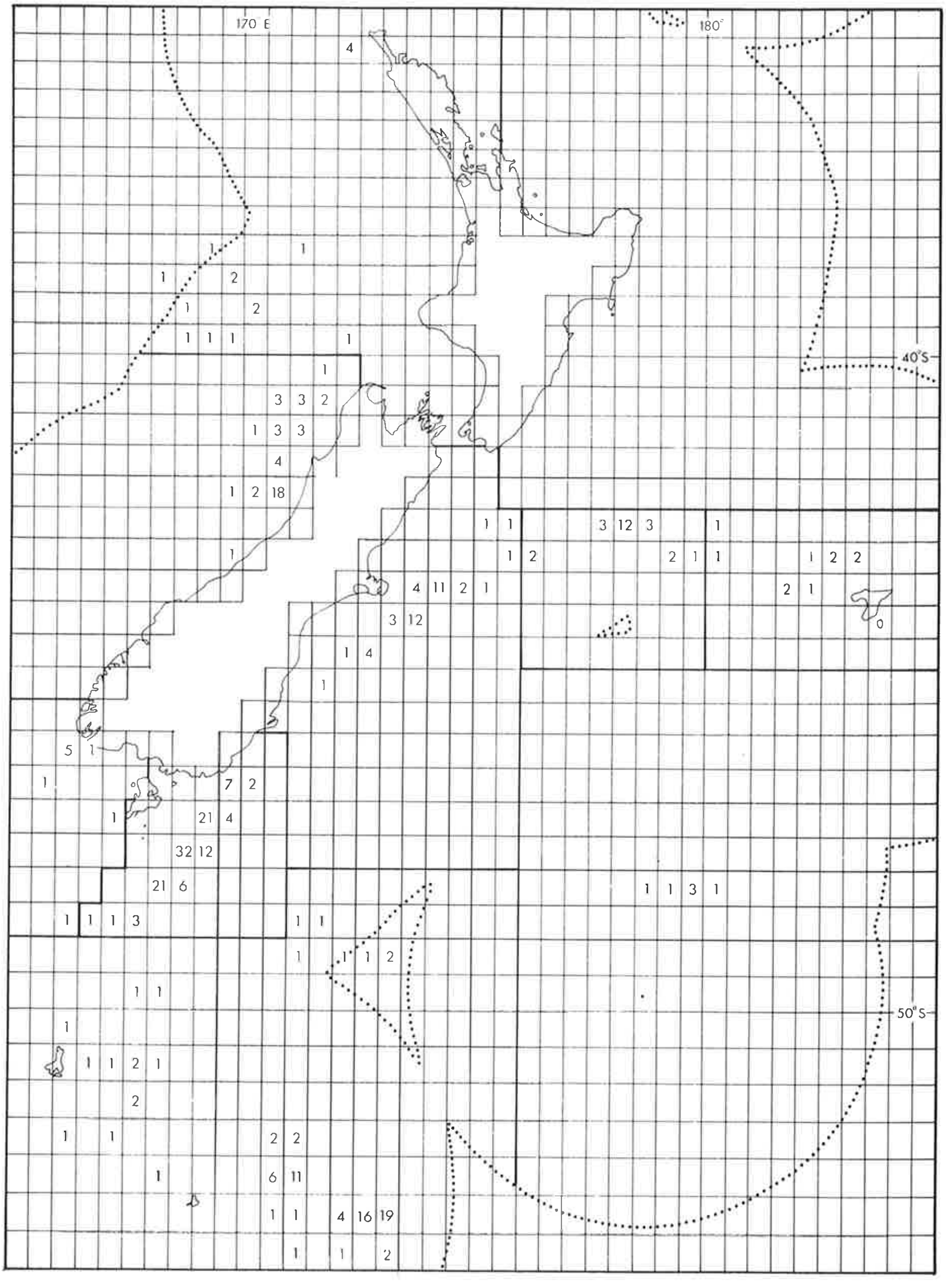
The second major data base for our study was detailed catch and effort information from all Japanese commercial trawlers which fished the New Zealand area in 1975 and 1976. Summaries of catch by species and hours fished are given by month, ½° latitude by ½° longitude, and vessel size class. These data are summarised for the periods of the *Shinkai Maru* cruises in Table 2.

The primary intent of the four *Shinkai Maru* cruises was to determine where deep-water commercial trawling potential was greatest at various times of year in the New Zealand EEZ. The fishing plan was therefore to explore an area until commercial concentrations of fish were found and then, with the help of the Japanese commercial fleet, fish these concentrations as hard as possible. Obviously this is not an "ideal" experimental design for a groundfish survey (Jones and Pope 1973).

For the estimation of stock densities extensive stratification was required. The entire ground surveyed was divided into five areas based on historic fishing patterns and predominant species caught (see Fig. 1). Areas 2, 3, and 4 were each divided into two subareas because of non-homogeneity of both physical and biological characteristics. Separate estimates were made for each subarea before being combined into areal estimates. The Chatham Rise (Area 2) was divided into east and west subareas at 180°, the Campbell Plateau was separated from the Bounty Platform in Area 3, and Southland (Area 4) was divided into east and west subareas because of the basic faunal differences between the two sides of the Stewart Island shelf.

Preliminary analyses indicated that catch variation within areas was most significant with depth and location. Species tend to have preferred depths and they tend to aggregate spatially. In areas where there were diurnal fluctuations in catch rates, *Shinkai Maru* did most fishing during daylight hours. Therefore diurnal influences on catch rates were minimal. For these reasons, and since the Japanese commercial data were given by ½° squares, it was

**Shinkai Maru* data for April to August 1975 have recently come to our notice. These were not included in the original data set received from JAMARC, but they are now being analysed.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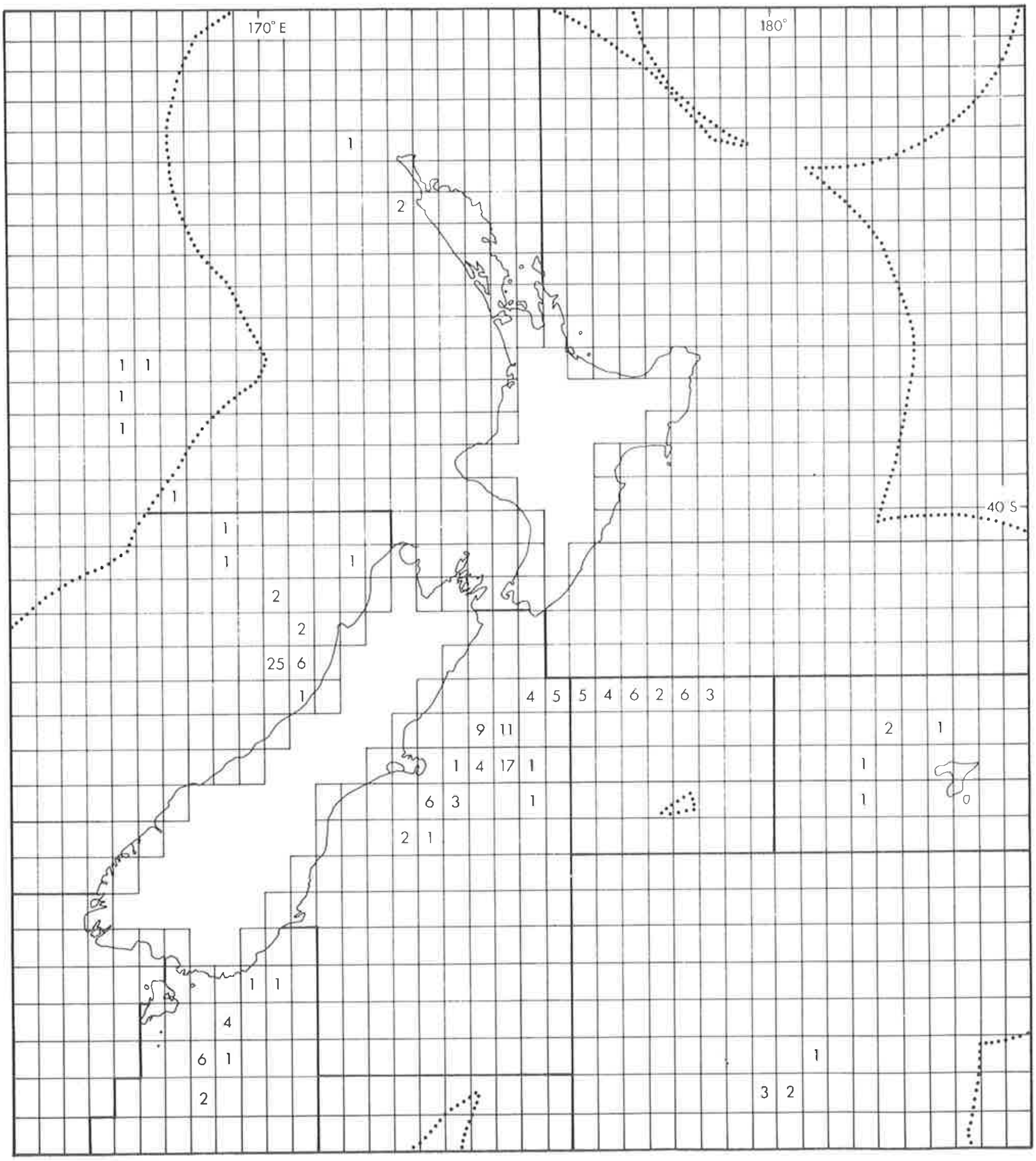

Figs. 7a and b (above and left): Number of *Shinkai Maru* stations in each ½° latitude by ½° longitude square, Cruises 1 and 2.

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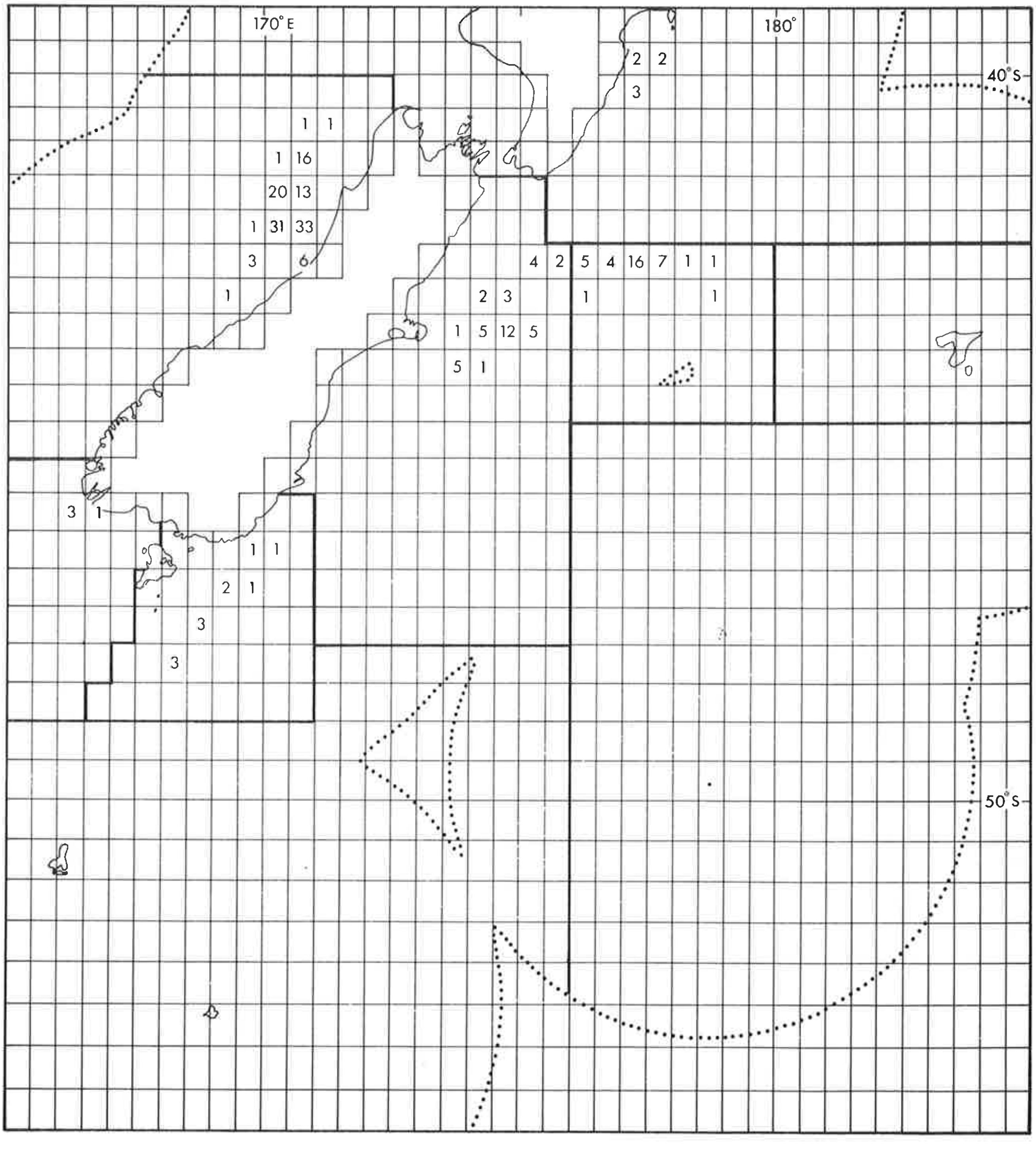

Fig. 7c: Number of *Shinkai Maru* stations in each ½° latitude by ½° longitude square, Cruise 3.

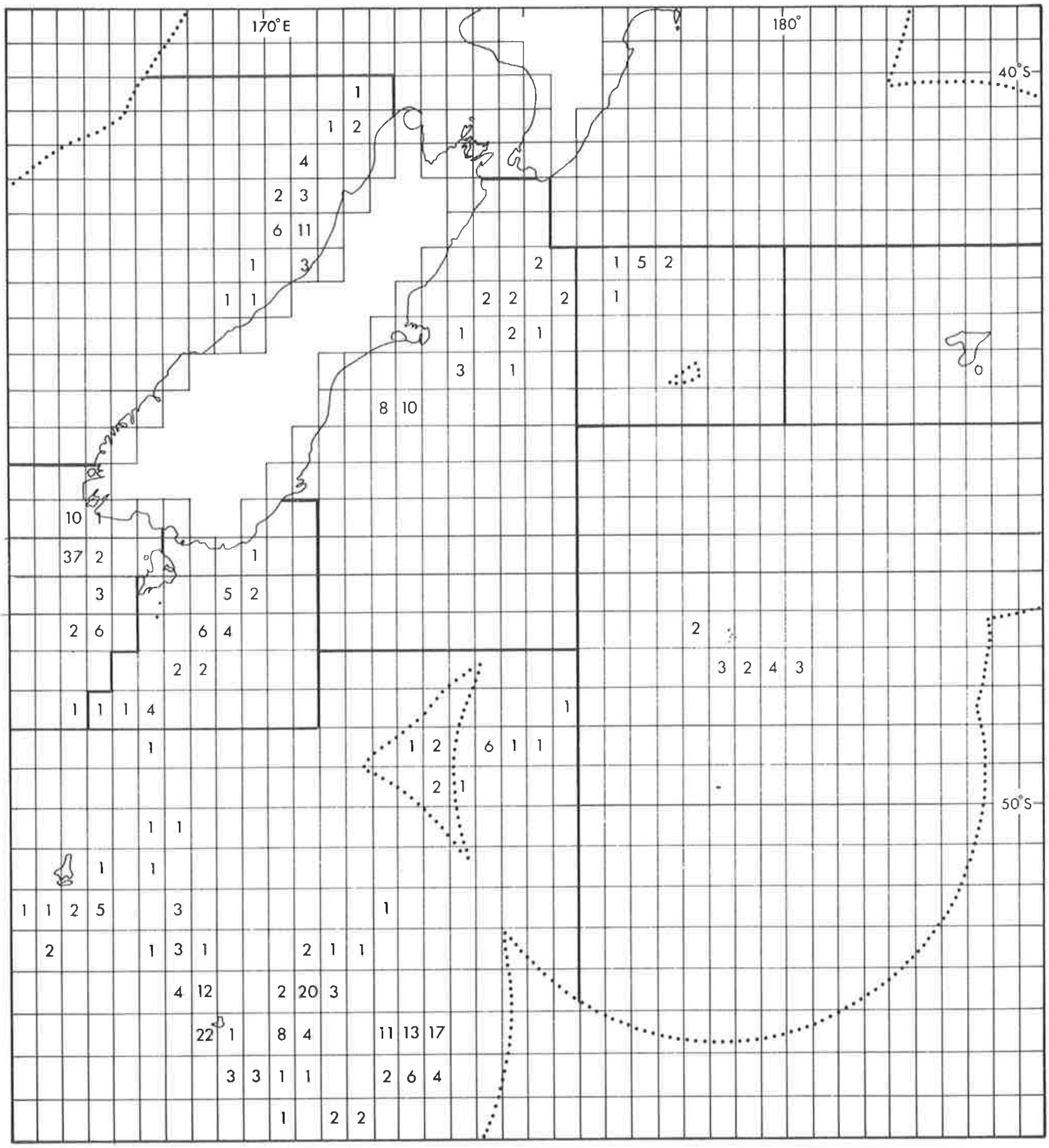

Fig. 7d: Number of *Shinkai Maru* stations in each ½° latitude by ½° longitude square, Cruise 4.

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TABLE 2: Summaries of *Shinkai Maru* cruises and corresponding Japanese commercial trawl data

	Shinkai Maru				Japanese commercial		
Area	No. of stations	Catch (t)	CPHF*	Sp. (%)†	Catch (t)	CPHF	Sp. (%)
Cruise 1 Oct 1975-Feb 1976							
1	42	142.714	1.18	HOK(43)	8 719	2.20	—‡
2E	10	17.760	0.66	HOK(57)	31	0.89	HOK(48)
2W	23	107.461	1.55	HOK(72)	150	1.92	HOK(66)
3E	6	8.377	0.40	SBW(85)	10	0.48	SBW(70)
3W	86	730.540	2.05	SBW(79)	5 318	1.30	BUT(48)
4E	110	1 425.610	3.23	SWA(80)	9 370	2.76	BUT(77)
4W	9	21.321	0.80	SKI(26)	43	1.16	BUT(38)
5	42	257.924	2.02	BAR(51)	2 058	1.96	BAR(39)
6	16	18.978	0.54	FRO(45)	4 663	2.16	JMA(72)
Cruise 2 Apr-Jun 1976							
1	65	446.678	1.91	HOK(39)	10 313	3.50	HOK(20)
2E	5	8.656	0.53	HOK(35)	7	0.70	—
2W	26	252.022	3.34	ORH(44)	1 011	6.40	—
3E	6	29.238	1.48	SBW(97)	30	1.50	SBW(97)
4E	15	130.259	2.16	SWA(83)	3 685	1.83	BUT(58)
5	39	393.328	2.54	HAK(57)	3 748	2.83	HAK(51)
6	8	9.429	0.50	SKI(50)	701	2.17	JMA(79)
Cruise 3 Jul-Sep 1976							
1	40	150.840	1.09	SWA(22)	857	1.00	JMA(43)
2W	36	140.743	1.10	SWA(22)	157	1.14	—
4E	11	22.181	0.56	HOK(20)	28	0.70	—
4W	4	22.992	1.49	LIN(49)	27	1.80	LIN(42)
5	127	2 258.709	4.26	HOK(51)	27 936	3.95	HOK(56)
7	7	74.212	2.16	BYX(90)	78	3.90	—
Cruise 4 Nov 1976-Feb 1977							
1	34	109.280	1.09	HOK(40)	22 785	1.85	SQU(38)
2W	9	63.585	2.05	HOK(79)	87	1.26	HOK(56)
3E	14	42.368	1.03	SBW(83)	46	1.12	SBW(76)
3W	186	1 493.200	2.42	SBW(55)	1 896	2.20	SBW(46)
4E	28	81.170	0.93	SWA(32)	3 962	1.18	BUT(57)
4W	62	433.042	2.03	LIN(62)	2 234	1.56	LIN(67)
5	36	169.953	1.50	FRO(34)	1 444	1.42	—

* Catch per hour fished (t/h trawled).
† Predominant species in catch (% of total).
‡ No predominant species.

decided that within each subarea-time period for which estimates of standing stock density were to be made, separate estimates would be made for each ½ ° square-depth interval. Three depth intervals were used: 200–400 m, 400–600 m, and 600–800 m. These depth constraints were forced by the facts that *Shinkai Maru* rarely fished shallower than 200 m or deeper than 800 m and that species tended to concentrate in 200-m depth ranges. Estimates of bottom area by depth interval and fishing area are given in Table 3.

For each area, estimates of stock density were made in time periods for which *Shinkai Maru* made a minimal number of hauls, preferably at all three depth intervals. Table 4 shows the timing of the estimates, which were made over periods ranging from 1 to 3 months. The length of each period relates to the amount of time that *Shinkai Maru* spent in a given area during a given cruise. Separate estimates were made for June-July and August-September 1976 in Area 5 because the species composition and depth distribution of the catch changed significantly between these two periods.

TABLE 3: Estimates of bottom area* (km²) by depth interval for deep-water fishing areas

Area	200–400 m	400–600 m	600–800 m	Total
1	8 035	18 536	10 629	37 200
2E	15 768	26 139	13 972	55 879
2W	19 076	18 722	6 981	44 779
3E	5 725	7 170	13 948	26 843
3W	19 142	151 303	83 912	254 357
4E	1 974	3 781	18 241	23 996
4W	3 990	2 634	2 233	8 857
5	9 310	6 325	9 646	25 281
Total	83 020	234 610	159 562	477 192

* Bottom areas are approximate because of inadequate bathymetric data.

TABLE 4: Timing of estimates made from *Shinkai Maru* data

Year	Month	Area 1	2	3	4	5
1975	Nov		x		x	
	Dec				x	
1976	Jan			x		
	Feb					
	Mar					
	Apr	x				
	May	x	x		x	
	Jun	x				x
	Jul		x			x
	Aug		x			x
	Sep		x			x
	Oct					
	Nov				x	
	Dec			x	x	
1977	Jan			x		

The analytic technique which was used for the estimation of standing stock is a modification of that discussed by Alverson and Pereyra (1969). The method is founded on the basic assumption (Gulland 1969) that catch per unit of effort (CPUE), in this instance catch per distance trawled, is a function of stock density in the stratum being surveyed and that changes in CPUE are proportional to changes in stock density. If one is then willing to make certain assumptions about the width of the sweep of a trawl, the efficiency of the gear (escapement), and the vertical distribution of the stock in the water column (availability), it is possible to calculate stock density and subsequently estimate the total standing stock of demersal fish in a defined area.

In most instances in which estimates could be made, the Japanese commercial trawl fleet fished a larger overall area than that fished by *Shinkai Maru*. However, since the commercial records were summaries of catch and hours trawled by ½° square, month, and vessel size class, they could not be used directly in the estimation of stock density. The detailed individual trawl records from *Shinkai Maru* had to be the basis of all estimates. The commercial fleet data had to be standardised to those of *Shinkai Maru* so that they could be used together. For a given area-time period stratum, the average efficiency (catch per hour fished) relative to *Shinkai Maru* of each commercial size class was computed by the geometric mean method (Shimada and Schaefer 1956). Let

C_{ijk} = catch (t) for size class k during month j in ½° square i (k = 0 for *Shinkai Maru*)

f_{ijk} = hours fished for size class k during month j in ½° square i (k = 0 for *Shinkai Maru*)

$U_{ijk} = C_{ijk}/f_{ijk}$

n_k = number of ½° square-months where $f_{ijk} > 5$ and $f_{ij0} > 1$

Then

ρ_k = relative fishing power of size class k to *Shinkai Maru*

$$= \exp\left[\frac{1}{n_k}\sum_i\sum_j \log_e\left(\frac{U_{ijk}}{U_{ij0}}\right)\right]$$

These values are given in Table 5.

For a given time period-area-depth stratum, the estimation of relative stock density was done by a three-step procedure.

1. *Shinkai Maru* (**SM**). Make a direct estimate for all ½° squares where *Shinkai Maru* fished for more than 1 hour at depth range d

Y_{il} = catch (t) of trawl l at depth range d in ½° square i

s_{il} = speed (knots) of trawl l at depth range d in ½° square i

t_{il} = time (hours) of trawl l at depth range d in ½° square i

Then for all ½° squares i where $\sum_l t_{il} > 1$

D_i = relative stock density (t/km trawled)

$$= \frac{\sum_l Y_{il}}{1.852 \sum_l s_{il}\, t_{il}}$$

2. **Step 1.** Make a comparative estimate for all ½° squares (i) where *Shinkai Maru* fished for less than 1 hour at depth range d, the Japanese commercial fleet fished for more than 5 standard hours, and more

TABLE 5: Relative fishing power of Japanese commercial fleet to *Shinkai Maru*

Area	Time	Size class 4	5	6	7	8
1	Apr-Jun '76	0.829 99		2.068 98	1.206 26	1.241 60
2	Nov '75					1.407 09
	May, Jul-Sep '76					1.023 21
3	Jan '76, Dec '76-Jan '77	0.682 85	0.239 49			1.184 72
4	Nov-Dec '75		0.250 68		0.614 50	0.691 76
	May '76	0.652 12		0.854 01	0.352 35	0.947 62
	Nov-Dec '76	0.667 10	0.558 56		0.464 64	1.386 56
5	Jun-Sep '76	0.641 05	0.409 88	2.358 52	1.574 67	1.553 48

than 20% of the bottom area between 200 and 800 m lies in depth range d. Let

Y_{ik} = catch of size class k in ½° square i (k = 0 for *Shinkai Maru*)

f_{ik} = hours fished of size class k in ½° square i

a_{i1} = bottom area of ½° square i at 200–400 m

a_{i2} = bottom area of ½° square i at 400–600 m

a_{i3} = bottom area of ½° square i at 600–800 m

a_{id} = bottom area of ½° square i at depth range d

$Z_{id} = a_{id}/(a_{i1} + a_{i2} + a_{i3})$

U_i = catch per standard hour fished (CPSHF) of Japanese commercial fleet in ½° square i

$= \sum_k Y_{ik}/\sum_k \rho_k f_{ik}$

Then for all ½° squares i where

a. $f_{i0} < 1$

b. $\sum_{k \neq 0} \rho_k f_{ik} > 5$

c. $Z_{id} > 0.20$

and all ½° squares j where SM estimates have been made, let

$R_{ij} = U_i/U_j$

X_{ij} = longitudinal distance (°) between ½° squares i and j

Y_{ij} = latitudinal distance (°) between ½° squares i and j

$W_{ij} = Z_{jd}/(X_{ij}^2 + Y_{ij}^2)$

then

$$\hat{D}_i = \left(\sum_j W_{ij}R_{ij}D_j\right) / \sum_j W_{ij}$$

Therefore for a given depth range d the Step 1 estimates are weighted means of the existing SM estimates at that depth adjusted for differences in commercial catch rates. The weighting factor between a ½° square i where the Step 1 estimate is to be made and a ½° square j where a SM estimate has already been made is directly proportional to the fraction of ½° square j at depth d and inversely proportional to the distance between ½° squares i and j. This system of weighting was chosen on an empirical basis as was the form of the Step 1 estimator. It was felt that W_{ij} should take into account the distance between ½° squares and the likelihood that the commercial CPSHF in ½° square j was recorded at depth range d.

3. **Step 2.** For all ½° squares (i) which have bottom area at depth d, but which do not satisfy the criteria for either *Shinkai Maru* or Step 1 estimates, compute a weighted average of all previous estimates where the weighting factor is identical to that for Step 1 estimates. Therefore, letting j range over all ½° squares where *Shinkai Maru* and Step 1 estimates have been made at depth d,

$$\hat{D}_i = \sum_j W_{ij}D_j / \sum_j W_{ij}$$

It was originally hoped that the fact that a ½° square had no *Shinkai Maru* or commercial effort in it during a given period might indicate that stock densities were low in that area, and that this information might be used in the Step 2 estimation procedure. However, tests indicated no significant relationship between catch rates and the total amount of effort expended in a ½° square-time period. That is why the Step 2 estimates are simple weighted averages of the SM and Step 1 estimates.

The ½° square-depth estimates of relative stock density are then combined to give an estimate of relative stock density for the time-area stratum at depth d as

$$\hat{D}_d = \sum_i a_{id}D_i / \sum_i a_{id}$$

These estimates are further combined to give an average stock density for the time-area stratum as a whole. Estimates are given for total standing stock as well as certain selected species in Table 6. For a given area missing time-depth strata densities are estimated by use of the analysis of variance model

$$Y_{ij} = \mu + \alpha_i + \beta_j + \epsilon_{ij}$$

where

i = time of estimate

j = depth stratum

Y_{ij} = natural logarithm of relative stock density at time i, depth j

μ = natural logarithm of mean density for the area as a whole

α_i = deviation of Y_{ij} from μ due to time i

β_j = deviation of Y_{ij} from μ due to depth j

ϵ_{ij} = random variable distributed $N(0, \sigma^2)$

The parameters μ, $\{\alpha_i\}$, $\{\beta_j\}$ are then estimated by the method of least squares. The form of the linear model resembles that of Robson (1966). The basic ½° square parameters and variables used in the estimates are presented in Appendix 2.

It is clear that *Shinkai Maru* did not fish at random or according to a predetermined grid pattern. Within

TABLE 6: Estimates of relative stock density (t/km trawled)

Area	Date	Species	200–400 m	400–600 m	600–800 m	Total (200–800 m)
1	Apr-Jun '76	Total	0.108	0.225	0.231	0.201
		HOK	0.009	0.103	0.054	0.068
2E	Nov '75	Total	0.091	0.081	0.169	0.106
		HOK	0.054	0.046	0.109	0.064
	May '76	Total	0.110*	0.099	0.205*	0.129
		HOK	0.053*	0.045	0.107*	0.063
2W	Nov '75	Total	0.100	0.146	0.243	0.142
		HOK	0.067	0.104	0.170	0.099
	May '76	Total	0.123*	0.274	0.195	0.210
		HOK	0.065*	0.142	0.117	0.105
	Jul-Sep '76	Total	0.065*	0.118	0.126	0.097
		HOK	0.007*	0.021	0.009	0.013
3E	Dec '76-Jan '77	Total	0.027	0.137	0.082	0.085
		SBW	0.001	0.114	0.063	0.063
		HOK	0.000	0.017	0.000	0.005
3W	Jan '76	Total	0.037	0.237	0.163	0.198
		SBW	0.000	0.164	0.024	0.105
		HOK	0.007	0.039	0.097	0.056
	Dec '76-Jan '77	Total	0.469	0.275	0.118	0.238
		SBW	0.134	0.173	0.012	0.117
		HOK	0.264	0.059	0.086	0.083
4E	Nov-Dec '75	Total	0.710	0.698	0.722*	0.717
		SWA	0.600	0.619	0.023*	0.164
	May '76	Total	0.404	0.352	0.387*	0.383
		SWA	0.384	0.276	0.012*	0.084
	Nov-Dec '76	Total	0.247	0.114	0.172	0.169
		SWA	0.136	0.005	0.000	0.012
4W	Nov-Dec '75	Total	0.159	0.061	0.129*	0.122
		LIN	0.012	0.022	0.082*	0.033
	Nov-Dec '76	Total	0.148	0.244	0.248	0.202
		LIN	0.007	0.187	0.183	0.105
5	Jun-Jul '76	Total	0.271	0.676	0.301	0.384
		HOK	0.000	0.558	0.139	0.193
		HAK	0.000	0.070	0.122	0.063
		BAR	0.007	0.000	0.000	0.003
	Aug-Sep '76	Total	0.718	0.454	0.163	0.440
		HOK	0.001	0.343	0.007	0.089
		HAK	0.000	0.018	0.140	0.058
		BAR	0.463	0.018	0.000	0.175

* Estimated by analysis of variance.

a given area she tended to fish, if possible, where fishing was the best. Therefore one might expect that the density where she did fish was considerably higher than the average density in that area as a whole and that this might be reflected by an upward bias in the estimates of biomass density. Our hope was that the stratification was sufficient to eliminate any bias of this sort from the estimates. To test for this bias, a comparison was made of statistics and density estimates generated by *Shinkai Maru* with similar statistics and estimates produced from a systematic grid survey by the Japanese fisheries research vessel *Kaiyo Maru* in late 1977 and early 1978.

Kaiyo Maru (Anon. 1978b) worked three New Zealand deep-water fishing areas: Chatham Rise-Mernoo Bank (Areas 1 and 2), Pukaki Rise (Area 3W), and Campbell Island Rise (Area 3W) from 11 December 1977 to 12 February 1978. In that period the vessel fished for 45 days, made 116 trawls, and caught a total of 92 t. Her characteristics were as follows: length 91.87 m; breadth 15.00 m moulded; tonnage 2539.48 GRT; net, a fourseam research bottom trawl with headline length 52.70 m; average headline height 5.00 m; average distance between wing-ends 19.00 m; interchangeable cod-ends of 104.3-mm, 76.1-mm, and 60.2-mm mesh, with a 30-mm mesh cod-end cover.

The location of stations latticed over the grid surveyed by *Kaiyo Maru* is given in Fig. 8. Two methods of comparison of the *Shinkai Maru* survey with the *Kaiyo Maru* survey were used. In the first the ratio between research vessel and Japanese commercial trawler catch rates (catch per hour trawled) was computed for selected times and areas for the two surveys. The commercial fleet was divided into two size classes of vessels because of differences in

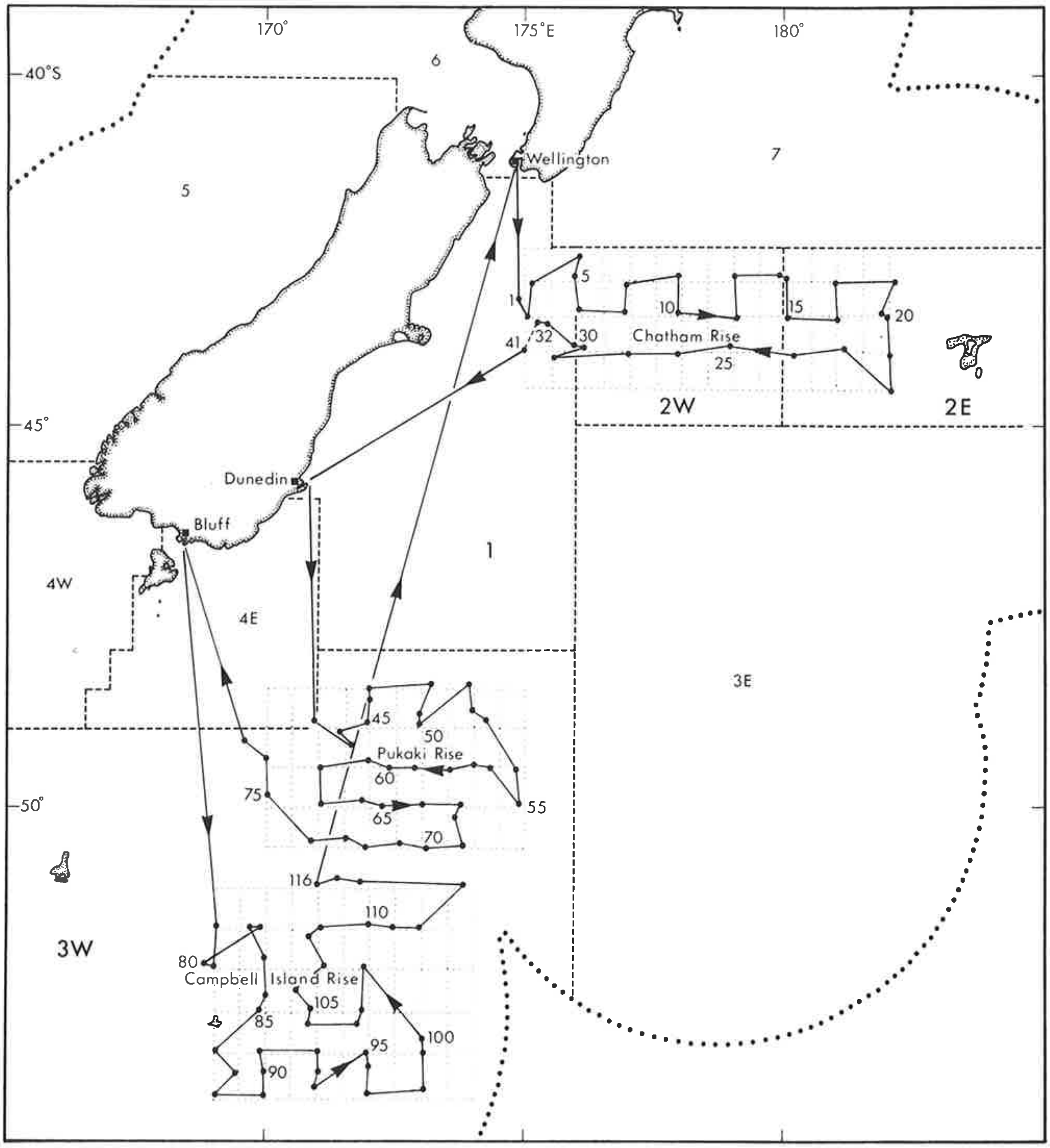


Fig. 8: *Kaiyo Maru* cruise track and station locations, December 1977 to February 1978.

relative fishing power: size class 5 – (smaller than 2000 GRT) and size class 6 + (larger than 2000 GRT). Unfortunately no Japanese commercial trawl statistics are at present available for the first quarter of 1978 in Area 3 and so that area could not be used in this first analysis. The *Kaiyo Maru* survey statistics of December 1977 are compared with Japanese commercial statistics from the fourth quarter (October, November, December) of 1977 and the *Shinkai Maru* survey statistics of November and December 1975 are

TABLE 7: Catch rates of research vessels and Japanese commercial vessels

Source	Size class	Time	Catch rate (t/h) Area 1	Area 2	Area 1 + 2
Kaiyo Maru		Dec '77	1.12	1.05	1.08
Japanese commercial	5 –	4th quarter '77	1.73	1.12	1.30
Japanese commercial	6 +	4th quarter '77	1.37	2.80	2.76
Shinkai Maru		Nov-Dec '75	1.18	1.42	1.29
Japanese commercial	5 –	4th quarter '75	0.84	0.88	0.84
Japanese commercial	6 +	4th quarter '75	1.83	1.77	1.82

compared with the Japanese commercial statistics from the fourth quarter of 1975 (Table 7).

Table 8 gives the ratios of the research vessel catch rates to the commercial catch rates. The *Kaiyo Maru* catch rates were first multiplied by 39/19 (= 2.05), the ratio of the width of sweep of the *Shinkai Maru* net to that of the *Kaiyo Maru* net, to make the ratios comparable. Further corrections in fishing power could be made to account for the change in commercial cod-end mesh size between 1975 and 1977 and the differences in average headline height between the two research vessels. However, these two factors, when estimated, appear to cancel each other out.

TABLE 8: Ratios of research vessel catch rates to commercial catch rates

Source	Area 1	Area 2	Area 1 + 2
2.05 x *Kaiyo Maru*/5 –	1.33	1.92	1.71
2.05 x *Kaiyo Maru*/6 +	1.68	0.77	0.80
Shinkai Maru/5 –	1.40	1.61	1.54
Shinkai Maru/6 +	0.64	0.80	0.71

Table 8 shows that, once the discrepancy in fishing power between *Kaiyo Maru* and *Shinkai Maru* is accounted for, there is no indication that differences in survey designs gave *Shinkai Maru* a significantly higher fishing power than *Kaiyo Maru* in relation to the commercial fleet.

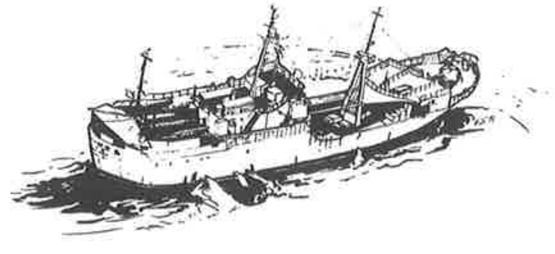
The second method of comparison between the two surveys was to estimate average stock density for comparable time-area-depth strata. *Kaiyo Maru* estimates were made for Areas 1 and 2 for 200–600-m depth range during December 1977 and for Area 3W for 200–800-m depth range during January and February 1978. (The estimates for Area 3W were made with no concomitant commercial statistics.) These are compared with *Shinkai Maru* estimates for Area 2 for 200–600-m depth range during November 1975 and for Area 3W for 200–800-m depth range during January 1976 and December 1976-January 1977. The estimates are given in Table 9.

TABLE 9: Average stock density (t/km trawled)

Source	Area 1	Area 2	Area 3W
Kaiyo Maru Dec '77-Feb '78	0.073	0.109	0.084
2.05 x *Kaiyo Maru*	0.150	0.224	0.172
2.05 x 1.40 x *Kaiyo Maru*	0.209	0.313	0.241
Shinkai Maru Nov '75	-*	0.103	-
Shinkai Maru Jan '76	-	-	0.198
Shinkai Maru Dec '76-Jan '77	-	-	0.238

* No estimates made during time period.

Three sets of *Kaiyo Maru* estimates are given: the raw estimates of average stock density, the estimates corrected for differences in width of sweep between the *Shinkai Maru* and *Kaiyo Maru* nets (2.05 x *Kaiyo Maru*), and the estimates corrected for differences in width of sweep (2.05) and average headline height (7/5 (= 1.40)) between *Shinkai Maru* and *Kaiyo Maru*. Again, once the *Kaiyo Maru* estimates are corrected for discrepancies in fishing power relative to *Shinkai Maru*, there is no indication that the *Shinkai Maru* survey, because of its design, tended to produce upwards biased estimates of biomass density.



Fishery Potential

The fishery potential of the deep-water area surveyed by *Shinkai Maru* was estimated according to the methods described by Alverson and Pereyra (1969). Estimates of unexploited standing stock were made from the estimates of relative standing stock density. Then potential stock production could be estimated. In this publication estimates of fishery potential were made for the total biomass and the two predominant species in the fishery, hoki and southern blue whiting. Table 10 gives the estimates of relative stock density (tonnes/kilometre trawled) selected to be used as the basis for the estimates of fishery potential. Time periods of highest recorded density were used for Areas 3, 4W, and 5. Note that in Area 5 the estimate for the 200–400-m depth stratum was chosen from the August-September 1976 period, a time when barracouta was densely concentrated at this depth, and the estimate for the two deeper strata was chosen from the June-July 1976 period, when hoki and English hake were densely concentrated in the deeper waters of this area.

The entire deep-water fishing ground of Areas 1, 2, and 4E lies under the Subtropical Convergence (see Fig. 2). There is evidence (Paul 1979) to indicate that certain stocks, in particular silver warehou, migrate along the Subtropical Convergence between these three areas. It was therefore decided that the estimates of relative stock density to be used as a basis for estimates of fishery potential for these three areas should all be made for the same general time period. The period around May 1976 was chosen for this reason.

For a given fishing area i, let

A_i = total bottom area between 200 and 800 m (km^2)

D_i = estimate of relative stock density (t/km trawled)

a = width of the area swept by the *Shinkai Maru* net (km)

$1 - E$ = fraction of the stock available to the *Shinkai Maru* net

Then

B_i = standing stock biomass of area i

$= D_iA_i/a(1 - E)$

The difficulty in the extrapolation is in the determination of a and E for different species and areas. Here, values of a range from 0.039 km (estimated distance between the wings of the *Shinkai Maru* net, T. Inada pers. comm.) to 0.033 km (head rope length divided by 1.5, a value commonly used by the Japanese in their trawl assessments) (Liu 1976). The value of E was subject to much speculation. Although escape of small fish through the *Shinkai Maru* 100-mm double cod-end was virtually nil (Fisheries Agency of Japan pers. comm.), the fact that the net reached to an average headline height of only 7 m certainly limited its ability to sample fully the demersal community. Values of E were used which ranged from $E = 0.0$ (100% availability) to $E = 0.5$ (50% availability, a value commonly used by the Japanese) (Liu 1976). This value compares favourably with the average availability ($1 - E = 0.57$) to Soviet and American research trawls reported by Edwards (1968) in his attempt to estimate the total fish resource of the continental shelf off New England in the north-west Atlantic Ocean. (This estimate is **only** for fish that go right to the bottom and are available to bottom trawl gear in substantial numbers in certain seasons or at certain times of the day.)

Several methods are at present being used to estimate potential fishery production of latent (unexploited) resources. The method used here, attributed to J. A. Gulland, is described by Alverson and Pereyra (1969) and Francis (1974) and is based on the following assumptions:

1. At or near the level of MSY, F (instantaneous fishing mortality) is approximately equal to M (instantaneous natural mortality).

2. According to the logistic stock production model of Schaefer (1954), MSY is reached when the exploitable population reaches about half of its unexploited biomass (B_0).

With these two assumptions, MSY can be calculated as

$$MSY = 0.5MB_0$$

Tables 11 and 12 give estimates of standing stock biomass and MSY in their extreme values (a = 0.039

km, E = 0.0 and a = 0.033 km, E = 0.5) and under the assumptions that:

1. All stocks were virtually unexploited when sampled by *Shinkai Maru,*

2. M = 0.4 for southern blue whiting (SBW),

3. M = 0.3 for hoki (HOK),

4. M = 0.3 for all other demersal species combined (OTH).

TABLE 10: Estimates of relative standing stock density used to estimate potential stock production (t/km trawled)

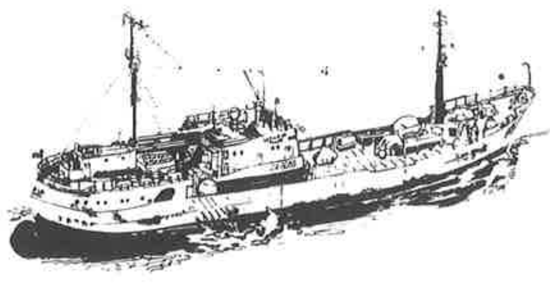
Area	Date	Species	200–400 m	400–600 m	600–800 m	Total (200–800 m)
1	Apr-Jun '76	Total	0.108	0.225	0.231	0.201
		HOK	0.009	0.103	0.054	0.068
2	May '76	Total	0.117	0.172	0.202	0.159
		HOK	0.060	0.085	0.110	0.082
3	Dec '76-Jan '77	Total	0.367	0.268	0.113	0.223
		HOK	0.203	0.057	0.074	0.076
		SBW	0.103	0.170	0.019	0.112
4E	May '76	Total	0.404	0.352	0.387	0.383
4W	Nov-Dec '76	Total	0.148	0.244	0.248	0.202
5	Jun-Sep '76	Total	0.718	0.676	0.301	0.548
		HOK	0.001	0.558	0.139	0.193

TABLE 11: Biomass estimates (10^3t), where a = 0.039 km and E = 0.0

	SBW		HOK		OTH		Total	
Area	B_0	MSY	B_0	MSY	B_0	MSY	B_0	MSY
1			65	10	127	19	192	29
2			212	32	198	30	410	62
3	808	162	548	82	252	38	1 608	282
4E					236	35	236	35
4W					46	7	46	7
5			125	19	230	35	355	54
Total	808	162	950	143	1 089	164	2 847	469

TABLE 12: Biomass estimates (10^3t), where a = 0.033 km and E = 0.5

	SBW		HOK		OTH		Total	
Area	B_0	MSY	B_0	MSY	B_0	MSY	B_0	MSY
1			154	24	300	45	454	69
2			501	76	468	71	969	147
3	1 910	383	1 295	194	596	90	3 801	667
4E					558	83	558	83
4W					109	17	109	17
5			295	45	544	83	839	128
Total	1 910	383	2 245	339	2 575	389	6 730	1 111



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Discussion

The question now becomes: How does one evaluate these broadly ranging estimates of potential deep-water demersal production? Regier (1978) suggests that "theory relevant to fisheries systems as such can be intuited, perhaps most readily by comparing and contrasting relatively gross events and large scale processes in a number of resource systems that appear to bear some resemblance to each other." We therefore decided that a more accurate overview of New Zealand deep-water demersal fishery production could be obtained if various physical and biological parameters from this system were compared with those of other major temperate demersal fisheries around the world.

First we looked at the relationship between potential demersal production (million tonnes/year) — for all practical purposes MSY — and bottom shelf area (million square kilometres) for the major temperate demersal fishing areas around the world (Fig. 9) (Gulland 1970a) and compared these with our two extreme estimates for the New Zealand area surveyed by *Shinkai Maru* (Table 13, Fig. 10). It is apparent that unless there is something abnormal about the New Zealand deep-water demersal fishing area, our first estimate (0.469 million t) is rather low when compared with those from other major temperate demersal fishing areas. However, the traditional argument (Waugh 1977) has been that since all life in the sea ultimately depends on photosynthesis, and since primary production (the production of plant material) tends to be low in New Zealand waters (due to New Zealand's relatively small land mass and the basic west to east oceanic circulation in the South Pacific), one cannot expect the sea around New Zealand to abound in the basic foods for fishes.

With this in mind we decided to investigate what was known about the relationship between primary production and demersal fishery production, as well as what information was available on the level of

TABLE 13: PDP* and BA† for major temperate demersal fishing areas and New Zealand area

Area	BA (10^6 km²)	PDP (10^6 t/yr)	PDP/BA
NW Atlantic (a)	1.260	3.550	2.82
NE Atlantic (b)	3.155	6.650	2.11
NW Pacific (c)	0.959	1.411	1.47
NE Pacific (d)	1.090	1.460	1.34
SW Atlantic (e)	1.940	3.825	1.97
SE Atlantic (f)	0.520	1.080	2.08
New Zealand			
a = 0.039 km, E = 0.0 (g)	0.477	0.469	0.98
a = 0.033 km, E = 0.5 (h)	0.477	1.111	2.33

* Potential demersal production.
† Bottom area.

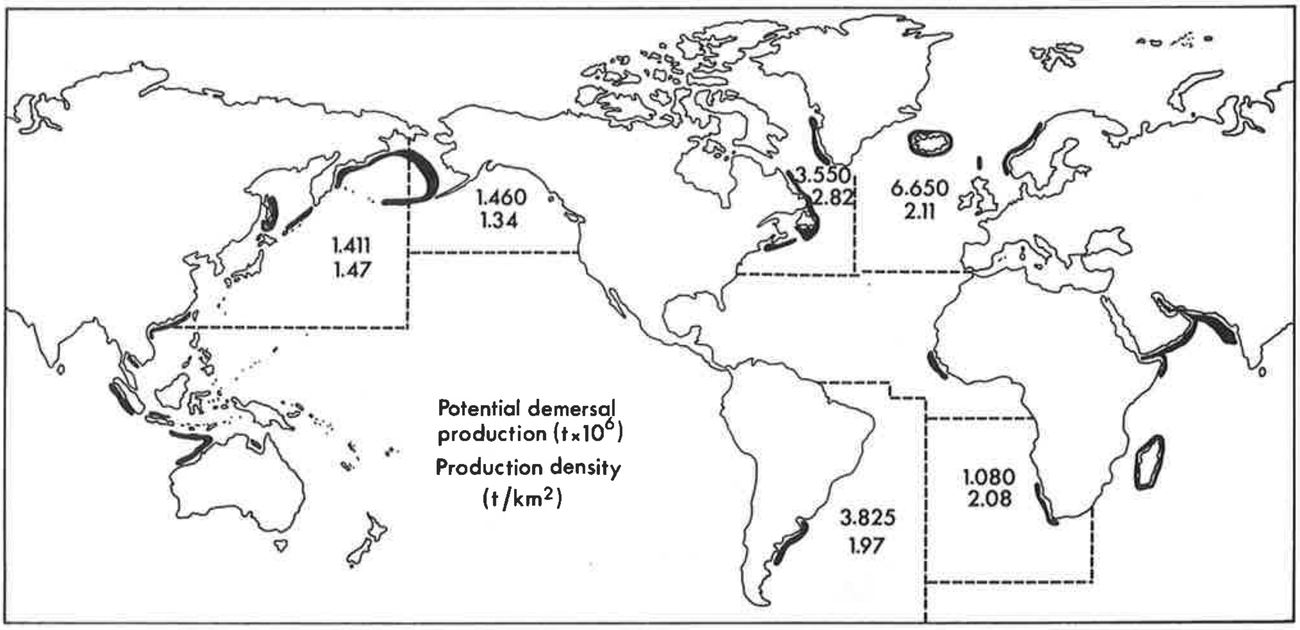


Fig. 9: Major temperate demersal fishing areas of the world (after Gulland 1970a).

TABLE 14: DPD* and PP† for some major temperate demersal fishing areas

Area	BA ($10^6 km^2$)	PP (gC/m^2yr)	PDP ($10^6 t/yr$)	DPD (t/km^2yr)
NE Pacific-Transition, Gulf of Alaska (a)	0.368	150	0.700	1.90
NE Atlantic, North Sea (b)	0.600	100	1.000	1.67
NE Atlantic, Barents Sea (c)	1.300	100	3.500	2.69
SW Atlantic, Argentina, Uruguay (d)	1.180	125	3.000	2.54
SE Atlantic, Angola, S Africa (e)	0.310	50	0.585	1.89
SE Atlantic, SW Africa (f)	0.200	200	0.720	3.60

* Demersal production density.

† Total annual primary production.

primary production in New Zealand waters. From Gulland (1970a) one can obtain the relationship between potential demersal production density and total annual primary production for some of the major temperate demersal fishing areas around the world (Table 14, Fig. 11).

Bradford and Roberts (1978) provide the most recent estimates of the areal distribution of integrated primary production for the New Zealand region. Estimates of total annual primary production in the New Zealand deep-water fishing area (J. M. Bradford, N.Z. Oceanographic Institute, pers. comm.) lie in the range of 90 gC/m^2yr (subtropical water) to 130 gC/m^2yr (subantarctic water). Therefore it appears that primary production in the New Zealand deep-water fishing area is average when compared with other temperate demersal fishing areas at a similar latitude. Accordingly, by use of a linear regression of production density on total annual primary production for Table 14, one gets a range of **point estimates** of potential production for the New Zealand deep-water fishing area of 0.992 million to 1.178 million t (corresponding to an estimated range of production density of 2.08 to 2.47 t/km^2 and a fishable bottom area of 477 192 km^2), with a 95% confidence interval of potential demersal production which ranges from 0.615 million to 1.506 million t annually. If the above regression ($y = 1.2097 + 0.0097x$, where y = DPD and x = PP) is used separately for subantarctic and subtropical fishing areas, one obtains a point estimate of potential demersal production for the subantarctic waters of the Campbell Plateau-Bounty Platform (Area 3) of 0.695 million t (PP = 130 gC/m^2yr) and for the subtropical waters of Areas 1, 2, 4, and 5 of 0.408 million t (PP = 90 gC/m^2yr). These values compare favourably with our direct estimates if a = 0.033 km and E = 0.5 are assumed.

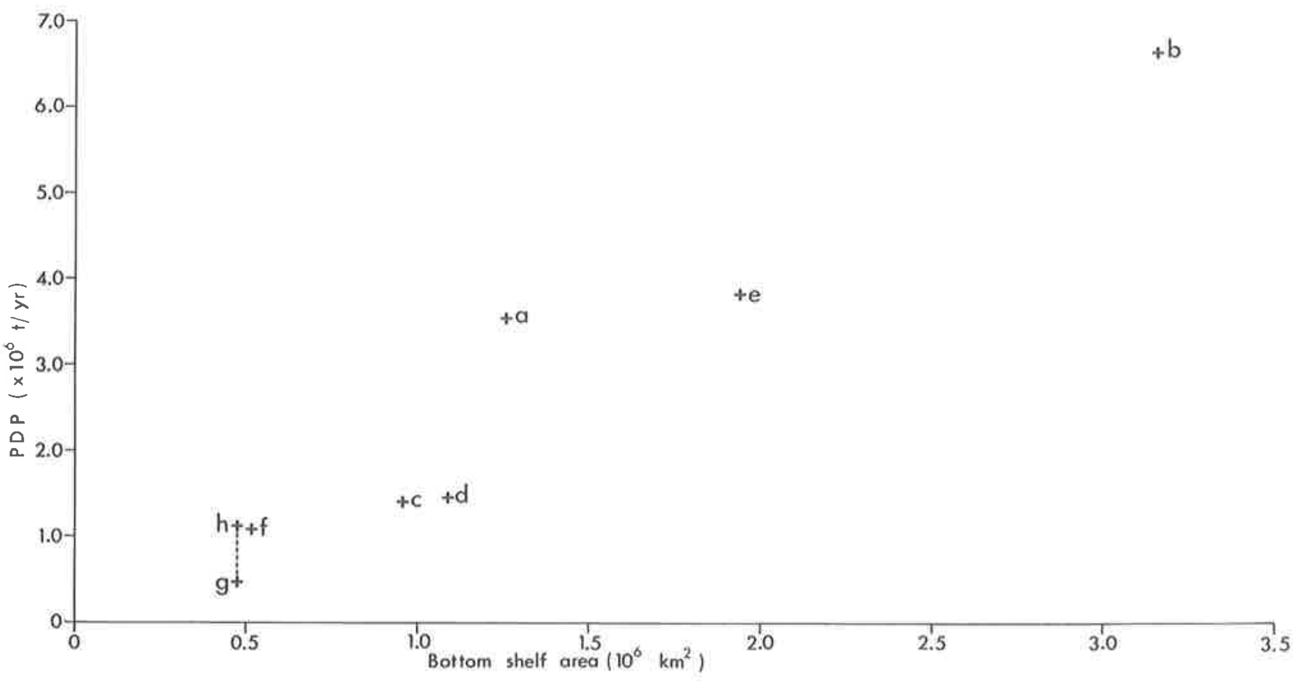


Fig. 10: Potential demersal production (PDP) plotted against bottom shelf area (see Table 13).

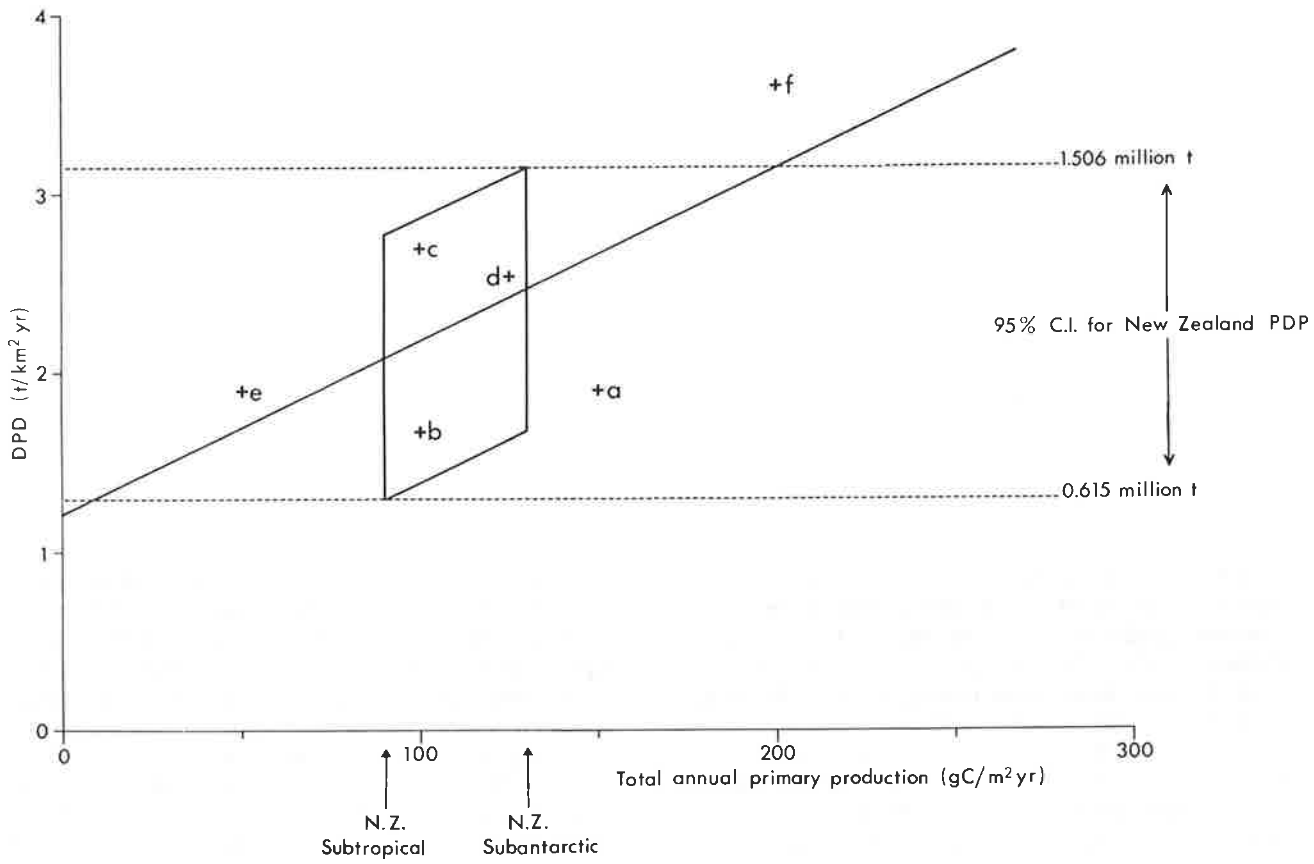


Fig. 11: Potential demersal production density (DPD) plotted against total annual primary production (see Table 14).

Finally, by use of food chain dynamics estimates similar to those of Steele (1965) and Gulland (1970b) and the assumption of a 10% efficiency of transfer between trophic levels and the same primary production values as above, one obtains potential demersal production estimates for the subantarctic waters of Area 3 of 0.627 million t and for the subtropical waters of Areas 1, 2, 4, and 5 of 0.309 million t. Once again, these resemble our direct estimates if a = 0.033 km and E = 0.5 are assumed. All estimates of potential demersal production are summarised in Table 15.

These comparative estimates, though useful for assessing the order of magnitude of the deep-water production potential, are conglomerates of many effects and should be treated with care. Gulland (1970b), Schaefer (1965), and Ryther (1969) have pointed out that not only primary production, but the associated food chain dynamics, act additively to produce differences in fish production. The deep-water demersal fishery of the New Zealand EEZ exploits a much deeper bottom area (400–500 m being potentially the most productive) than most of the other major demersal fisheries with which the above comparisons have been made. Regier and Henderson (1973) report on work by Ryder (1970), Jenkins (1970), and others who have shown that fish catches from lakes and reservoirs of a geographical region, fished at roughly equal intensities, are inversely related to mean depth. The implication is that the shallower a lake is, the less constant is the environment that it provides and the higher is the average environmental temperature, two factors which are

TABLE 15: Summary of estimates of PDP (10^6 t/yr)

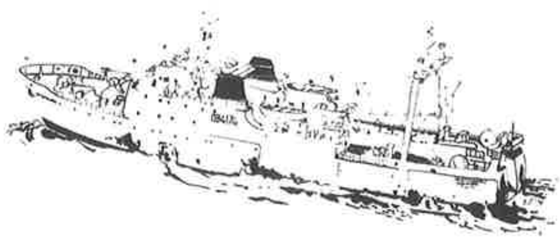
Source	Assumptions	PDP Subantarctic	PDP Subtropical	Total
Direct *(Shinkai Maru)*	a = 0.039 km, E = 0.0	0.282	0.187	0.469
	a = 0.033 km, E = 0.5	0.667	0.444	1.111
Regression (primary production)		0.695	0.408	1.103
Food chain (Steele 1965)	Trophic efficiency = 0.10	0.627	0.309	0.936

hypothesised to be directly proportional to fish production. J. A. Gulland (pers. comm.) feels that this depth factor would put the deeper New Zealand waters somewhat below the general trend line of production density on total annual primary production discussed above. On the other hand, K. Radway Allen (pers. comm.) feels that one cannot carry over Regier and Henderson's (1973) inference from closed freshwater lakes and reservoirs to open marine systems.

One interesting point to note is that stomach content analyses indicate that the most abundant species in the New Zealand deep-water demersal fishery, southern blue whiting and hoki, feed primarily in the mid-water layers on planktonic crustaceans and small mesopelagic fish. The same is true of the gadoids (cods, hakes, and pollocks) that predominate in the other major temperate demersal fisheries around the world. The implication is that the difference in average bottom depth between the New Zealand deep-water demersal fishery and most of the other major temperate demersal fisheries with which comparisons have been made is of minor importance.

Alverson and Pereyra (1969) aptly put these types of first approximation estimates into perspective in saying: "More sophisticated scientific investigation obviously will permit refinement of these preliminary forecasts and estimates. Nevertheless the estimates can serve as a basis for a rational approach to management problems. In fact, at times one wonders whether management decisions at an early stage of fisheries development based on the analysis of exploratory survey data might not lead to a more stable and economically viable fishery than a fishery that follows the normal course of boom and bust, followed by a parade of scientific post mortems." Our general feeling is that until these estimates become more refined and certain, for the immediate management of the resource we must act as if our most **conservative** estimates of resource potential are correct.

Our basic conclusion is that our second estimate of 1.111 million t per year is the most realistic estimate of potential demersal production in the area surveyed by *Shinkai Maru*. The two sets of comparative estimates (regression and food chain) certainly tend to bear this out. In addition, they indicate that the direct estimates predict a relative distribution of demersal fish production between the subantarctic waters of Area 3 and the subtropical waters of Areas 1, 2, 4, and 5 which seems reasonable when compared with other fishing areas about which more is known. However, this **does not** imply that the New Zealand fishery will be able to support a sustained annual yield of over 1 million t. To quote Larkin (1977), ". . . it should be stressed that it [MSY] provides a valuable rough index of production potential. As a first rough cut at management policy for major commercial species, MSY is probably acceptable. But once the level of MSY is attained, it should be expected that it may not be sustained." Therefore we feel more confident in predicting that the New Zealand deep-water demersal fishery will most likely be able to support a sustained annual yield of between 500 000 and 1 million t. Finally, one should keep in mind that these estimates were made for the deep-water trawl grounds surveyed by *Shinkai Maru*, around and to the south and east of the South Island. Because of a lack of basic information no estimates were made of deep-water trawl potential around the North Island or deep-water long-line potential.



Acknowledgments

This is dedicated to the memory of Dr David Eggleston, former deputy director of Fisheries Research Division, a colleague whose ideas and guidance motivated much of what is contained in this publication. We thank all of our colleagues at Fisheries Research Division for their helpful comments and suggestions throughout this project. In addition, we thank the Japan Marine Fishery Resource Research Center, Far Seas Fisheries Research Laboratory, and Fisheries Agency of Japan for making the detailed *Shinkai Maru*, *Kaiyo Maru*, and Japanese commercial trawl data available to us. Finally we thank J. A. Gulland, D. J. Garrod, and D. L. Alverson for their thoughtful and provocative reviews of this paper.

References

ALVERSON, D. L., and PEREYRA, W. T. 1969: Demersal fish explorations in the northeastern Pacific Ocean — an evaluation of exploratory fishing methods and analytical approaches to stock size and yield forecasts. *Journal of the Fisheries Research Board of Canada 26*: 1985–2001.

ANON. 1978a: On the biomass estimates and the potential yield of bottom fish in New Zealand waters. (Unpublished manuscript from Fishery Agency of Japan, held in Fisheries Research Division library.)

ANON. 1978b: Report of the voyage and investigations of the *Kaiyo Maru* 1977, 1978 in New Zealand waters. Japan Fisheries Agency, Tokyo. 259 pp. (In Japanese.)

BEEBY, C. D. 1975: The United Nations Conference on the law of the sea: A New Zealand view. *Pacific Viewpoint 16*: 113–42.

BLAGODYOROV, A. I., and NOSOV, E. V. 1978: The biological basis of rational exploitation of *Macruronus novaezelandiae*. (Unpublished TINRO manuscript. English translation held in Fisheries Research Division library.)

BRADFORD, J. M., and ROBERTS, P. E. 1978: Distribution of reactive phosphorus and plankton in relation to upwelling and surface circulation around New Zealand. *N.Z. Journal of Marine and Freshwater Research 12*: 1–15.

DUDAREV, V. A. 1978: A brief summary on biology and fisheries of the deepwater dory *Neocittus rhomboidalis* of the New Zealand plateau. (Unpublished TINRO manuscript. English translation held in Fisheries Research Division library.)

EDWARDS, R. L. 1968: Fishery resources of the North Atlantic area. *In* Gilbert, D. W. (Ed.), The future of the fishing industry of the United States, pp. 52–60. University of Washington Publications in Fisheries, New Series, Vol. 4.

FRANCIS, R. C. 1974: Relationship of fishing mortality to natural mortality at the level of maximum sustainable yield under the logistic stock production model. *Journal of the Fisheries Research Board of Canada 31*: 1539–42.

GULLAND, J. A. 1969: Manual of methods for fish stock assessment. Part I. Fish population analysis. *FAO Manuals in Fisheries Science, No. 4.* 154 pp.

________ (Comp. and Ed.) 1970a: The fish resources of the oceans. *FAO Fisheries Technical Paper No. 97.* 425 pp.

________ 1970b: Food chain studies and some problems in world fisheries. *In* Steele, J. H. (Ed.), "Marine Food Chains", pp. 296–315. Oliver and Boyd, Edinburgh.

JENKINS, R. M. 1970: Reservoir fish management. *In* Benson, N.G. (Ed.), A century of fisheries in North America, pp. 173–82. *Special Publication, American Fisheries Society, No. 7.*

JONES, B. W., and POPE, J. G. 1973: A groundfish survey of Faroe Bank. *Research Bulletin, International Commission for the Northwest Atlantic Fisheries, No. 10*: 53–61.

LARKIN, P. A. 1977: An epitaph for the concept of maximum sustained yield. *Transactions of the American Fisheries Society 106*: 1–11.

LIU, H.-C. 1976: The demersal fish stocks of the waters of north and northwest Australia. *Acta Oceanographica Taiwanica. Science Reports of the National Taiwan University, No. 6*: 128–34.

NOSOV, E. V. 1978: Some biological aspects of the New Zealand *Trachurus declivis* (Jenyns, 1842) and its fishery perspectives. (Unpublished TINRO manuscript. English translation held in Fisheries Research Division library.)

PAUL, L. J. 1979: Deep-water fish resources off the south-east coast of New Zealand. *In* Elder, R. D., and Taylor, J. L. (Comps.), Prospects and problems for New Zealand's demersal fisheries: Proceedings of the demersal fisheries conference, October 1978, pp. 52–6. *Fisheries Research Division Occasional Publication, N.Z. Ministry of Agriculture and Fisheries, No. 19.*

REGIER, H. A. 1978: A balanced science of renewable resources with particular reference to fisheries. *University of Washington Sea Grant Publication WSG 78-1.* 108 pp.

REGIER, H. A., and HENDERSON, H. F. 1973: Towards a broad ecological model of fish communities and fisheries. *Transactions of the American Fisheries Society 102*: 56–72.

ROBSON, D. S. 1966: Estimation of the relative fishing power of individual ships. *Research Bulletin, International Commission for the Northwest Atlantic Fisheries, No. 3*: 5–14.

RYDER, R. A. 1970: Major advances in fisheries management in North American glacial lakes. *In* Benson, N. G. (Ed.), A century of fisheries in North America, pp. 115–27. *Special Publication, American Fisheries Society, No. 7.*

RYTHER, J. H. 1969: Photosynthesis and fish production in the sea. *Science, New York 166 (3901)*: 72–6.

SCHAEFER, M. B. 1954: Some aspects of the dynamics of populations important to the management of the commercial marine fisheries. *Bulletin, Inter-American Tropical Tuna Commission 1*: 27–56.

________ 1965: The potential harvest of the sea. *Transactions of the American Fisheries Society 94*: 123–8.

SHIMADA, B. M., and SCHAEFER, M. B. 1956: A study of changes in fishing effort, abundance, and yield for yellowfin and skipjack tuna in the eastern tropical Pacific Ocean. *Bulletin, Inter-American Tropical Tuna Commission 1*: 351–469.

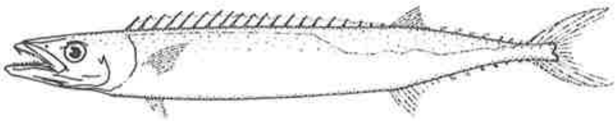
SHPACK, V. M. 1978: The results of biological investigations of the southern putassu *Micromesistius australis* (Norman, 1937) on the New Zealand plateau and perspectives of its fishery. (Unpublished TINRO manuscript. English translation held in Fisheries Research Division library.)

STEELE, J. H. 1965: Some problems in the study of marine resources. *Special Publication, International Commission for the Northwest Atlantic Fisheries, No. 6*: 463–76.

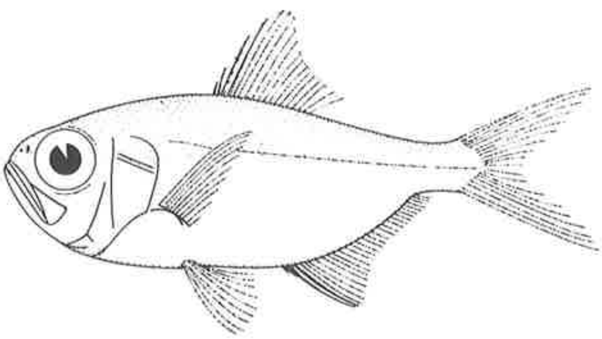
WAUGH, G. D. 1977: Resource potential of the 200 mile economic zone. *Fishing Industry Board Bulletin 42*: 8.

Appendix 1

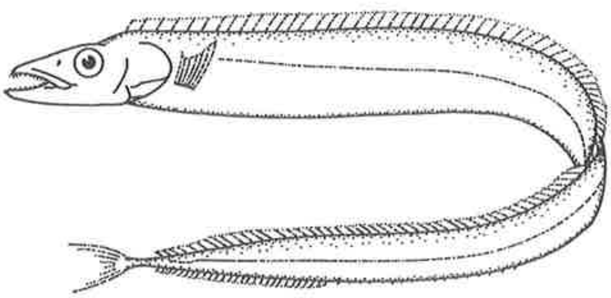
Major deep-water fish species of the New Zealand 200-mile Exclusive Economic Zone. (Alphabetic species codes as used in this publication.)



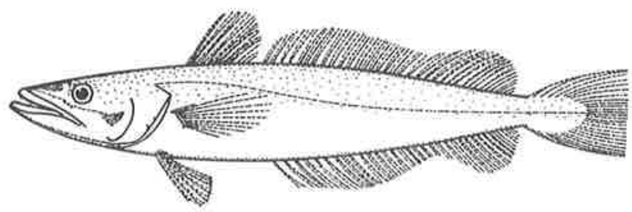
BAR
BARRACOUTA *Thyrsites atun.* Family Gempylidae (snake mackerels).
New Zealand and southern coasts of Australia, South Africa, and South America. Dark blue back; silvery sides and belly; skin smooth. Distinguished from the gemfish by a single lateral line. Average size 60–90 cm. Common, locally abundant, in coastal waters in 100–200 m. Trawled throughout its range, but main grounds around the South Island.



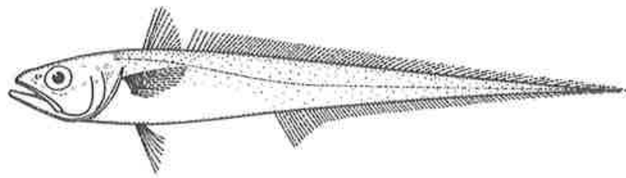
BYX
ALFONSINO *Beryx splendens.* Family Berycidae (golden snappers).
Widespread in many oceans. Brilliant scarlet above; sides red with a silvery tinge; body slender; large scales, smoother than red snapper; large eye; tail deeply forked. Average size 30–50 cm. Widespread, but only locally common in 200–800 m.



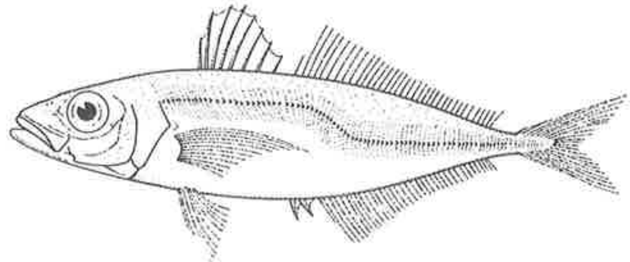
FRO
FROSTFISH *Lepidopus caudatus.* Family Trichiuridae (cutlassfishes).
Widespread distribution in most cool oceans. Uniformly silver; skin smooth. The elongated, ribbon-like body, sharp head, and thin attachment of tail to body are clear distinguishing features. Average size 120–160 cm. Apparently fairly common in some off-shore areas, probably west of Cape Farewell and on Chatham Rise, but distribution and concentrations poorly known. Sometimes strands on beaches.



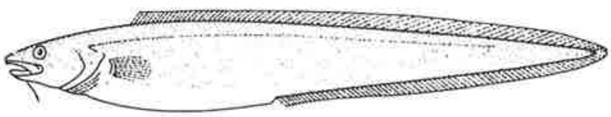
HAK
HAKE *Merluccius australis* English hake. Family Merlucciidae (hakes), subfamily Merlucciinae.
New Zealand and southern Australia; similar species elsewhere. Silvery-grey above; white below; small scales. Distinguished from cods by two dorsal fins and one anal fin (anal and second dorsal indented). Average size 50–90 cm. Occurs around the South Island in 200–800 m. Main trawling ground off Westland in winter.



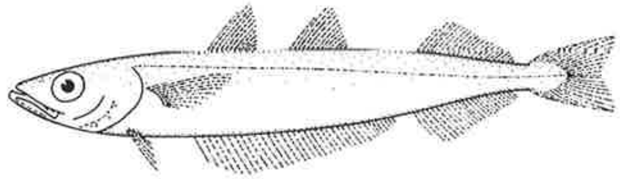
HOK
HOKI *Macruronus novaezelandiae* whiptail, blue hake, blue grenadier. Family Merlucciidae (hakes), subfamily Macruroninae.
New Zealand and southern Australia. Blue-green above; silvery on sides and belly; dark fins; skin smooth. Distinguished from the smaller javelin fish by the pointed snout, smaller eye, and silver belly. Average size 60–100 cm. Most abundant around the South Island in 200–800 m. Trawling grounds on outer shelf, Chatham Rise, and Campbell Plateau.



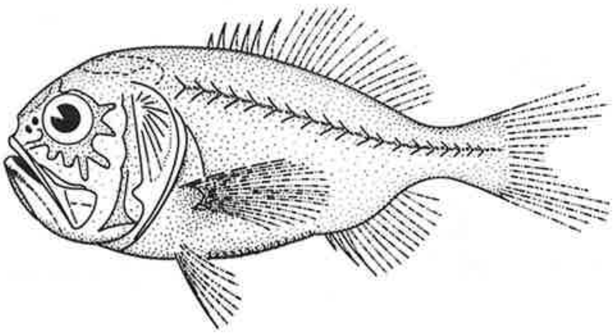
JMA
JACK MACKERELS *Trachurus declivis* (illustrated) and *T. novaezelandiae* horse mackerels, mackerel scads. Family Carangidae (jacks).
New Zealand and southern Australia; *T. novaezelandiae* also in South-east Asia and Japan. Blue or green with faint brown bands above; silvery-white below; small scales and a row of rough scutes along the body. Average size *T. declivis* 35–50 cm, *T. novaezelandiae* 30–40 cm. Widespread and common on the bottom and in mid water around most of New Zealand out to 300 m. Main trawling grounds off the North Island's west coast.



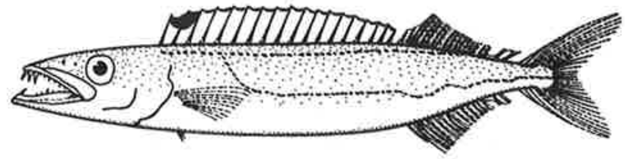
LIN
LING *Genypterus blacodes.* Family Ophidiidae (cusk-eels). New Zealand and southern coasts of Australia and South America, with a similar species (king-klip) off southern Africa. Not related to European ling, but superficially similar. Robust and eel-shaped, becoming relatively thicker with increasing size. Orange-pink and brown above, with irregular markings; paler to white below; skin smooth. Average size 80–140 cm. Widespread and common in 200–700 m around the South Island.



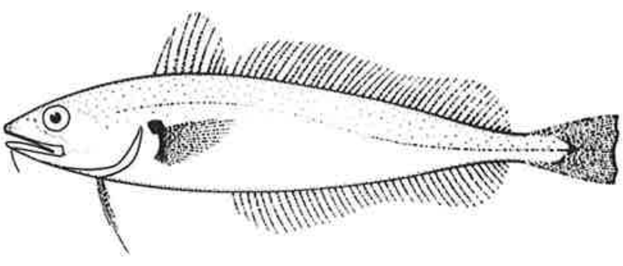
SBW
SOUTHERN BLUE WHITING *Micromesistius australis* southern poutassou. Family Gadidae (cods).
New Zealand and southern South America; a similar species occurs in the Northern Hemisphere. Grey, faintly bluish above, with many small black spots; silvery-white below; small loose scales. Distinguished from small hake by three dorsal and two anal fins, but similar to some other deep-water cods. Average size 30–50 cm. Abundant on the Campbell Plateau in 300–600 m.



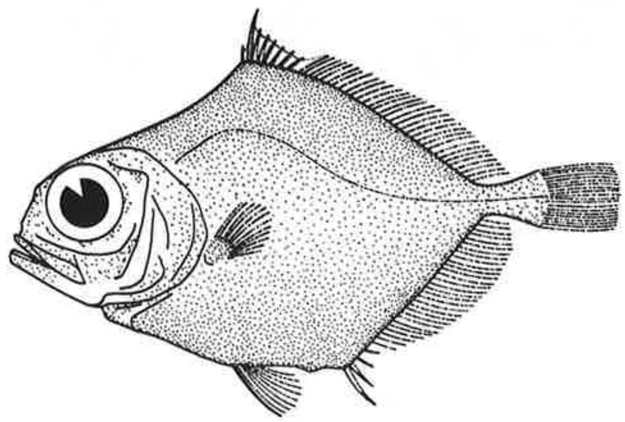
ORH
ORANGE ROUGHY *Hoplostethus atlanticus.* Family Trachichthyidae (roughies).
Widespread in temperate seas. Orange body and fins, some silver on sides; deep body; massive head with conspicuous bony ridges and cavities; scales small and irregular in shape and pattern, lateral line scales larger than body scales; a keel of larger scales on belly of smaller specimens. Average size 25–40 cm; juvenile specimens unknown from New Zealand. Spasmodic in distribution and abundance, but very common in some areas on the Chatham Rise in 500–1000 m.



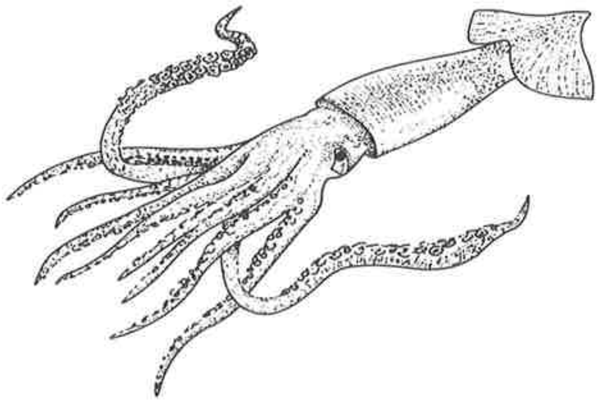
SKI
GEMFISH *Rexea solandri* southern kingfish, silver kingfish, hake. Family Gempylidae (snake mackerels).
New Zealand, southern Australia, and Japan. Blue back; silvery sides and belly; skin smooth. Distinguished from the barracouta by two lateral lines. Average size 60–90 cm. Occurs throughout coastal waters, but more common in the south in 150–200 m. Trawled incidentally throughout its range; no major grounds known.



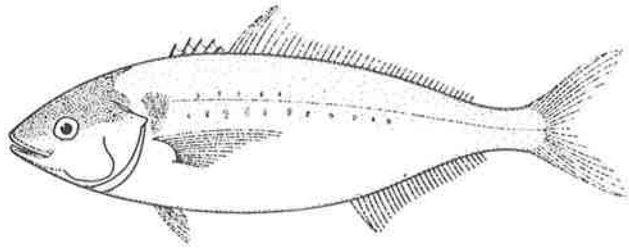
RCO
RED COD *Pseudophycis bacchus.* Family Moridae (morid cods).
New Zealand and southern Australia. Greyish-pink above; white below; prominent dark pectoral spot; soft scales. Distinguished from hake and southern blue whiting by pink colouring and from bastard red cod by square-tipped tail. Less easily distinguished from several uncommon deep-water cods. Average size 30–50 cm. Occurs mainly around the South Island in 100–300 m. Main trawling grounds in the outer Canterbury Bight and off Westland.



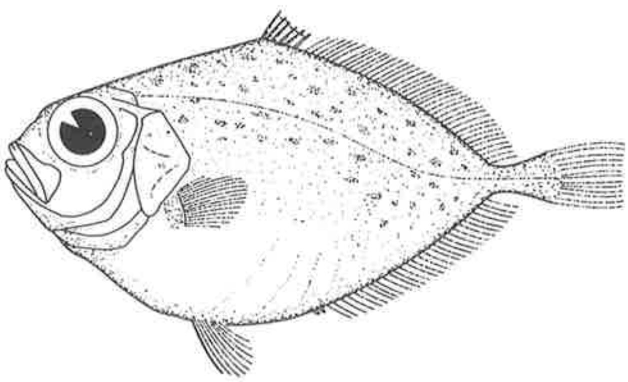
SOR
SPIKY OREO *Neocyttus* sp. spiky dory. Family Oreosomatidae (oreos).
New Zealand, southern Australia, and South Africa. Body grey; fins dark grey; scales rough, of moderate size, and can be dislodged with pressure. There are two other superficially similar species (black oreos, *Allocyttus* spp.) which have darker bodies, black fins, and rough scales which cannot be dislodged. Average size 20–30 cm. Occurs around and south of New Zealand in 300–1000 m.



SQU
ARROW SQUID *Nototodarus sloanii.* Family Ommastrephidae.
New Zealand, with similar species in Australia, Fiji, Philippines, and Hawaii. Smooth, pale pink skin with blood-red to brick-red chromatophores scattered over the body and concentrated as a dark band along the back. Average size 15-35 cm mantle length. Concentrated in shelf regions along the South Island and southern North Island in depths of 50-250 m. Caught by jigging and trawling.



SWA BUT
SILVER WAREHOU *Seriolella punctata* = *S. porosa* spotted warehou. Family Centrolophidae (butterfishes).
New Zealand and southern coasts of Australia and South America. Blue-grey above; silvery-white below; head dark, with a coloured point extending towards dorsal fin; dark pectoral blotch and some spots along the side, fewer in larger fish; skin pitted. Distinguished from the other warehou species by skin and colour pattern and a more slender shape. Average size 40-60 cm. Mainly South Island, with main fishing grounds on Chatham Rise, in Canterbury Bight, and south-east of Stewart Island in 300-500 m.



SSO
SMALL-SPINED OREO *Pseudocyttus maculatus.* Family Oreosomatidae (oreos).
New Zealand and southern coasts of Australia, South Africa, and South America. Grey with large dark spots, more prominent in small fish. Scales very small and easily dislodged. Distinguished from other oreos by the very small scales, small fin spines, and generally rounded, smooth body form. Average size 20-40 cm. Occurs around and south of New Zealand in 400-800 m.

Appendix 2

Relative stock density estimates (tonnes/kilometre trawled), estimate type (SM = *Shinkai Maru,* S1 = Step 1, S2 = Step 2), and bottom area* (km^2) by 200-m depth interval, ½° area†; and catch per standard hour fished (CPSHF) (tonnes/hour) by ½° area for the Japanese commercial fishing fleet. Latitude S and longitude E unless otherwise stated.

In all tables

. . = no Japanese commercial fishing;

\- = no bottom area in depth range.

* Bottom areas are approximate because of inadequate bathymetric data.

† For example, the area designated 48° 170° is the area from 48° to 48° 30′ and 170° to 170° 30′.

East Coast, South Island (Area 1), April-June 1976

Area		Japanese	200-400 m			400-600 m			600-800 m		
Lat.	Long.	Comm. CPSHF	Rel. density	Type	Bottom area	Rel. density	Type	Bottom area	Rel. density	Type	Bottom area
41° 30'	174°	..	0.107	S2	79	-	-	-	-	-	-
41 30	174 30	..	0.106	S2	529	0.247	S2	298	0.209	S2	298
41 30	175	..	0.102	S2	93	0.238	S2	53	0.188	S2	179
42	173 30	..	0.100	S2	72	0.261	S2	39	0.277	S2	52
42	174	..	0.104	S2	196	0.260	S2	91	0.250	S2	65
42 30	173 30	1.96	0.081	S1	209	0.267	S1	209	0.270	S1	150
42 30	174 30	..	-	-	-	0.264	S2	39	0.205	S2	332
42 30	175	1.28	0.088	S2	20	0.309	SM	300	0.176	SM	339
42 30	175 30	1.02	-	-	-	0.155	SM	469	0.140	S1	554
43	173	0.93	0.040	S1	39	0.113	S1	39	-	-	-
43	173 30	3.82	0.140	S1	283	0.519	S1	315	0.526	S1	295
43	174	1.72	-	-	-	0.304	SM	1 130	0.237	S1	597
43	174 30	2.56	0.109	S1	623	0.277	SM	1 195	0.217	S2	109
43	175	..	0.088	S2	263	0.224	S2	26	-	-	-
43	175 30	0.82	0.038	S1	1 098	0.103	S1	661	-	-	-
43 30	173 30	3.15	0.095	SM	257	0.247	S2	45	-	-	-
43 30	174	1.35	0.116	S2	167	0.152	SM	1 952	0.275	S2	32
43 30	174 30	2.30	0.114	S2	385	0.386	SM	1 670	0.197	S2	71
43 30	175	2.77	0.127	S1	559	0.127	SM	1 117	-	-	-
43 30	175 30	..	0.081	S2	1 188	0.176	S2	957	-	-	-
44	171	1.81	-	-	-	-	-	-	-	-	-
44	171 30	1.15	-	-	-	-	-	-	-	-	-
44	172	7.31	-	-	-	-	-	-	-	-	-
44	172 30	3.08	0.205	S1	37	-	-	-	-	-	-
44	173	2.87	0.224	SM	405	0.177	SM	374	0.333	S2	106
44	173 30	2.74	0.271	SM	237	0.270	S1	748	0.378	S2	936
44	174	..	0.136	S2	19	0.229	S2	848	0.267	S2	1 266
44	174 30	..	0.122	S2	31	0.227	S2	1 435	0.139	S2	611
44	175	6.10	-	-	-	0.124	SM	1 809	0.084	S2	343
44	175 30	..	0.103	S2	256	0.174	S2	1 272	0.080	S2	156
44 30	171	4.93	-	-	-	-	-	-	-	-	-
44 30	171 30	2.15	0.125	S1	37	0.266	S1	12	-	-	-
44 30	172	1.03	0.063	S1	299	0.144	S1	212	0.351	S2	94
44 30	172 30	1.87	0.122	S1	212	0.329	SM	474	0.318	S2	156
44 30	173	..	-	-	-	0.157	SM	237	0.306	S2	543
44 30	173 30	..	-	-	-	0.229	S2	19	0.301	S2	349
44 30	174	..	-	-	-	-	-	-	0.210	S2	561
44 30	174 30	0	-	-	-	-	-	-	0.094	S2	705
44 30	175	0.32	-	-	-	-	-	-	0.044	S1	911
44 30	175 30	0.45	-	-	-	-	-	-	0.062	S1	125
45	171	2.99	0.170	S1	61	0.355	S1	31	0.413	S1	37
45	171 30	2.79	0.162	S1	197	0.341	S1	215	0.384	S1	215
45 30	170 30	..	0.160	S2	43	0.329	S2	31	-	-	-
45 30	171	3.30	0.187	S1	141	0.385	S1	184	0.455	S1	340
46	171	..	-	-	-	0.325	S2	30	0.423	S2	102

Chatham Rise (Area 2), November 1975

Area		Japanese Comm.	200-400 m			400-600 m			600-800 m		
Lat.	Long.	CPSHF	Rel. density	Type	Bottom area	Rel. density	Type	Bottom area	Rel. density	Type	Bottom area
42° 30'	176°	..	-	-	-	0.184	S2	687	0.264	S2	302
42 30	176 30	..	0.102	S2	26	0.207	S2	745	0.270	S2	263
42 30	177	..	0.104	S2	141	0.247	S2	520	0.277	S2	283
42 30	177 30	1.62	0.105	S1	347	0.301	SM	379	0.278	S1	225
42 30	178	1.65	-	-	-	0.236	SM	128	0.297	SM	263
42 30	178 30	..	-	-	-	0.189	SM	135	0.276	S2	250
42 30	179	..	-	-	-	-	-	-	0.206	S2	347
42 30	179 30	..	-	-	-	-	-	-	0.138	S2	360
42 30	179 30 W	..	-	-	-	0.059	S2	128	0.120	SM	475
42 30	179 W	..	-	-	-	0.065	S2	276	0.127	S2	437
42 30	178 30 W	..	-	-	-	0.078	S2	327	0.138	S2	340
42 30	178 W	..	-	-	-	0.076	S2	411	0.149	S2	231
42 30	177 30 W	..	-	-	-	0.063	S2	308	0.157	S2	295
42 30	177 W	..	-	-	-	0.060	S2	51	0.163	S2	456
42 30	176 30 W	..	-	-	-	-	-	-	0.169	S2	501
42 30	176 W	..	-	-	-	-	-	-	0.173	S2	116
42 30	175 30 W	..	-	-	-	-	-	-	0.177	S2	26
43	176	..	0.100	S2	1 516	0	SM	655	-	-	-
43	176 30	..	0.102	S2	1 850	0.197	S2	334	-	-	-
43	177	..	0.103	S2	2 126	0.221	S2	26	-	-	-
43	177 30	..	0.104	S2	2 151	-	-	-	-	-	-
43	178	..	0.102	S2	1 760	0.195	S2	372	-	-	-
43	178 30	..	0.098	S2	1 349	0.152	S2	822	-	-	-
43	179	..	0.093	S2	828	0.149	SM	1 317	-	-	-
43	179 30	..	0.088	S2	244	0.057	SM	1 927	-	-	-
43	179 30 W	0.56	0.084	S2	13	0.031	SM	2 158	-	-	-
43	179 W	..	0.079	S2	257	0.057	S2	1 907	-	-	-
43	178 30 W	..	0.072	S2	109	0.089	S2	2 023	-	-	-
43	178 W	..	0.076	S2	469	0.091	S2	1 702	-	-	-
43	177 30 W	..	0.094	S2	700	0.048	SM	1 374	-	-	-
43	177 W	0.33	0.065	SM	970	0.032	SM	456	0.164	S2	315
43	176 30 W	..	0.149	SM	398	0.075	SM	302	0.169	S2	668
43	176 W	..	0.118	S2	591	0.073	S2	880	0.174	S2	206
43	175 30 W	..	0.108	S2	193	0.076	S2	1 201	0.177	S2	719
43	175 W	..	0.103	S2	19	0.080	S2	122	0.180	S2	1 702
43	174 30 W	..	-	-	-	-	-	-	0.183	S2	655
43 30	176	..	0.100	S2	974	0.169	S2	1 202	-	-	-
43 30	176 30	..	0.100	S2	1 259	0.178	S2	823	0.264	S2	44
43 30	177	..	0.101	S2	1 221	0.185	S2	620	0.268	S2	323
43 30	177 30	..	0.101	S2	810	0.181	S2	854	0.270	S2	367
43 30	178	..	0.099	S2	835	0.160	S2	899	0.266	S2	316
43 30	178 30	..	0.096	S2	702	0.133	S2	1 050	0.246	S2	392
43 30	179	..	0.092	S2	247	0.111	S2	1 746	0.208	S2	152
43 30	179 30	..	0.087	S2	285	0.075	S2	1 860	0.170	S2	32
43 30	179 30 W	..	0.082	S2	1 379	0.058	S2	766	-	-	-
43 30	179 W	..	0.076	S2	1 974	0.070	S2	184	-	-	-
43 30	178 30 W	..	0.060	S2	354	0.109	S2	1 778	-	-	-
43 30	178 W	0.80	0.019	S1	785	0.150	SM	1 360	-	-	-

Chatham Rise (Area 2), November 1975 (cont.)

Area Lat.	Area Long.	Japanese Comm. CPSHF	200-400 m Rel. density	200-400 m Type	200-400 m Bottom area	400-600 m Rel. density	400-600 m Type	400-600 m Bottom area	600-800 m Rel. density	600-800 m Type	600-800 m Bottom area
43° 30'	177° 30' W	..	0.127	SM	1 671	0.090	S2	475	-	-	-
43 30	177 W	..	0.101	S2	734	-	-	-	-	-	-
43 30	176 W	..	0.110	S2	95	-	-	-	-	-	-
43 30	175 30 W	..	0.106	S2	1 487	0.078	S2	32	-	-	-
43 30	175 W	..	0.103	S2	475	0.081	S2	696	0.181	S2	664
43 30	174 30 W	..	-	-	-	-	-	-	0.183	S2	1 373
44	176	..	0.098	S2	405	0.158	S2	715	0.254	S2	589
44	176 30	..	-	-	-	0.162	S2	532	0.257	S2	601
44	177	..	-	-	-	0.162	S2	44	0.259	S2	519
44	177 30	..	-	-	-	-	-	-	0.257	S2	82
44	178 30	..	-	-	-	-	-	-	0.234	S2	114
44	179	..	-	-	-	-	-	-	0.209	S2	690
44	179 30	..	-	-	-	0.087	S2	329	0.184	S2	411
44	179 30 W	..	0.083	S2	158	0.078	S2	608	0.168	S2	589
44	179 W	..	0.078	S2	563	0.084	S2	443	0.162	S2	677
44	178 30 W	..	0.072	S2	177	0.105	S2	892	0.161	S2	589
44	178 W	..	-	-	-	0.119	S2	1 240	0.164	S2	392
44	177 30 W	..	-	-	-	0.101	S2	949	0.167	S2	785
44	177 W	..	0.104	S2	462	0.084	S2	1 190	0.171	S2	405
44	176 30 W	..	0.102	S2	380	0.079	S2	272	-	-	-
44	175 30 W	..	0.103	S2	487	0.081	S2	165	0.180	S2	32
44	175 W	..	0.101	S2	519	0.083	S2	595	0.182	S2	601
44 30	176	..	-	-	-	-	-	-	0.249	S2	56
44 30	177 W	..	-	-	-	0.089	S2	31	0.175	S2	168
44 30	176 30 W	..	0.100	S2	37	0.085	S2	530	0.177	S2	112
44 30	176 W	..	0.100	S2	287	0.084	S2	231	0.179	S2	112
44 30	175 30 W	..	0.100	S2	25	0.084	S2	75	0.181	S2	243
44 30	175 W	..	-	-	-	-	-	-	0.183	S2	87

Chatham Rise (Area 2), May 1976

Area		Japanese Comm.	200-400 m			400-600 m			600-800 m		
Lat.	Long.	CPSHF	Rel. density	Type	Bottom area	Rel. density	Type	Bottom area	Rel. density	Type	Bottom area
42° 30'	176°	1.53	-	-	-	0.267	SM	687	0.075	SM	302
42 30	176 30	..	-	-	26	0.377	SM	745	0.291	SM	263
42 30	177	2.46	-	-	141	0.344	SM	520	0.631	SM	283
42 30	177 30	..	-	-	347	0.161	SM	379	0.242	SM	225
42 30	178	3.62	-	-	-	0.388	SM	128	0.298	SM	263
42 30	178 30	5.69	-	-	-	0.317	SM	135	0.222	SM	250
42 30	179	..	-	-	-	-	-	-	0.233	S2	347
42 30	179 30	..	-	-	-	-	-	-	0.232	S2	360
42 30	179 30 W	..	-	-	-	0.182	S2	128	-	-	-
42 30	179 W	..	-	-	-	0.136	S2	276	-	-	-
42 30	178 30 W	..	-	-	-	0.103	S2	327	-	-	-
42 30	178 W	..	-	-	-	0.081	S2	411	-	-	-
42 30	177 30 W	..	-	-	-	0.066	S2	308	-	-	-
42 30	177 W	..	-	-	-	0.054	S2	51	-	-	-
42 30	176 30 W	..	-	-	-	-	-	-	-	-	-
42 30	176 W	..	-	-	-	-	-	-	-	-	-
42 30	175 30 W	..	-	-	-	-	-	-	-	-	-
43	176	..	-	-	1 516	0.302	S2	655	-	-	-
43	176 30	..	-	-	1 850	0.329	S2	334	-	-	-
43	177	..	-	-	2 126	0.314	S2	26	-	-	-
43	177 30	..	-	-	2 151	-	-	-	-	-	-
43	178	..	-	-	1 760	0.304	S2	372	-	-	-
43	178 30	..	-	-	1 349	0.302	S2	822	-	-	-
43	179	..	-	-	828	0.275	S2	1 317	-	-	-
43	179 30	..	-	-	244	0.224	S2	1 927	-	-	-
43	179 30 W	..	-	-	13	0.169	S2	2 158	-	-	-
43	179 W	..	-	-	257	0.124	S2	1 907	-	-	-
43	178 30 W	..	-	-	109	0.095	S2	2 023	-	-	-
43	178 W	..	-	-	469	0.077	S2	1 702	-	-	-
43	177 30 W	..	-	-	700	0.060	SM	1 374	-	-	-
43	177 W	0.39	-	-	970	0.001	S1	456	-	-	-
43	176 30 W	..	-	-	398	0.051	SM	302	-	-	-
43	176 W	..	-	-	591	0.064	S2	880	-	-	-
43	175 30 W	..	-	-	193	0.079	S2	1 201	-	-	-
43	175 W	..	-	-	19	0.091	S2	122	-	-	-
43	174 30 W	..	-	-	-	-	-	-	-	-	-
43 30	176	..	-	-	974	0.303	S2	1 202	-	-	-
43 30	176 30	..	-	-	1 259	0.309	S2	823	0.199	S2	44
43 30	177	..	-	-	1 221	0.302	S2	620	0.158	S2	323
43 30	177 30	..	-	-	810	0.290	S2	854	0.118	S2	367
43 30	178	..	-	-	835	0.286	S2	899	0.155	S2	316
43 30	178 30	..	-	-	702	0.276	S2	1 050	0.193	S2	392
43 30	179	..	-	-	247	0.250	S2	1 746	0.206	S2	152
43 30	179 30	..	-	-	285	0.206	S2	1 860	0.210	S2	32
43 30	179 30 W	..	-	-	1 379	0.157	S2	766	-	-	-
43 30	179 W	..	-	-	1 974	0.117	S2	184	-	-	-
43 30	178 30 W	..	-	-	354	0.094	S2	1 778	-	-	-
43 30	178 W	..	-	-	785	0.078	SM	1 360	-	-	-

Chatham Rise (Area 2), May 1976 (cont.)

Area Lat.	Area Long.	Japanese Comm. CPSHF	200-400 m Rel. density	200-400 m Type	200-400 m Bottom area	400-600 m Rel. density	400-600 m Type	400-600 m Bottom area	600-800 m Rel. density	600-800 m Type	600-800 m Bottom area
43° 30'	177° 30' W	..	-	-	1 671	0.076	S2	475	-	-	-
43 30	177 W	..	-	-	734	-	-	-	-	-	-
43 30	176 W	..	-	-	95	-	-	-	-	-	-
43 30	175 30 W	..	-	-	1 487	0.083	S2	32	-	-	-
43 30	175 W	..	-	-	475	0.093	S2	696	-	-	-
43 30	174 30 W	..	-	-	-	-	-	-	-	-	-
44	176	..	-	-	405	0.296	S2	715	0.176	S2	589
44	176 30	..	-	-	-	0.296	S2	532	0.146	S2	601
44	177	..	-	-	-	0.292	S2	44	0.085	S2	519
44	177 30	0.56	-	-	-	-	-	-	0.042	S1	82
44	178 30	..	-	-	-	-	-	-	0.147	S2	114
44	179	..	-	-	-	-	-	-	0.179	S2	690
44	179 30	..	-	-	-	0.191	S2	329	0.194	S2	411
44	179 30 W	..	-	-	158	0.151	S2	608	-	-	-
44	179 W	..	-	-	563	0.119	S2	443	-	-	-
44	178 30 W	..	-	-	177	0.104	S2	892	-	-	-
44	178 W	..	-	-	-	0.111	SM	1 240	-	-	-
44	177 30 W	..	-	-	-	0.096	S2	949	-	-	-
44	177 W	..	-	-	462	0.084	S2	1 190	-	-	-
44	176 30 W	..	-	-	380	0.080	S2	272	-	-	-
44	175 30 W	..	-	-	487	0.090	S2	165	-	-	-
44	175 W	..	-	-	519	0.097	S2	595	-	-	-
44 30	176	..	-	-	-	-	-	-	0.161	S2	56
44 30	177 W	..	-	-	-	0.096	S2	31	-	-	-
44 30	176 30 W	..	-	-	37	0.093	S2	530	-	-	-
44 30	176 W	..	-	-	287	0.094	S2	231	-	-	-
44 30	175 30 W	..	-	-	25	0.098	S2	75	-	-	-
44 30	175 W	..	-	-	-	-	-	-	-	-	-

Chatham Rise (Area 2W), July-September 1976

Area		Japanese Comm. CPSHF	200-400 m			400-600 m			600-800 m		
Lat.	Long.		Rel. density	Type	Bottom area	Rel. density	Type	Bottom area	Rel. density	Type	Bottom area
42° 30'	176°	..	-	-	-	0.095	SM	687	0.097	S2	302
42 30	176 30	1.10	-	-	26	0.163	SM	745	0.060	SM	263
42 30	177	1.37	-	-	141	0.209	SM	520	0.174	SM	283
42 30	177 30	0.92	-	-	347	0.152	SM	379	0.252	SM	225
42 30	178	..	-	-	-	0.120	S2	128	0.087	SM	263
42 30	178 30	..	-	-	-	0.071	SM	135	0.103	S2	250
42 30	179	..	-	-	-	-	-	-	0.113	S2	347
42 30	179 30	..	-	-	-	-	-	-	0.118	S2	360
43	176	..	-	-	1 516	0.189	SM	655	-	-	-
43	176 30	..	-	-	1 850	0.156	S2	334	-	-	-
43	177	..	-	-	2 126	0.161	S2	26	-	-	-
43	177 30	..	-	-	2 151	-	-	-	-	-	-
43	178	..	-	-	1 760	0.109	S2	372	-	-	-
43	178 30	0.63	-	-	1 349	0.060	SM	822	-	-	-
43	179	..	-	-	828	0.084	S2	1 317	-	-	-
43	179 30	..	-	-	244	0.099	S2	1 927	-	-	-
43 30	176	..	-	-	974	0.155	S2	1 202	-	-	-
43 30	176 30	..	-	-	1 259	0.150	S2	823	0.128	S2	44
43 30	177	..	-	-	1 221	0.136	S2	620	0.138	S2	323
43 30	177 30	1.03	-	-	810	0.110	S1	854	0.137	S2	367
43 30	178	..	-	-	835	0.112	S2	899	0.126	S2	316
43 30	178 30	..	-	-	702	0.092	S2	1 050	0.120	S2	392
43 30	179	..	-	-	247	0.095	S2	1 746	0.120	S2	152
43 30	179 30	..	-	-	285	0.103	S2	1 860	0.121	S2	32
44	176	..	-	-	405	0.146	S2	715	0.127	S2	589
44	176 30	..	-	-	-	0.142	S2	532	0.130	S2	601
44	177	..	-	-	-	0.132	S2	44	0.133	S2	519
44	177 30	..	-	-	-	-	-	-	0.132	S2	82
44	178 30	..	-	-	-	-	-	-	0.125	S2	114
44	179	..	-	-	-	-	-	-	0.123	S2	690
44	179 30	..	-	-	-	0.110	S2	329	0.123	S2	411
44 30	176	..	-	-	-	-	-	-	0.128	S2	56

Bounty (Area 3E), December 1976-January 1977

Area		Japanese	200-400 m			400-600 m			600-800 m		
Lat.	Long.	Comm. CPSHF	Rel. density	Type	Bottom area	Rel. density	Type	Bottom area	Rel. density	Type	Bottom area
47°	176° 30'	..	-	-	-	-	-	-	0.030	S2	91
47	177	..	-	-	-	0.113	S2	46	0.027	S2	273
47	177 30	..	-	-	-	-	-	-	0.024	S2	46
47	178	..	-	-	-	0.096	S2	46	0.023	S2	455
47	178 30	..	0.031	S2	228	0.125	S2	273	0.028	S2	319
47	179	..	0.026	S2	46	0.156	S2	91	0.044	S2	91
47	179 30	..	0.023	S2	273	0.162	S2	319	0.068	S2	228
47	179 30 W	..	-	-	-	0.149	S2	91	0.084	S2	182
47 30	176 30	..	-	-	-	-	-	-	0.029	S2	45
47 30	177	..	-	-	-	0.112	S2	45	0.026	S2	89
47 30	177 30	..	-	-	-	-	-	-	0.023	S2	45
47 30	178	..	-	-	-	0.066	SM	891	0.021	SM	891
47 30	178 30	..	0.037	S2	1 515	0.130	S2	178	-	-	-
47 30	179	..	0.026	S2	178	-	-	-	-	-	-
47 30	179 30	..	0.021	S2	1 203	0.186	S2	45	-	-	-
47 30	179 30 W	..	0.021	S2	446	0.128	S2	1 381	0.102	S2	267
47 30	179 W	..	-	-	-	0.121	S2	267	0.100	S2	624
48	178	..	-	-	-	0.116	S2	87	0.024	S2	394
48	178 30	..	0.049	SM	262	0.135	SM	700	0.031	S2	1 049
48	179	..	0.026	S2	44	0.207	SM	962	0.058	S2	525
48	179 30	..	0.019	SM	874	0.306	SM	568	0.098	S2	612
48	179 30 W	..	0.020	S2	656	0.055	SM	918	0.111	SM	568
48	179 W	..	-	-	-	0.103	S2	262	0.105	S2	481
48 30	178 30	..	-	-	-	-	-	-	0.041	S2	1 312
48 30	179	..	-	-	-	-	-	-	0.063	S2	1 968
48 30	179 30	..	-	-	-	-	-	-	0.092	S2	1 924
48 30	179 30 W	..	-	-	-	-	-	-	0.104	S2	612
49	179	..	-	-	-	-	-	-	0.064	S2	686
49	179 30	..	-	-	-	-	-	-	0.081	S2	171

Campbell Plateau (Area 3W), January 1976

Area		Japanese Comm. CPSHF	200-400 m			400-600 m			600-800 m		
Lat.	Long.		Rel. density	Type	Bottom area	Rel. density	Type	Bottom area	Rel. density	Type	Bottom area
48° 30'	170°	..	-	-	-	-	-	-	0.238	S2	536
48 30	170 30	..	-	-	-	-	-	-	0.251	S2	1 117
48 30	171	..	-	-	-	0.225	S2	175	0.254	SM	1 006
48 30	171 30	..	0.037	S2	131	0.176	SM	437	0.252	S2	874
48 30	172	..	0.037	S2	44	0.143	S2	656	0.245	S2	874
48 30	172 30	..	-	-	-	-	-	-	0.237	S2	1 137
48 30	173	..	-	-	-	-	-	-	0.228	S2	1 443
48 30	173 30	..	-	-	-	0.227	S2	44	0.220	S2	1 224
48 30	174	..	-	-	-	0.230	S2	131	0.213	S2	874
48 30	174 30	..	-	-	-	0.235	S2	44	0.206	S2	1 224
48 30	175	..	-	-	-	-	-	-	0.200	S2	656
49	166	..	-	-	-	0.173	S2	44	0.090	S2	438
49	166 30	1.07	-	-	-	0.169	S2	963	0.095	S2	1 051
49	167	2.66	0.037	S2	44	0.171	S2	253	0.103	S2	1 708
49	167 30	0.78	-	-	-	0.179	S2	88	0.114	S2	1 926
49	168	..	-	-	-	-	-	-	0.130	S2	2 014
49	168 30	..	-	-	-	-	-	-	0.152	S2	1 576
49	169	..	-	-	-	-	-	-	0.179	S2	1 489
49	169 30	..	-	-	-	0.228	S2	306	0.207	S2	1 620
49	170	..	-	-	-	0.235	S2	219	0.231	S2	1 620
49	170 30	..	-	-	-	0.250	S2	1 270	0.246	S2	744
49	171	0.96	0.037	S2	728	0.291	SM	1 114	-	-	-
49	171 30	..	0.037	S2	986	0.171	S2	86	-	-	-
49	172	..	0.037	S2	471	0.023	SM	1 414	-	-	-
49	172 30	..	0.037	S2	86	0.175	SM	1 885	0.234	S2	43
49	173	1.13	-	-	-	0.259	SM	1 971	0.226	S2	43
49	173 30	1.03	-	-	-	0.237	S2	1 971	0.218	S2	43
49	174	..	-	-	-	0.234	S2	1 200	0.210	S2	771
49	174 30	..	-	-	-	0.239	S2	1 671	0.204	S2	343
49	175	..	-	-	-	0.245	S2	643	0.198	S2	943
49	175 30	..	-	-	-	-	-	-	0.193	S2	43
49 30	166	..	0.037	S2	257	0.158	S2	600	0.082	S2	214
49 30	166 30	..	0.037	S2	343	0.148	S2	300	-	-	-
49 30	167	..	0.037	S2	857	0.148	S2	771	-	-	-
49 30	167 30	..	0.037	S2	171	0.162	S2	1 414	0.104	S2	214
49 30	168	..	-	-	-	0.181	S2	857	0.118	S2	1 157
49 30	168 30	..	-	-	-	0.202	S2	86	0.137	S2	1 928
49 30	169	..	-	-	-	-	-	-	0.163	S2	2 014
49 30	169 30	..	-	-	-	0.230	S2	643	0.191	S2	1 371
49 30	170	..	-	-	-	0.237	S2	857	0.216	S2	1 157
49 30	170 30	..	-	-	-	0.242	S2	2 014	-	-	-
49 30	171	..	0.037	S2	43	0.240	S2	1 971	-	-	-
49 30	171 30	..	0.037	S2	171	0.191	S2	1 843	-	-	-
49 30	172	1.46	0.037	S2	129	0.150	S2	1 885	-	-	-
49 30	172 30	..	0.037	S2	343	0.186	S2	1 671	-	-	-
49 30	173	..	-	-	-	0.224	S2	2 014	-	-	-
49 30	173 30	..	-	-	-	0.234	S2	1 500	0.213	S2	386
49 30	174	0.73	-	-	-	0.240	S2	1 585	0.207	S2	429

Campbell Plateau (Area 3W), January 1976 (cont.)

Area Lat.		Long.		Japanese Comm. CPSHF	200-400 m Rel. density	Type	Bottom area	400-600 m Rel. density	Type	Bottom area	600-800 m Rel. density	Type	Bottom area
49°	30'	174°	30'	..	-	-	-	0.246	S2	1 114	0.201	S2	686
49	30	175		..	-	-	-	0.252	S2	86	0.195	S2	1 114
50		165	30	..	0.037	S2	41	0.162	S2	41	0.072	S2	41
50		166		..	0.037	S2	164	0.143	S2	164	0.075	S2	82
50		167	30	..	0.037	S2	904	0.151	S2	493	-	-	-
50		168		..	-	-	-	0.173	S2	1 973	-	-	-
50		168	30	..	-	-	-	0.197	S2	1 850	0.123	S2	123
50		169		..	-	-	-	0.219	S2	1 315	0.146	S2	658
50		169	30	0	-	-	-	0.233	S2	82	0.171	S2	1 891
50		170		..	-	-	-	0.241	S2	336	0.196	S2	1 637
50		170	30	..	-	-	-	0.243	S2	1 427	0.213	S2	546
50		171		..	-	-	-	0.239	S2	1 973	-	-	-
50		171	30	..	-	-	-	0.225	S2	1 973	-	-	-
50		172		..	-	-	-	0.214	S2	1 973	-	-	-
50		172	30	..	-	-	-	0.219	S2	1 973	-	-	-
50		173		..	-	-	-	0.232	S2	1 931	0.212	S2	42
50		173	30	..	-	-	-	0.243	S2	378	0.207	S2	1 469
50		174		..	-	-	-	0.251	S2	84	0.201	S2	966
50	30	165	30	..	0.037	S2	493	0.160	S2	206	0.065	S2	123
50	30	166		..	0.037	S2	123	0.137	S2	49	-	-	-
50	30	166	30	..	0.037	SM	247	0.102	S2	247	-	-	-
50	30	167		..	0.037	S2	123	0.063	SM	1 233	-	-	-
50	30	167	30	3.02	0.037	S2	288	0.177	SM	1 685	-	-	-
50	30	168		..	-	-	-	0.172	S2	1 973	-	-	-
50	30	168	30	..	0.037	S2	41	0.198	S2	1 932	-	-	-
50	30	169		0	0.037	S2	41	0.223	S2	1 932	-	-	-
50	30	169	30	2.09	0.037	S2	164	0.238	S2	1 809	-	-	-
50	30	170		..	-	-	-	0.247	S2	1 385	0.174	S2	588
50	30	170	30	..	-	-	-	0.252	S2	1 595	0.191	S2	378
50	30	171		..	-	-	-	0.254	S2	1 973	-	-	-
50	30	171	30	..	-	-	-	0.254	S2	1 973	-	-	-
50	30	172		..	-	-	-	0.253	S2	1 973	-	-	-
50	30	172	30	..	-	-	-	0.256	S2	1 931	0.206	S2	42
50	30	173		..	-	-	-	0.261	S2	1 805	0.203	S2	168
50	30	173	30	..	-	-	-	0.267	S2	126	0.199	S2	1 133
51		165	30	..	0.037	S2	348	0.165	S2	464	0.056	S2	155
51		166		..	0.037	S2	309	0.146	S2	1 121	0.055	S2	155
51		166	30	..	-	-	-	0.123	S2	1 275	0.074	S2	618
51		167		..	-	-	-	0.117	S2	1 160	0.094	S2	773
51		167	30	..	-	-	-	0.153	S2	1 391	0.096	S2	541
51		168		..	-	-	-	0.177	S2	1 121	0.098	S2	811
51		168	30	..	-	-	-	0.205	S2	1 932	-	-	-
51		169		..	-	-	-	0.228	S2	1 932	-	-	-
51		169	30	..	-	-	-	0.242	S2	1 932	-	-	-
51		170		..	-	-	-	0.252	S2	1 932	-	-	-
51		170	30	..	-	-	-	0.259	S2	1 932	-	-	-
51		171		..	-	-	-	0.265	S2	1 932	-	-	-
51		171	30	..	-	-	-	0.270	S2	1 932	-	-	-

Campbell Plateau (Area 3W), January 1976 (cont.)

Area Lat.	Area Long.	Japanese Comm. CPSHF	200-400 m Rel. density	200-400 m Type	200-400 m Bottom area	400-600 m Rel. density	400-600 m Type	400-600 m Bottom area	600-800 m Rel. density	600-800 m Type	600-800 m Bottom area
51°	172°	..	-	-	-	0.279	S2	1 932	-	-	-
51	172 30	..	-	-	-	0.289	S2	1 932	-	-	-
51	173	..	-	-	-	0.295	S2	1 883	0.193	S2	749
51	173 30	..	-	-	-	-	-	-	0.190	S2	1 893
51	174	..	-	-	-	-	-	-	0.188	S2	1 104
51 30	166	..	-	-	-	-	-	-	0.046	SM	79
51 30	166 30	..	-	-	-	0.154	S2	355	0.073	S2	867
51 30	167	0.51	-	-	-	0.155	S2	237	0.103	SM	1 656
51 30	167 30	..	-	-	-	-	-	-	0.098	S2	1 932
51 30	168	..	-	-	-	0.193	S2	552	0.097	S2	1 380
51 30	168 30	..	0.037	S2	789	0.216	S2	1 143	-	-	-
51 30	169	..	0.037	S2	1 498	0.233	S2	276	-	-	-
51 30	169 30	..	0.037	S2	1 222	0.243	S2	710	-	-	-
51 30	170	..	0.037	S2	513	0.249	S2	1 380	-	-	-
51 30	170 30	..	-	-	-	0.266	SM	1 932	-	-	-
51 30	171	0	-	-	-	0.276	SM	1 932	-	-	-
51 30	171 30	..	-	-	-	0.279	S2	1 932	-	-	-
51 30	172	..	-	-	-	0.304	S2	1 932	-	-	-
51 30	172 30	..	-	-	-	0.326	S2	1 695	0.182	S2	237
51 30	173	..	-	-	-	0.332	S2	828	0.182	S2	1 064
51 30	173 30	..	-	-	-	-	-	-	0.182	S2	1 263
51 30	174	..	-	-	-	-	-	-	0.181	S2	1 025
51 30	174 30	..	-	-	-	-	-	-	0.179	S2	158
52	167	..	-	-	-	-	-	-	0.093	S2	227
52	167 30	..	-	-	-	-	-	-	0.095	S2	907
52	168	..	0.037	S2	113	0.210	S2	302	0.095	S2	1 398
52	168 30	..	0.037	S2	831	0.225	S2	76	-	-	-
52	169	..	0.037	S2	113	-	-	-	-	-	-
52	169 30	1.58	0.037	S2	151	-	-	-	-	-	-
52	170	1.32	0.037	S2	1 133	0.236	S2	340	-	-	-
52	170 30	1.11	0.037	S2	76	0.196	SM	1 813	-	-	-
52	171	1.49	-	-	-	0.285	SM	1 889	-	-	-
52	171 30	..	-	-	-	0.288	S2	1 587	0.162	S2	302
52	172	..	-	-	-	0.348	S2	1 511	0.167	S2	378
52	172 30	12.53	-	-	-	0.381	S2	756	0.171	S2	1 133
52	173	0	-	-	-	0.371	S2	227	0.173	S2	1 209
52 30	168	..	0.037	S2	38	0.221	S2	227	0.094	S2	1 360
52 30	168 30	2.44	0.037	S2	680	0.231	S2	680	0.098	S2	302
52 30	169	2.66	0.037	S2	491	0.237	S2	38	-	-	-
52 30	169 30	2.72	0.037	S2	76	0.238	S2	38	-	-	-
52 30	170	..	0.037	S2	529	0.235	S2	1 247	-	-	-
52 30	170 30	..	-	-	-	0.234	SM	1 889	-	-	-
52 30	171	..	0.037	S2	76	0.267	SM	1 813	-	-	-
52 30	171 30	..	0.037	S2	113	0.291	S2	1 776	-	-	-
52 30	172	..	0.037	S2	302	0.436	SM	1 511	0.157	S2	76
52 30	172 30	2.00	-	-	-	0.469	SM	1 813	0.162	S2	76
52 30	173	2.54	-	-	-	0.365	SM	1 473	0.164	S2	378
52 30	173 30	..	-	-	-	0.379	S2	38	0.166	S2	254

Campbell Plateau (Area 3W), January 1976 (cont.)

Area		Japanese Comm. CPSHF	200-400 m			400-600 m			600-800 m		
Lat.	Long.		Rel. density	Type	Bottom area	Rel. density	Type	Bottom area	Rel. density	Type	Bottom area
53°	168°	..	-	-	-	-	-	-	0.093	S2	355
53	168 30	..	-	-	-	0.234	S2	142	0.097	S2	1 562
53	169	..	0.037	S2	497	0.238	S2	923	0.104	S2	355
53	169 30	..	0.037	S2	710	0.237	S2	284	0.111	S2	604
53	170	..	0.037	S2	497	0.231	S2	817	0.120	S2	462
53	170 30	..	-	-	-	0.207	S2	1 775	0.129	S2	71
53	171	..	0.037	S2	142	0.063	SM	1 633	0.137	S2	71
53	171 30	..	0.037	S2	355	0.253	S2	1 136	0.144	S2	355
53	172	..	0.037	S2	107	0.296	SM	1 349	0.149	S2	391
53	172 30	1.06	-	-	-	0.388	S2	1 278	0.154	S2	462
53	173	..	-	-	-	0.679	SM	355	0.157	S2	1 030
53	173 30	..	-	-	-	-	-	-	0.159	S2	178
53 30	168 30	..	-	-	-	-	-	-	0.097	S2	801
53 30	169	..	-	-	-	-	-	-	0.103	S2	871
53 30	169 30	..	-	-	-	-	-	-	0.110	S2	592
53 30	170	..	-	-	-	-	-	-	0.117	S2	488
53 30	170 30	..	-	-	-	0.213	S2	139	0.124	S2	348
53 30	171	..	-	-	-	0.194	S2	35	0.131	S2	906
53 30	171 30	..	-	-	-	0.253	S2	70	0.138	S2	1 045
53 30	172	..	-	-	-	0.308	S2	35	0.143	S2	488
53 30	172 30	..	-	-	-	-	-	-	0.148	S2	70

Campbell Plateau (Area 3W), December 1976-January 1977

Area		Japanese Comm.	200-400 m			400-600 m			600-800 m		
Lat.	Long.	CPSHF	Rel. density	Type	Bottom area	Rel. density	Type	Bottom area	Rel. density	Type	Bottom area
48° 30'	170°	..	-	-	-	-	-	-	0.125	S2	536
48 30	170 30	..	-	-	-	-	-	-	0.116	S2	1 117
48 30	171	..	-	-	-	0.248	S2	175	0.104	S2	1 006
48 30	171 30	..	0.488	S2	131	0.226	S2	437	0.093	S2	874
48 30	172	..	0.486	S2	44	0.193	S2	656	0.085	S2	874
48 30	172 30	0	-	-	-	-	-	-	0.082	SM	1 137
48 30	173	..	-	-	-	-	-	-	0.083	S2	1 443
48 30	173 30	..	-	-	-	0.254	S2	44	0.084	S2	1 224
48 30	174	..	-	-	-	0.360	S2	131	0.079	S2	874
48 30	174 30	..	-	-	-	0.372	S2	44	0.070	S2	1 224
48 30	175	..	-	-	-	-	-	-	0.065	S2	656
49	166	..	-	-	-	0.258	S2	44	0.141	S2	438
49	166 30	..	-	-	-	0.246	S2	963	0.136	S2	1 051
49	167	..	0.321	S2	44	0.235	S2	253	0.127	S2	1 708
49	167 30	..	-	-	-	0.231	S2	88	0.121	SM	1 926
49	168	..	-	-	-	-	-	-	0.128	S2	2 014
49	168 30	..	-	-	-	-	-	-	0.137	S2	1 576
49	169	..	-	-	-	-	-	-	0.140	S2	1 489
49	169 30	..	-	-	-	0.258	S2	306	0.137	S2	1 620
49	170	..	-	-	-	0.264	S2	219	0.129	S2	1 620
49	170 30	..	-	-	-	0.263	S2	1 270	0.119	S2	744
49	171	..	0.497	S2	728	0.253	S2	1 114	-	-	-
49	171 30	..	0.494	S2	986	0.228	S2	86	-	-	-
49	172	..	0.492	S2	471	0.178	S2	1 414	-	-	-
49	172 30	..	0.489	S2	86	0.124	SM	1 885	0.084	S2	43
49	173	..	-	-	-	0.119	SM	1 971	0.085	S2	43
49	173 30	..	-	-	-	0.245	S2	1 971	0.085	S2	43
49	174	..	-	-	-	0.506	SM	1 200	0.078	S2	771
49	174 30	..	-	-	-	0.403	SM	1 671	0.066	S2	343
49	175	..	-	-	-	0.371	S2	643	0.060	SM	943
49	175 30	..	-	-	-	-	-	-	0.064	S2	43
49 30	166	..	0.242	S2	257	0.263	S2	600	0.146	S2	214
49 30	166 30	..	0.249	S2	343	0.243	S2	300	-	-	-
49 30	167	..	0.286	S2	857	0.221	S2	771	-	-	-
49 30	167 30	..	0.351	S2	171	0.215	S2	1 414	0.132	S2	214
49 30	168	..	-	-	-	0.224	S2	857	0.140	S2	1 157
49 30	168 30	..	-	-	-	0.231	S2	86	0.149	S2	1 928
49 30	169	..	-	-	-	-	-	-	0.149	S2	2 014
49 30	169 30	..	-	-	-	0.258	S2	643	0.143	S2	1 371
49 30	170	..	-	-	-	0.268	S2	857	0.134	S2	1 157
49 30	170 30	..	-	-	-	0.271	S2	2 014	-	-	-
49 30	171	..	0.505	S2	43	0.267	S2	1 971	-	-	-
49 30	171 30	..	0.501	S2	171	0.248	S2	1 843	-	-	-
49 30	172	..	0.496	S2	129	0.210	S2	1 885	-	-	-
49 30	172 30	..	0.492	S2	343	0.167	S2	1 671	-	-	-
49 30	173	..	-	-	-	0.121	SM	2 014	-	-	-
49 30	173 30	..	-	-	-	0.216	S2	1 500	0.087	S2	386
49 30	174	..	-	-	-	0.344	S2	1 585	0.080	S2	429

Campbell Plateau (Area 3W), December 1976-January 1977 (cont.)

Area Lat.	Area Long.	Japanese Comm. CPSHF	200-400 m Rel. density	200-400 m Type	200-400 m Bottom area	400-600 m Rel. density	400-600 m Type	400-600 m Bottom area	600-800 m Rel. density	600-800 m Type	600-800 m Bottom area
49° 30'	174° 30'	..	-	-	-	0.366	S2	1 114	0.070	S2	686
49 30	175	..	-	-	-	0.352	S2	86	0.065	S2	1 114
50	165 30	..	0.212	S2	41	0.296	S2	41	0.151	S2	41
50	166	..	0.202	S2	164	0.283	S2	164	0.154	S2	82
50	167 30	..	0.345	S2	904	0.181	S2	493	-	-	-
50	168	..	-	-	-	0.231	SM	1 973	-	-	-
50	168 30	..	-	-	-	0.224	S2	1 850	0.171	S2	123
50	169	..	-	-	-	0.241	S2	1 315	0.161	S2	658
50	169 30	..	-	-	-	0.259	S2	82	0.149	S2	1 891
50	170	..	-	-	-	0.273	S2	336	0.137	S2	1 637
50	170 30	..	-	-	-	0.280	S2	1 427	0.127	S2	546
50	171	..	-	-	-	0.284	S2	1 973	-	-	-
50	171 30	..	-	-	-	0.278	S2	1 973	-	-	-
50	172	..	-	-	-	0.259	S2	1 973	-	-	-
50	172 30	..	-	-	-	0.225	S2	1 973	-	-	-
50	173	..	-	-	-	0.199	S2	1 931	0.094	S2	42
50	173 30	..	-	-	-	0.236	S2	378	0.090	S2	1 469
50	174	..	-	-	-	0.292	S2	84	0.085	S2	966
50 30	165 30	..	0.168	S2	493	0.335	S2	206	0.155	S2	123
50 30	166	..	0.180	S2	123	0.341	S2	49	-	-	-
50 30	166 30	..	0.156	SM	247	0.270	S2	247	-	-	-
50 30	167	..	0.221	S2	123	0.181	S2	1 233	-	-	-
50 30	167 30	..	0.371	S2	288	0.066	SM	1 685	-	-	-
50 30	168	..	-	-	-	0.178	S2	1 973	-	-	-
50 30	168 30	..	0.557	S2	41	0.210	S2	1 932	-	-	-
50 30	169	..	0.572	S2	41	0.237	S2	1 932	-	-	-
50 30	169 30	..	0.564	S2	164	0.261	S2	1 809	-	-	-
50 30	170	..	-	-	-	0.276	S2	1 385	0.139	S2	588
50 30	170 30	..	-	-	-	0.286	S2	1 595	0.128	S2	378
50 30	171	..	-	-	-	0.299	S2	1 973	-	-	-
50 30	171 30	..	-	-	-	0.307	S2	1 973	-	-	-
50 30	172	..	-	-	-	0.303	S2	1 973	-	-	-
50 30	172 30	..	-	-	-	0.287	S2	1 931	0.101	S2	42
50 30	173	..	-	-	-	0.273	S2	1 805	0.098	S2	168
50 30	173 30	..	-	-	-	0.278	S2	126	0.095	S2	1 133
51	165 30	..	0.125	S2	348	0.370	S2	464	0.156	S2	155
51	166	..	0.180	S2	309	0.456	SM	1 121	0.162	S2	155
51	166 30	..	-	-	-	0.253	SM	1 275	0.170	S2	618
51	167	..	-	-	-	0.223	S2	1 160	0.181	S2	773
51	167 30	..	-	-	-	0.168	S2	1 391	0.203	S2	541
51	168	..	-	-	-	0.149	SM	1 121	0.326	SM	811
51	168 30	..	-	-	-	0.191	S2	1 932	-	-	-
51	169	..	-	-	-	0.231	S2	1 932	-	-	-
51	169 30	..	-	-	-	0.264	S2	1 932	-	-	-
51	170	..	-	-	-	0.274	S2	1 932	-	-	-
51	170 30	..	-	-	-	0.275	S2	1 932	-	-	-
51	171	..	-	-	-	0.305	S2	1 932	-	-	-
51	171 30	..	-	-	-	0.342	S2	1 932	-	-	-

Campbell Plateau (Area 3W), December 1976-January 1977 (cont.)

Area Lat.	Area Long.	Japanese Comm. CPSHF	200-400 m Rel. density	200-400 m Type	200-400 m Bottom area	400-600 m Rel. density	400-600 m Type	400-600 m Bottom area	600-800 m Rel. density	600-800 m Type	600-800 m Bottom area
51°	172°	..	-	-	-	0.310	SM	1 932	-	-	-
51	172 30	..	-	-	-	0.318	S2	1 932	-	-	-
51	173	..	-	-	-	0.315	S2	1 883	0.100	S2	749
51	173 30	..	-	-	-	-	-	-	0.098	S2	1 893
51	174	..	-	-	-	-	-	-	0.096	S2	1 104
51 30	165 30	1.48	0	SM	0*	0.168	SM	0*	-	-	-
51 30	166	..	-	-	-	-	-	-	0.161	S2	79
51 30	166 30	..	-	-	-	0.285	S2	355	0.167	S2	867
51 30	167	..	-	-	-	0.242	S2	237	0.177	S2	1 656
51 30	167 30	..	-	-	-	-	-	-	0.186	SM	1 932
51 30	168	1.04	-	-	-	0.206	SM	552	0.205	SM	1 380
51 30	168 30	..	0.707	S2	789	0.118	SM	1 143	-	-	-
51 30	169	..	0.670	S2	1 498	0.227	S2	276	-	-	-
51 30	169 30	..	0.601	S2	1 222	0.271	S2	710	-	-	-
51 30	170	..	0.549	S2	513	0.274	S2	1 380	-	-	-
51 30	170 30	1.15	-	-	-	0.202	SM	1 932	-	-	-
51 30	171	1.43	-	-	-	0.269	SM	1 932	-	-	-
51 30	171 30	..	-	-	-	0.477	SM	1 932	-	-	-
51 30	172	..	-	-	-	0.358	S2	1 932	-	-	-
51 30	172 30	..	-	-	-	0.344	S2	1 695	0.101	S2	237
51 30	173	..	-	-	-	0.347	S2	828	0.101	S2	1 064
51 30	173 30	..	-	-	-	-	-	-	0.101	S2	1 263
51 30	174	..	-	-	-	-	-	-	0.100	S2	1 025
51 30	174 30	..	-	-	-	-	-	-	0.098	S2	158
52	167	..	-	-	-	-	-	-	0.161	S2	227
52	167 30	..	-	-	-	-	-	-	0.145	S2	907
52	168	..	0.702	S2	113	0.252	SM	302	0.051	SM	1 398
52	168 30	3.69	0.759	SM	831	0.312	SM	76	-	-	-
52	169	..	0.680	S2	113	-	-	-	-	-	-
52	169 30	..	0.564	S2	151	-	-	-	-	-	-
52	170	..	0.507	S2	1 133	0.172	SM	340	-	-	-
52	170 30	2.12	0.492	S2	76	0.406	SM	1 813	-	-	-
52	171	..	-	-	-	0.286	SM	1 889	-	-	-
52	171 30	..	-	-	-	0.348	S2	1 587	0.103	S2	302
52	172	..	-	-	-	0.370	S2	1 511	0.097	S2	378
52	172 30	..	-	-	-	0.368	S2	756	0.096	S2	1 133
52	173	..	-	-	-	0.393	S2	227	0.100	S2	1 209
52 30	168	..	0.669	S2	38	0.268	S2	227	0.104	S2	1 360
52 30	168 30	2.97	0.716	SM	680	0.332	SM	680	0.109	S2	302
52 30	169	..	0.547	S2	491	0.545	SM	38	-	-	-
52 30	169 30	..	0.424	S2	76	0.304	S2	38	-	-	-
52 30	170	..	0.426	S2	529	0.388	SM	1 247	-	-	-

* Insufficient bathymetric data available for bottom area calculation.

Campbell Plateau (Area 3W), December 1976-January 1977 (cont.)

Area Lat.	Area Long.	Japanese Comm. CPSHF	200-400 m Rel. density	200-400 m Type	200-400 m Bottom area	400-600 m Rel. density	400-600 m Type	400-600 m Bottom area	600-800 m Rel. density	600-800 m Type	600-800 m Bottom area
52° 30'	170° 30'	2.35	-	-	-	0.187	SM	1 889	-	-	-
52 30	171	..	0.466	S2	76	0.304	S2	1 813	-	-	-
52 30	171 30	..	0.474	S2	113	0.350	S2	1 776	-	-	-
52 30	172	3.55	0.478	S2	302	0.460	SM	1 511	0.083	S2	76
52 30	172 30	2.08	-	-	-	0.334	SM	1 813	0.081	S2	76
52 30	173	..	-	-	-	0.500	SM	1 473	0.105	S2	378
52 30	173 30	..	-	-	-	0.415	S2	38	0.108	S2	264
53	168	..	-	-	-	-	-	-	0.116	S2	355
53	168 30	..	-	-	-	0.258	S2	142	0.098	S2	1 562
53	169	0.78	0.169	S1	497	0.144	SM	923	0.041	S1	355
53	169 30	1.49	0.309	S1	710	0.344	SM	284	0.090	S1	604
53	170	..	0.367	S2	497	0.285	SM	817	0.095	S2	462
53	170 30	2.68	-	-	-	0.390	SM	1 775	0.098	S2	71
53	171	..	0.449	S2	142	0.325	S2	1 633	0.099	S2	71
53	171 30	..	0.463	S2	355	0.340	S2	1 136	0.093	S2	355
53	172	..	0.471	S2	107	0.329	SM	1 349	0.069	S2	391
53	172 30	2.34	-	-	-	0.356	SM	1 278	0.012	S1	462
53	173	..	-	-	-	0.570	SM	355	0.121	SM	1 030
53	173 30	..	-	-	-	-	-	-	0.112	S2	178
53 30	168 30	..	-	-	-	-	-	-	0.102	S2	801
53 30	169	..	-	-	-	-	-	-	0.090	S2	871
53 30	169 30	..	-	-	-	-	-	-	0.094	S2	592
53 30	170	1.37	-	-	-	-	-	-	0.093	SM	488
53 30	170 30	..	-	-	-	0.329	S2	139	0.096	S2	348
53 30	171	..	-	-	-	0.150	SM	35	0.098	S2	906
53 30	171 30	..	-	-	-	0.202	SM	70	0.094	S2	1 045
53 30	172	..	-	-	-	0.345	S2	35	0.082	S2	488
53 30	172 30	..	-	-	-	-	-	-	0.080	S2	70

Southland (East) (Area 4E), November-December 1975

Area Lat.	Area Long.	Japanese Comm. CPSHF	200-400 m Rel. density	200-400 m Type	200-400 m Bottom area	400-600 m Rel. density	400-600 m Type	400-600 m Bottom area	600-800 m Rel. density	600-800 m Type	600-800 m Bottom area
46°	170°	..	0.499	S2	90	0.443	S2	60	-	-	36
46	170 30	2.38	0.336	S1	179	0.322	S1	179	-	-	419
46 30	169 30	4.27	0.697	SM	144	0.560	SM	179	-	-	269
46 30	170	2.98	0.595	S2	108	0.372	S1	179	-	-	538
47	169	3.74	0.296	SM	295	0.621	SM	678	-	-	-
47	169 30	3.92	1.158	SM	29	0.126	SM	519	-	-	1 404
47	170	..	-	-	-	-	-	-	-	-	147
47 30	167 30	3.43	-	-	-	-	-	-	-	-	-
47 30	168 30	4.16	0.515	SM	88	1.044	SM	112	-	-	342
47 30	169	3.90	0.397	SM	29	0.855	SM	490	-	-	1 593
47 30	169 30	..	-	-	-	0.571	S2	47	-	-	767
48	167 30	7.33	1.380	S1	35	1.221	S1	17	-	-	-
48	168	5.17	1.261	SM	81	0.699	SM	87	-	-	954
48	168 30	5.04	0.896	S2	17	0.859	S2	47	-	-	1 996
48	169	..	-	-	-	0.768	S2	35	-	-	2 118
48	169 30	..	-	-	-	-	-	-	-	-	1 222
48 30	166 30	4.69	0.768	S1	559	0.784	S1	303	-	-	81
48 30	167	..	0.998	S2	244	1.001	S2	291	-	-	553
48 30	167 30	7.37	1.546	SM	76	1.234	S1	506	-	-	1 245
48 30	168 30	5.61	-	-	-	-	-	-	-	-	-
48 30	169	..	-	-	-	0.784	S2	17	-	-	1 670
48 30	169 30	..	-	-	-	0.714	S2	35	-	-	1 147
48 30	170	..	-	-	-	-	-	-	-	-	553
48 30	170 30	..	-	-	-	-	-	-	-	-	1 187

Southland (East) (Area 4E), May 1976

Area Lat.	Area Long.	Japanese Comm. CPSHF	200-400 m Rel. density	200-400 m Type	200-400 m Bottom area	400-600 m Rel. density	400-600 m Type	400-600 m Bottom area	600-800 m Rel. density	600-800 m Type	600-800 m Bottom area
46°	169° 30'	2.19	-	-	-	-	-	-	-	-	-
46	170	3.99	0.551	S1	90	0.070	SM	60	-	-	36
46	170 30	5.28	0.701	S1	179	0.200	S1	179	-	-	419
46 30	169	1.36	-	-	-	-	-	-	-	-	-
46 30	169 30	1.71	0.265	SM	144	0.163	S1	179	-	-	269
46 30	170	1.17	0.463	S2	108	0.066	S1	179	-	-	538
47	168	1.53	-	-	-	-	-	-	-	-	-
47	168 30	1.59	-	-	-	-	-	-	-	-	-
47	169	1.83	0.151	SM	295	0.208	SM	678	-	-	-
47	169 30	0.83	0.282	S2	29	0.097	S1	519	-	-	1 404
47	170	..	-	-	-	-	-	-	-	-	147
47 30	167 30	2.08	-	-	-	-	-	-	-	-	-
47 30	168 30	1.98	0.311	SM	88	0.654	SM	112	-	-	342
47 30	169	2.71	0.112	SM	29	0.429	S1	490	-	-	1 593
47 30	169 30	..	-	-	-	0.250	S2	47	-	-	767
48	167	0.99	-	-	-	-	-	-	-	-	-
48	167 30	3.65	0.468	S1	35	0.681	S1	17	-	-	-
48	168	3.81	0.437	S2	81	0.546	S2	87	-	-	954
48	168 30	3.77	0.361	S2	17	0.226	SM	47	-	-	1 996
48	169	13.40	-	-	-	0.368	S2	35	-	-	2 118
48	169 30	..	-	-	-	-	-	-	-	-	1 222
48 30	166 30	..	0.444	S2	559	0.541	S2	303	-	-	81
48 30	167	..	0.453	S2	244	0.599	S2	291	-	-	553
48 30	167 30	3.66	0.456	S2	76	0.645	S1	506	-	-	1 245
48 30	168	14.19	-	-	-	-	-	-	-	-	-
48 30	169	..	-	-	-	0.373	S2	17	-	-	1 670
48 30	169 30	..	-	-	-	0.325	S2	35	-	-	1 147
48 30	170	..	-	-	-	-	-	-	-	-	553
48 30	170 30	..	-	-	-	-	-	-	-	-	1 187

Southland (East) (Area 4E), November-December 1976

Area Lat.	Area Long.	Japanese Comm. CPSHF	200-400 m Rel. density	200-400 m Type	200-400 m Bottom area	400-600 m Rel. density	400-600 m Type	400-600 m Bottom area	600-800 m Rel. density	600-800 m Type	600-800 m Bottom area
46°	170°	..	0.207	S2	90	0.093	S2	60	0.154	S2	36
46	170 30	..	0.211	S2	179	0.099	S2	179	0.161	S2	419
46 30	169 30	0.93	0.207	SM	144	0.072	S1	179	0.118	S1	269
46 30	170	0	0.203	S2	108	0.090	S2	179	0.152	S2	538
46 30	170 30	2.16	-	-	-	-	-	-	-	-	-
47	168	0.82	-	-	-	-	-	-	-	-	-
47	168 30	0	-	-	-	-	-	-	-	-	-
47	169	1.26	0.153	SM	295	0.086	SM	678	-	-	-
47	169 30	1.24	0.146	SM	29	0.100	SM	519	0.166	S1	1 404
47	170	..	-	-	-	-	-	-	0.165	S2	147
47 30	167 30	1.07	-	-	-	-	-	-	-	-	-
47 30	168 30	1.44	0.143	SM	88	0.121	SM	112	0.187	S1	342
47 30	169	1.25	0.119	SM	29	0.161	SM	490	0.177	SM	1 593
47 30	169 30	..	-	-	-	0.112	S2	47	0.176	S2	767
48	167 30	5.21	0.403	S1	35	0.308	S1	17	-	-	-
48	168	2.21	0.046	SM	81	0.191	S2	87	0.137	S1	954
48	168 30	1.44	0.221	S2	17	0.169	SM	47	0.160	S1	1 996
48	169	1.38	-	-	-	0.132	S2	35	0.183	S1	2 118
48	169 30	..	-	-	-	-	-	-	0.189	S2	1 222
48 30	166 30	..	0.344	S2	559	0.123	SM	303	0.130	S2	81
48 30	167	..	0.351	S2	244	0.148	S2	291	0.103	S2	553
48 30	167 30	1.96	0.190	SM	76	0.094	S1	506	0.052	SM	1 245
48 30	168	1.90	-	-	-	-	-	-	-	-	-
48 30	168 30	1.76	-	-	-	-	-	-	-	-	-
48 30	169	2.42	-	-	-	0.134	S2	17	0.263	S1	1 670
48 30	169 30	..	-	-	-	0.126	S2	35	0.212	S2	1 147
48 30	170	..	-	-	-	-	-	-	0.193	S2	553
48 30	170 30	..	-	-	-	-	-	-	0.185	S2	1 187

Southland (West) (Area 4W), November-December 1975

Area Lat.	Area Long.	Japanese Comm. CPSHF	200-400 m Rel. density	200-400 m Type	200-400 m Bottom area	400-600 m Rel. density	400-600 m Type	400-600 m Bottom area	600-800 m Rel. density	600-800 m Type	600-800 m Bottom area
45° 30'	166°	..	0.172	S2	123	0.061	S2	166	-	-	135
46	165 30	..	0.172	S2	161	0.061	S2	293	-	-	138
46	166	1.18	0.175	SM	819	0.061	SM	586	-	-	6
46	166 30	..	0.168	S2	640	0.061	S2	120	-	-	-
46 30	165 30	..	0.168	S2	730	0.061	S2	383	-	-	239
46 30	166	..	0.168	S2	114	0.061	S2	155	-	-	407
46 30	166 30	..	0.153	S2	120	0.061	S2	227	-	-	257
46 30	167	..	0.135	S2	484	0.061	S2	275	-	-	167
47	165 30	..	-	-	-	0.061	S2	12	-	-	236
47	166 30	..	0.135	S2	18	0.061	S2	65	-	-	88
47	167	..	0.125	SM	147	0.061	S2	71	-	-	88
47 30	166	..	0.145	S2	224	0.061	S2	59	-	-	106
47 30	166 30	..	0.135	S2	177	0.061	S2	59	-	-	41
48	166	..	0.144	S2	87	0.061	S2	93	-	-	81
48 30	166	..	0.145	S2	146	0.061	S2	70	-	-	244

Southland (West) (Area 4W), November-December 1976

Area Lat.	Area Long.	Japanese Comm. CPSHF	200-400 m Rel. density	200-400 m Type	200-400 m Bottom area	400-600 m Rel. Density	400-600 m Type	400-600 m Bottom area	600-800 m Rel. density	600-800 m Type	600-800 m Bottom area
45° 30'	166°	..	0.139	S2	123	0.227	S2	166	0.260	S2	135
46	165 30	..	0.146	S2	161	0.245	S2	293	0.286	S2	138
46	166	2.34	0.134	S1	819	0.212	SM	586	0.283	S2	6
46	166 30	..	0.132	S2	640	0.117	SM	120	-	-	-
46 30	165 30	..	0.169	S2	730	0.282	S2	383	0.298	S2	239
46 30	166	2.61	0.161	S2	114	0.375	SM	155	0.329	SM	407
46 30	166 30	1.48	0.141	S2	120	0.350	SM	227	0.186	S1	257
46 30	167	1.07	0.072	S1	484	0.189	S1	275	0.175	S2	167
47	165 30	..	-	-	-	0.278	S2	12	0.281	S2	236
47	166 30	..	0.465	SM	18	0.252	S2	65	0.198	S2	88
47	167	0.64	0.050	S1	147	0.112	S1	71	0.080	S1	88
47 30	166	..	0.278	SM	224	0.255	S2	59	0.238	S2	106
47 30	166 30	1.53	0.204	SM	177	0.251	S1	59	0.191	S2	41
48	166	..	0.233	S2	87	0.248	S2	93	0.225	S2	81
48 30	166	..	0.211	S2	146	0.244	S2	70	0.222	S2	244

West Coast, South Island (Area 5), June-July 1976

Area Lat.		Long.		Japanese Comm. CPSHF	200-400 m Rel. density	200-400 m Type	200-400 m Bottom area	400-600 m Rel. density	400-600 m Type	400-600 m Bottom area	600-800 m Rel. density	600-800 m Type	600-800 m Bottom area
40°		169°		0.37	-	-	-	-	-	-	-	-	-
40		172		0.96	-	-	-	-	-	-	-	-	-
40	30	169	30	..	-	-	-	-	-	-	0.248	S2	37
40	30	170		..	-	-	-	-	-	-	0.241	S2	2 243
40	30	170	30	2.48	0.234	S2	147	0.466	S1	1 213	0.266	S1	993
40	30	171		..	0.247	S2	1 471	0.537	S2	880	-	-	-
40	30	171	30	0.96	0	SM	404	-	-	-	-	-	-
40	30	172		1.65	-	-	-	-	-	-	-	-	-
41		169	30	0	-	-	-	-	-	-	-	-	-
41		170		2.09	-	-	-	0.608	S2	145	0.203	SM	1 739
41		170	30	3.80	0.211	S1	1 377	0.635	S1	942	-	-	-
41		171		..	0.231	S2	1 631	-	-	-	-	-	-
41	30	170		2.85	-	-	-	0.719	SM	456	0.299	SM	1 405
41	30	170	30	3.50	0.132	SM	1 757	0.008	SM	211	-	-	-
41	30	171		..	0.240	S2	35	-	-	-	-	-	-
42		170		2.70	-	-	-	0.711	SM	588	0.426	SM	1 003
42		170	30	3.30	0.356	SM	553	0.559	SM	553.	-	-	-
42	30	168	30	0	-	-	-	-	-	-	-	-	-
42	30	169		0.44	-	-	-	-	-	-	0.060	S1	67
42	30	169	30	2.49	-	-	-	0.558	S1	436	0.372	SM	671
42	30	170		3.03	0.384	S1	873	0.669	S1	470	0.341	S2	34
42	30	170	30	3.58	0.536	SM	269	0.665	S2	34	-	-	-
43		169		3.96	0.577	S2	99	0.848	S1	330	0.495	SM	859
43		169	30	6.44	0.750	S1	463	1.380	S1	595	0.332	S2	132
43		170		..	0.490	S2	33	-	-	-	-	-	-
43	30	168		..	0.458	S2	33	0.850	S2	33	0.301	S2	33
43	30	168	30	..	0.492	S2	99	0.889	S2	99	0.334	S2	397
43	30	169		..	0.547	S2	66	0.956	S2	132	0.370	S2	33

West Coast, South Island (Area 5), August-September 1976

Area		Japanese	200-400 m			400-600 m			600-800 m		
Lat.	Long.	Comm. CPSHF	Rel. density	Type	Bottom area	Rel. density	Type	Bottom area	Rel. density	Type	Bottom area
40°	171° 30'	0.11	-	-	-	-	-	-	-	-	-
40	172	0.92	-	-	-	-	-	-	-	-	-
40 30	169 30	..	-	-	-	-	-	-	0.159	S2	37
40 30	170	..	-	-	-	-	-	-	0.145	S2	2 243
40 30	170 30	1.57	0.692	S2	147	0.592	SM	1 213	0.099	S1	993
40 30	171	..	0.791	S2	1 471	0.023	SM	880	-	-	-
40 30	171 30	..	0.858	S2	404	-	-	-	-	-	-
41	170	2.29	-	-	-	0.554	S2	145	0.145	S1	1 739
41	170 30	4.33	0.482	SM	1 377	0.946	SM	942	-	-	-
41	171	..	0.885	S2	1 631	-	-	-	-	-	-
41	172	2.18	-	-	-	-	-	-	-	-	-
41 30	170	3.88	-	-	-	0.280	SM	456	0.245	S1	1 405
41 30	170 30	2.88	0.766	S1	1 757	0.544	SM	211	-	-	-
41 30	171	4.67	1.206	S1	35	-	-	-	-	-	-
42	170	2.45	-	-	-	0.229	SM	588	0.155	SM	1 003
42	170 30	2.25	1.086	SM	553	0.366	SM	553	-	-	-
42 30	169	..	-	-	-	-	-	-	0.177	S2	67
42 30	169 30	..	-	-	-	0.279	S2	436	0.175	S2	671
42 30	170	1.48	0.362	S1	873	0.195	S1	470	0.170	S2	34
42 30	170 30	3.26	0.605	SM	269	0.319	S2	34	-	-	-
43	169	..	0.651	S2	99	0.326	S2	330	0.176	S2	859
43	169 30	..	0.597	S2	463	0.295	S2	595	0.175	S2	132
43	170	..	0.570	S2	33	-	-	-	-	-	-
43 30	168	..	0.705	S2	33	0.363	S2	33	0.174	S2	33
43 30	168 30	..	0.690	S2	99	0.351	S2	99	0.175	S2	397
43 30	169	..	0.669	S2	66	0.336	S2	132	0.175	S2	33

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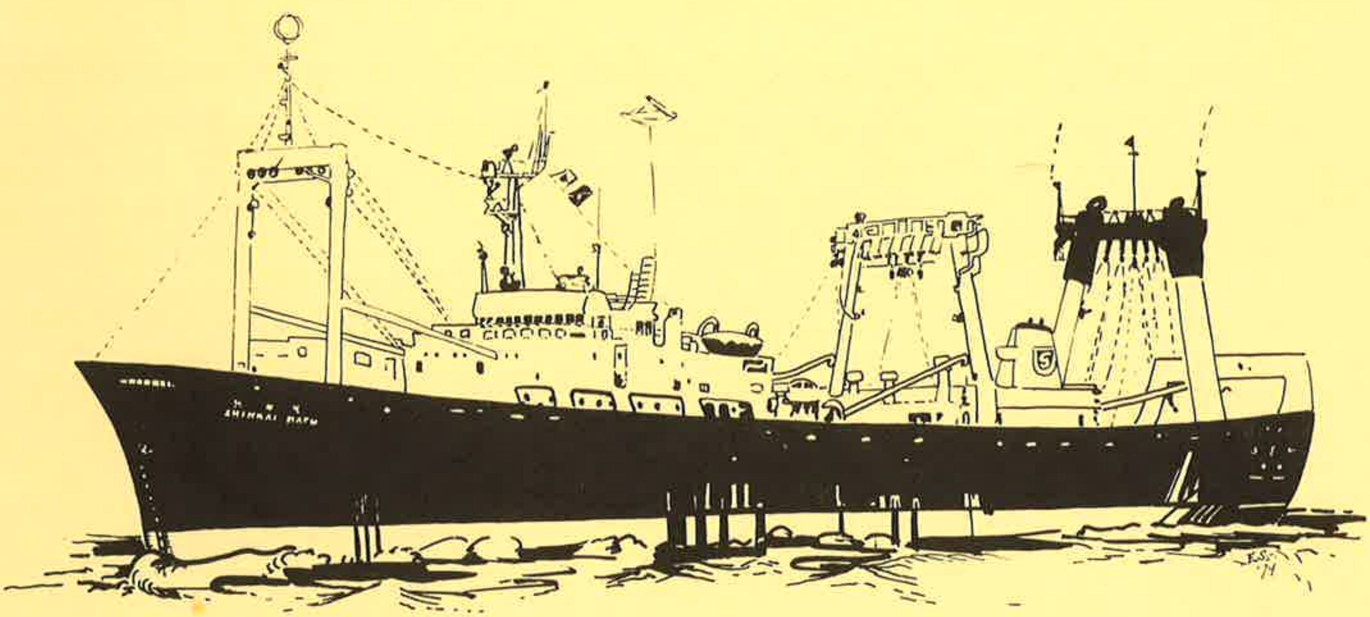

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