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A Hydroacoustic Survey of Pacific Hake on the Continental Shelf off British Columbia from the Canada/U.S. Boundary to Queen Charlotte Sound: August 8 to September 2, 1992

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A HYDROACOUSTIC SURVEY OF PACIFIC HAKE ON THE CONTINENTAL SHELF OFF BRITISH COLUMBIA FROM THE CANADA/U.S. BOUNDARY TO QUEEN CHARLOTTE SOUND: AUGUST 8 TO SEPTEMBER 2, 1992

by

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ABSTRACT

Andrews, W.T., K. Cooke, R. Kieser, M.W. Saunders and M.S. Smith. 1994. A hydroacoustic survey of Pacific hake on the continental shelf off British Columbia from the Canada/U.S. boundary to Queen Charlotte Sound: August 8 to September 2, 1992. Can. Manuscr. Rep. Fish. Aquat. Sci. 2263: 51 p.

A hydroacoustic survey of Pacific Hake was conducted off the lower west coast of Vancouver Island and into Queen Charlotte Sound from August 8 to September 2, 1992. Total and hake biomass estimates are given for the survey area. Summary information of associated midwater trawl catches is also included.

Key words: Hydroacoustic survey, Pacific hake, echo integration, biomass, abundance, distribution.

RESUME

Andrews, W.T., K. Cooke, R. Kieser, M.W. Saunders and M.S. Smith. 1994. A hydroacoustic survey of Pacific hake on the continental shelf off British Columbia from the Canada/U.S. boundary to Queen Charlotte Sound: August 8 to September 2, 1992. Can. Manuscr. Rep. Fish. Aquat. Sci. 2263: 51 p.

Du 8 août au 2 septembre 1992, on a effectué un relevé hydroacoustique du merlu du Pacifique au large de la partie inférieure de la côte ouest de l'île de Vancouver et dans le détroit de la Reine-Charlotte. Les estimations comprennent la biomasse totale et la biomasse de merlu pour la zone étudiée. Le rapport contient également des renseignements sommaires sur les prises associées effectuées par chaluts pélagiques.

Mots-clés : Relevé hydroacoustique, merlu du Pacifique, écho-intégration, biomasse, abondance, répartition.

INTRODUCTION

Pacific hake *(Merluccius productus)* is a migratory species that spawns annually in American waters off California and feeds during the summer months from northern California to Queen Charlotte Sound. Hake in Canadian waters tend to be predominantly female and larger at age than hake in American waters.

Pacific hake is a valuable resource harvested annually in American and Canadian fisheries. Pacific hake were under utilized in the past, however, in recent years quotas have been fully subscribed. Hydroacoustic estimates of abundance are used in assessments and in studies of the factors influencing distribution.

The first Canadian quantitative hydroacoustic survey to determine distribution and abundance of Pacific hake off southern Vancouver Island was conducted in 1983 (Barner et al. 1984). From 1987 through 1989, qualitative surveys to examine the distribution and biology of hake from the Canada/U.S. border to Queen Charlotte Sound were carried out (M. Saunders, unpublished data). Results of these surveys indicated substantial hake concentrations from the Canada/U.S. border to Goose Island Gully in Queen Charlotte Sound. The presence of signatory strong year-classes, not found in local populations, indicated that these hake were part of the migratory offshore stock. Quantitative surveys of this larger area were conducted in 1990 (Saunders et al. 1992) and 1991 (Cooke et al. 1992). This report describes the 1992 survey. The primary objective of this survey was to determine the distribution and abundance of hake in the study area. Mid-water trawl hauls were conducted to verify acoustic targets and to examine the hake size distribution and age composition as a function of latitude. An intership comparison was conducted with American researchers who were independently assessing the hake stock coastwide. Additional research examined hake diel behaviour, acoustic survey strategy and variability in acoustic abundance estimation.

This report includes a description of the study area, survey design, hydroacoustic data acquisition system, analysis procedure, as well as hydroacoustic and fishing results. Acoustic biomass estimates and distribution maps for all fish species combined and for Pacific hake are presented. Trawl catch composition and biological information for Pacific hake and other species are provided. Conventional and GIS based biomass estimation procedures are used. Northern transects from earlier cruises are reanalysed to provide a comparison of biomass estimates between years.

MATERIALS AND METHODS

The survey was conducted from August 8 to September 2, 1992 using the *CSS W.E. RICKER*, a 58 m, 2500 h.p. research stern trawler. The survey design and instrumentation were similar to those used in earlier surveys (Barner et al. 1984; Kieser 1983; Saunders et al. 1992; Cooke et al. 1992).

SURVEY AREA

The overall survey area extended from the Canada/U.S. boundary (approximately 48° 15′) to 52° north latitude. The survey included the traditional Canadian hake fishing grounds between 48° 15′ and 49° as well as northern areas where earlier surveys indicated the presence of hake. Exploratory work was carried out between 51° and 52°. Waters were sounded from 50 m depth to beyond the shelf break (~300 m) or until the echogram hake sign diminished to a negligible level. In the northern most portion of the survey area transects extended beyond the 500 m depth contour, reflecting a deeper shelf break in this area.

The survey area was divided into four major transect groups. The A and B series transects covered the near shore area of southwest Vancouver Island (Figure 1a). The C and Q series transects extended the coverage from 49°, just north of Barkley Sound, to Queen Charlotte Sound and the entrance to Queen Charlotte Strait (Figures 1b and 1c). A grid of east/west parallel transects was used for the A and B series. The distance between transects was 4.6 km (2.5 nmi). Previous sounding surveys indicated that in areas north of the La Perouse region, hake were generally found in an intermittent band along the shelf break (Saunders et al. 1992). In this region, the C and Q series used a combination of parallel and zigzag transects to maximize the northward progression and the number of shelf-break crossings. Parallel transects with 5 nm separation were run off Brooks Peninsula to adequately sample the higher hake densities associated with this area (Saunders et al. 1992). The survey was conducted during daylight hours only, from about 0600 to 2100 PDT.

ADDITIONAL RESEARCH

An intership calibration experiment was conducted to compare the acoustic systems on board the *W.E. RICKER* and the National Oceanographic and Atmospheric Administration (NOAA) research vessel *MILLER FREEMAN*. The study was designed to reveal possible differences in acoustically measured fish density and variability, and to provide information on fish behaviour and distribution with respect to vessel movement and time of day. The comparison included: 1) collection of concurrent density measurements of the same fish distribution, and 2) standard target calibrations. A SIMRAD EK500/BI500 echosounder/analysis system was used on *MILLER FREEMAN*. Its 38 kHz split-beam transducer was mounted below the keel on a retractable centre board. The Canadian acoustic system will be described in the next section.

During the first part of the comparison, data were simultaneously collected over a 12 h period from both vessels for five successive passes along two parallel T transects (Figure 1d) just west of Barkley Canyon along the shelf break. The transects were 4.6 km (2.5 nmi) apart and, approximately 15.5 km long, covering an area of about 70 km^2. Ships alternately assumed the leading and trailing position between passes with the trailing vessel about 400 - 500 m aft and starboard of the leader.

The second aspect of the comparison was a standard target calibration (Foote et al. 1987) of each acoustic system using 60 mm diameter copper spheres. On August 13, 1992, both vessels anchored in Kendrick Inlet, on the west coast of Vancouver Island. Each team collected target measurements with their respective system. Calibration of both acoustic systems under similar conditions provided researchers an opportunity to observe procedural details and discuss possible differences in methodology and results.

DATA ACQUISITION and ANALYSIS

The calibrated echo integration system on the *W.E. RICKER* consisted of a BioSonics 38 Khz echo sounder, a BioSonics chart recorder, a BioSonics digital echo integrator, a PCM/VCR tape recording system and auxiliary equipment. The 'wet end' included a towed body with a SIMRAD ceramic transducer and armoured tow cable. A 20(log R) time varied gain was set on the echo sounder and the echo integrator was programmed to analyze the return echoes for a series of strata (range slices) starting just below the transducer and continuing to bottom. Bottom tracking was obtained with a 5 m bottom buffer. An echo integration sequence was completed every 60 pings (1 minute) and the measured echo intensities were stored on a personal computer. The echo integrator and chart recorder thresholds were set to 0.2 V, thus, all integrated echoes were displayed on the echogram. At this threshold level occasional noise pulses were visible on the deeper portions of the echogram. Significant noise levels were excluded during the analysis. These included flow and vessel noise, as well as occasional interference from the navigational sounder or porpoises in the vicinity of the towed body. Standard data acquisition and analysis procedures were used (Burczynski 1982; Clay and Medwin 1977; Forbes and Nakken 1972; Kieser et al. 1987). A target strength (TS) of -35 dB/kg was used for hake and -32 dB/kg for all other species to calculate surface density and biomass estimates (Cooke et al. 1992; Kieser 1992).

Figure 2 shows a typical echogram that was recorded at the shelf break. Solid horizontal and vertical lines indicate range and 10 minute intervals respectively. Tick marks across the top margin represent minute intervals. The dashed vertical lines are event marks. Bottom tracking was monitored by a line that follows just above the bottom. Although not visible in Figure 2, a surface echo occasionally appeared between 10 and 15 m range. This signal was used to estimate the depth of the towed body and transducer. It was excluded from the subsequent analysis. The range of the surface echo was added to the target range shown on the echogram to estimate target depth. Typical day time rockfish schools are shown at a range of 80 to 120 m just at the shelf break. Hake appear between 70 and 140 m in a dense band that continues outward from the shelf break; plankton are indicated by a diffuse scattering layer that starts at the shelf break.

Estimation of biomass by species requires target identification. Targets observed on the echogram were classified according to a number of criteria. In the day, hake schools formed cone-like clusters which produce a zigzag pattern across the echogram as illustrated in Figure 2. At dusk, dawn, and at night, Pacific hake dispersed to form layers of single fish, over a considerable depth range. Potentially confusing species included pollock, herring, rockfish and dogfish. Pollock were mixed with the hake and, while they could not be separately identified on the echogram, test fishing showed pollock contributed very little to hake schools in this survey. Herring were characterized by dense 'haystack-type' schools near the bottom or 'needle shaped' schools in mid-water. Column-like schools just beyond the shelf break or near steep slopes or pinnacles were believed to be rockfish (Figure 2). The target strength of dogfish is so low that they generally appeared as a haze on the echogram and contributed relatively little to the measured echo intensity.

The integrated output was processed with custom software to exclude ocean bottom, noise, and echoes from unwanted sources in the water column. The total or 'all species' estimates included all echoes from fish-like targets. Two methods were used to expand the measured surface densities to a biomass estimate.

Our conventional area-expansion procedure expands each measured surface density to a cell that is bounded by equidistant lines between adjacent transects and by lines perpendicular to and midway between the measurements along the transect. Using the conventional analysis, cell boundaries are easily defined for parallel transects, however, the process is very labour intensive for irregularly spaced transects.

A second area expansion algorithm, proximal analysis (Kieser and Langford 1991; Langford 1992), was primarily used to estimate abundance in areas with irregularly spaced transects. Our implementation of proximal used a custom program to enter surface density measurements (Figure 3 a-c and 4 a-c), geographic coordinates and related information into the COMPUGRID raster-based GIS (Langford 1992). One minute surface density measurements were averaged to 5 minute intervals (~1400 m) along each transect. Data were then written to a geographically referenced matrix with 250 m spacing between elements and scaled to the available integer range of 0 to 32000, to obtain maximum resolution. Proximal was run to assign the nearest measured surface density to each unknown matrix element.

The survey area was delineated using a hand drawn mask (Figure 5). Its boundaries were determined by: 1) connecting zigzag or parallel transect end points along the outside edge, and 2) adding half the distance between adjacent transects, to a maximum distance of 2.5 nm, to end or solitary transects. As a result, transects were grouped in blocks from C1A/AE to C53E, C59E to C66S, C67S to C69S, and Q1W to Q11E (Figure 5).

Both procedures estimated total fish biomass by summing all products of surface density and cell area and generated the same results, regardless of transect pattern, provided survey area boundaries are the same. However, proximal analysis was more easily applied to irregular transects and was suitable for automation of the analysis process. Being a standard GIS procedure; transect, cell, and surface density maps are readily produced.

Conventional analysis was used for the A-B series (Table 2); conventional and proximal analyses were used for the C-Q series (Table 3). To provide a comparison with earlier reports, C series survey data from 1990 (Saunders et al. 1992), 1991 (Cooke et al. 1992), and 1992 were analyzed using both methods. Summary tables are given in the DISCUSSION section.

FISHING SURVEY

Test fishing hauls were carried out from the *CSS W.E. RICKER* to obtain species composition for verification of echogram interpretations and to obtain biological information. Trawl gear consisted of a Canadian Diamond-7 midwater trawl with 13.5 m vertical opening and 3.8 cm cod end mesh, a pair of 5 m^2 Superkrub midwater trawl doors, 80 m sweep wires with 300 kg chain weights, and a SIMRAD FS3300 trawl sonar. Fishing positions were selected to sample major fish concentrations where echogram species signatures were ambiguous. An effort was made to have less than 3 hours elapse from the time of target detection to actual fishing.

Trawl catches were spilled from the codend into a below deck hopper and sorted by species from a conveyor belt into tubs. All tubs of fish were weighed on a platform scale to the nearest kilogram. Representative subsamples of hake were selected by retaining at least 3 tubs of fish each from the start, middle and end of the hopper load. Six of the 9 tubs retained were randomly selected for routine biological sampling with the entire catch being sampled from small hauls of less than 6 tubs.

Measurements of fork length to the nearest millimetre and sex were recorded for all hake sampled. Otoliths were collected and maturity state (Weir et al. 1978) recorded for a portion of the hake catch. Otoliths, to be aged at a later date, were stored in a 1/1 solution of glycerine and freshwater with thymol at 0.3% added as an antibacterial. The stomach contents of hake from 1 or 2 tubs were examined with prey items being identified to the lowest possible taxon. The volume of each prey item was estimated visually to the nearest cc. The state of digestion was recorded for each prey item and any identifiable herring remains were counted and measured.

OCEANOGRAPHIC DATA

Conductivity and temperature were sampled at pre-selected stations and some trawl haul locations using a GUILDLINE CTD (8770 series) oceanographic probe to within 10 m of the bottom or 500 m if bottom depth allowed. Sea surface temperatures were recorded at 10 minute intervals using the CSAIL software/hardware system (Revlis Electronics Ltd. Vernon, B.C., and Simmie Software Solutions, Regina, Sask.; Saunders et al. 1992) via the *CSS W.E. RICKER's* seawater intake located approximately 4 m below sea surface.

Plankton samples were collected at pre-selected stations for use by the Cooperative Plankton Research Monitoring Program (COPRA). Plankton sampling gear consisted of twin 60 cm diameter bongo net frames with 230 micron mesh nets attached. A stainless steel flowmeter is located inside the mouth of one of the nets. Oblique tows were conducted to within 20 m of the bottom or to a maximum depth of 500 m. Wire was paid out at a rate of 1 m/sec and retrieved at a rate of 0.3 m/sec. The samples were preserved in labelled 1 litre jars with a 10% formalin to seawater solution.

RESULTS

BIOMASS ESTIMATES: MAIN SURVEY AREA

A total of 96 transects were run encompassing a survey area of 23694 km^2 (Table 1; Figures 1a-d). The estimates of total biomass (all species) and hake biomass by transect are in Tables 2 and 3. A summary by survey area is given below. Column 3 (Method) indicates use of conventional (CONV; Table 2) or proximal (PROX; Table 3) analysis.

Transect Series	Area km^2	Method	Total biomass All species (kt)	Hake biomass (kt)
A	2519	CONV	137	99
B	5047	CONV	345	288
C	12397	PROX	811	694
Q	3582	PROX	23	0
BRK	149	CONV	3	1
Total	23694		1319	1082

The above totals include the entire Canadian survey area. They exclude estimates from: 1) a portion of transect B12E which, when extrapolated to 2.5 nmi width, included U.S. waters, and 2) duplication of a portion of transect B13W.

Plots of the biomass distribution for all fish and for hake only are shown in Figures 3a-c and 4a-c, respectively.

BIOMASS ESTIMATES: T TRANSECTS

Total biomass estimates for *CSS W.E. RICKER* passes along the T transects (Figure 1d), based only on conventional analysis, are presented in

Table 2. For clarity, in Figure 1d only a typical transect pair is plotted, all repeats followed a similar pattern.

ADDITIONAL RESEARCH

The intership calibration study (T series) focused on comparative data sets from two independent acoustic systems. This information will be the subject of a future joint Canada/U.S. report and will examine variability in acoustic abundance estimation as well as *in situ* target calibrations.

Observations on diel distribution changes and species specific behaviour were obtained from the five successive passes of the T series transects (Tables 1 and 2). During the day, aggregations of hake were characterized by relatively continuous, dense, and vertically stacked schools located near the 200 m shelf break (Figure 6, top). Schools located shoreward of the shelf break were typically at 100 to 180 m range and appeared very close to or on bottom. Hake were found to depths of at least 250 m off the shelf edge. Rockfish species were often found in association with the hake at the shelf break (Figure 2), but generally were recognizable from hake by narrower and more vertically stacked shoals (Leaman et al. 1990; Kieser et al. 1993). Transitional movement between day to night formation occurred very rapidly at twilight. At dusk the normal pattern was one of dispersal of diurnal schools in both horizontal and vertical directions, including a net motion towards the surface (Figure 6, middle). Nocturnal echograms show much more diffuse distributions that include considerable mixing of species (Figure 6, bottom). At dawn schools rapidly regrouped nearer the bottom to complete the diel cycle.

FISHING RESULTS

A total of 13 midwater trawl hauls were conducted to obtain species composition and biological samples (Figure 7). Table 4 lists bridge log and catch data. Pacific hake were present in all hauls and accounted for 55.5% of the total catch by weight (Table 5). Tables 6 and 7 detail the biological samples for Pacific hake and other species sampled. The length frequencies by haul, are presented in Tables 8 and 9. Oceanographic station locations for CTD and COPRA are listed in Tables 10 and 11.

DISCUSSION

The 1992 hake survey covered a total area of 23694 km^2 off Vancouver Island and through Queen Charlotte Sound. It extended from the Canada/U.S. boundary (approximately 48° 15') to Cape St. James, Queen Charlotte Islands (52° 10'). Transects ran from about the 50 m depth contour, to well seaward of the continental shelf. South of Cape Scott, on the northern end of Vancouver Island, each line generally extended seaward to the 300 m depth contour; north of this point, transects ran beyond the 500 m contour.

Hake biomass for the entire survey area was estimated at 1082 kt in 1992, compared with 568 kt for 1991 (Cooke et al. 1992) and 316 kt for 1990 (Saunders et al. 1992). Hake biomass for series A in 1992 was 99 kt compared with 120 kt in 1991 and 63 kt in 1990. For the B series, hake biomass estimates were slightly less in 1992 than 1991 (288 kt and 321 kt, respectively) but remained three times greater than in 1990 (75 kt). Hake estimates for the C series, using proximal analysis, were 694 kt. This was based on an area of 12397 km^2, over three times that done in previous years. The increase in survey area in 1992 was due to the presence of hake much farther offshore than in previous years. The overall increase of hake in this zone was possibly due to the El Nino conditions that were positively correlated with an increase in abundance in the Canadian zone (Smith et al. 1990). Comparable data sets for the C series in 1991 and 1990 are discussed below. No hake biomass was observed north of 51.5° latitude.

GIS-BASED BIOMASS ESTIMATION AND COMPARISON OF C SERIES BIOMASS ESTIMATES FOR 1990, 1991 AND 1992

Biomass for the C and Q areas was estimated using proximal analysis. Our conventional analysis would yield the same result provided the same transect area boundaries were used, however, proximal analysis is more readily implemented for non-parallel and variably-spaced transect patterns. In combination with our GIS, proximal also provides graphical presentations that are important for data visualization and quality control. Neither method provides a statistical evaluation or confidence estimates.

Earlier results (Cooke et al. 1992; Saunders et al. 1992) made minimal use of GIS-based area expansion and the analysis of the C series was carried out to provide only approximate biomass estimates. We re-analyzed the C series data from 1990 and 1991 using proximal to provide better biomass estimates and a basis for comparing results between cruises.

The following biomass estimates were based on our standard TS values of -35 Db/kg for hake and -32 Db/kg for all other species. The C series transect pattern changed between years, therefore, we grouped transects between 49° and 52° latitude into bins of 0.5° latitude. Proximal analysis produced the following results:

	1990			1991			1992		
Lat deg	Area km^2	Hake kt	All kt	Area km^2	Hake kt	All kt	Area km^2	Hake kt	All kt
49-49.5	896	27	42	1552	27	48	2181	135	156
49.5-50	806	40	61	767	1	8	4458	237	250
50-50.5	1049	114	126	1303	77	93	1690	162	189
50.5-51	1157	19	39	1460	39	111	2179	124	165
51-51.5	3148	19	63	847	0	10	1889	36	51
51.5-52	-	-	-	-	-	-	3582	0	23
TOTAL	7056	219	331	5929	144	270	15978	694	834

The following table compares the original and the new proximal based results for the entire C series south of 51.5° latitude. The 51.5° to 52.0° latitude bin (Q series, Queen Charlotte Sound) from 1992 has been excluded.

	1990			1991			1992		
TOTAL	Area km^2	Hake kt	All kt	Area km^2	Hake kt	All kt	Area km^2	Hake kt	All kt
PROXIMAL	7056	219	331	5929	144	270	12397	694	811
CONVEN.	4300	178	250	4400	117	195	13678	901	1036

Proximal analysis yields larger area and biomass estimates for the 1990 and 1991 C series than were reported earlier (Saunders et al. 1992, Cooke et al. 1992) and less for the current survey. As discussed, differences are primarily due to the use of approximate transect area boundaries in the conventional method.

Future studies will examine target distribution and abundance estimation with respect to species specific behaviour, bottom slope and topographic features, and other oceanographic and biological parameters. It is hoped that GIS-based procedures will provide the tools needed to incorporate these data into a comprehensive multi-species stock assessment package.

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Table 1. Transect information including date, start time, and start and end latitude and longitude for the CSS W. E. RICKER Pacific hake survey, August 8 to September 2, 1992.

EVENT #	NAME	Date	Time	LATITUDE deg	LATITUDE min	LONGITUDE deg	LONGITUDE min	LATITUDE deg	LATITUDE min	LONGITUDE deg	LONGITUDE min
13.0	A1E	09-AUG-92	08:43	48	55.93	125	46.86	48	55.95	125	37.89
16.0	A1.5W	09-AUG-92	09:33	48	55.15	125	38.02	48	55.09	125	47.04
21.0	A2E	09-AUG-92	10:26	48	54.18	125	47.04	48	54.09	125	42.35
23.0	A3E	09-AUG-92	11:05	48	52.66	125	42.75	48	52.63	125	30.92
27.0	A4W	09-AUG-92	12:29	48	50.05	125	27.09	48	50.08	125	42.25
32.0	A5E	09-AUG-92	13:59	48	47.48	125	41.80	48	47.69	125	16.86
53.0	A6W	09-AUG-92	19:03	48	44.91	125	14.00	48	45.06	125	41.10
62.0	A6AW	10-AUG-92	06:19	48	45.03	125	41.18	48	45.03	125	50.03
65.0	A6BW	10-AUG-92	06:57	48	45.03	125	50.03	48	45.10	126	6.26
139.0	A7E	11-AUG-92	05:58	48	42.60	125	49.78	48	42.55	125	9.83
150.0	A8W	11-AUG-92	09:42	48	39.97	125	4.41	48	40.10	125	42.13
160.0	A9E	11-AUG-92	12:50	48	37.73	125	41.40	48	37.61	124	49.07
174.0	A10W	11-AUG-92	17:00	48	34.90	124	46.16	48	34.92	124	54.93
179.0	A10AW	12-AUG-92	05:52	48	35.00	124	59.87	48	34.92	125	27.42
187.0	A10BW	12-AUG-92	07:52	48	34.92	125	27.42	48	35.05	125	30.81
188.0	A10CW	12-AUG-92	08:09	48	35.05	125	30.81	48	35.07	125	38.17
192.0	A11E	12-AUG-92	09:03	48	32.63	125	38.35	48	32.40	124	39.90
208.0	A12W	12-AUG-92	13:44	48	29.99	124	38.38	48	30.17	125	41.91
225.0	A13E	12-AUG-92	19:19	48	27.77	125	41.89	48	27.64	125	19.66
237.0	A13AE	14-AUG-92	08:21	48	27.65	125	19.14	48	27.64	125	18.35
239.0	A13BE	14-AUG-92	08:25	48	27.64	125	18.35	48	27.55	125	4.95
40.0	BRK2E	09-AUG-92	16:06	48	50.25	125	15.68	48	57.91	125	6.64
47.0	BRK3	09-AUG-92	17:20	48	58.28	125	8.72	48	52.31	125	15.98
284.0	B1W	15-AUG-92	05:47	48	15.24	125	41.27	48	15.31	125	57.48
297.5	B2W	15-AUG-92	08:30	48	17.68	126	6.00	48	17.86	126	27.36
333.0	B2AW	16-AUG-92	05:56	48	17.73	125	34.92	48	17.68	125	35.75
334.0	B2BW	16-AUG-92	06:01	48	17.68	125	35.75	48	17.62	125	36.27
335.0	B2CW	16-AUG-92	06:04	48	17.62	125	36.27	48	17.75	126	6.00
306.0	B3E	15-AUG-92	10:57	48	20.29	126	25.50	48	20.30	126	4.74
313.0	B3AE	15-AUG-92	16:18	48	20.33	126	4.22	48	20.21	125	25.76
266.0	B4E	14-AUG-92	16:53	48	22.80	126	28.56	48	22.85	125	32.03
323.0	B4AW	15-AUG-92	19:37	48	22.66	125	18.33	48	22.77	125	32.13
245.0	B5W	14-AUG-92	10:10	48	24.78	125	12.73	48	25.36	126	28.44
356.0	B6E	16-AUG-92	11:34	48	27.74	126	32.19	48	27.71	125	41.89
369.0	B7W	16-AUG-92	15:50	48	30.18	125	42.78	48	30.24	126	37.50
389.0	B8W	17-AUG-92	05:51	48	32.71	125	48.25	48	32.93	126	41.93
409.0	B9E	17-AUG-92	11:01	48	35.36	126	42.39	48	35.20	125	59.78
421.0	B10W	17-AUG-92	14:31	48	37.65	125	59.49	48	37.88	126	43.05
435.0	B11E	17-AUG-92	18:42	48	40.37	126	42.58	48	40.23	126	21.82
445.0	B11AE	18-AUG-92	06:14	48	40.18	126	21.86	48	40.13	125	59.17
452.5	B12W	18-AUG-92	08:23	48	42.72	125	58.97	48	42.79	126	43.85
68.0	B13W	10-AUG-92	08:07	48	45.10	126	6.26	48	45.09	126	23.13
460.0	B13E	18-AUG-92	12:41	48	45.34	126	44.31	48	45.11	126	1.51
472.0	B14W	18-AUG-92	16:04	48	47.54	126	1.63	48	47.73	126	46.20
493.0	B15E	19-AUG-92	05:57	48	50.15	126	44.18	48	50.15	126	29.07
498.0	B15AE	19-AUG-92	07:03	48	50.15	126	29.07	48	50.07	126	26.53
499.0	B15BE	19-AUG-92	07:15	48	50.07	126	26.53	48	50.11	126	9.69
503.0	B16W	19-AUG-92	08:48	48	52.61	126	10.23	48	52.71	126	44.76
515.0	B17E	19-AUG-92	13:43	48	55.22	126	46.33	48	55.61	126	5.62
526.0	B18W	19-AUG-92	16:59	48	57.55	126	6.40	48	57.71	126	51.10
538.0	B19W	20-AUG-92	14:12	49	0.08	126	15.55	49	0.18	126	55.27

Table 1. (cont'd.)

EVENT #	NAME	Date	Time	LATITUDE deg	LATITUDE min	LONGITUDE deg	LONGITUDE min	LATITUDE deg	LATITUDE min	LONGITUDE deg	LONGITUDE min
548.1	C1E	20-AUG-92	17:28	49	0.18	126	55.27	49	4.72	126	42.64
551.0	C1AE	20-AUG-92	18:27	49	4.72	126	42.64	49	4.65	126	39.48
554.0	C2W	20-AUG-92	18:46	49	5.07	126	39.58	49	5.16	126	58.68
561.0	C3E	20-AUG-92	20:21	49	5.31	126	58.99	49	10.39	126	49.45
570.0	C4W	21-AUG-92	06:08	49	10.19	126	44.98	49	9.95	127	8.90
577.0	C5E	21-AUG-92	07:59	49	10.27	127	8.92	49	14.86	126	52.91
581.0	C6W	21-AUG-92	09:13	49	15.29	126	52.90	49	14.91	127	19.82
589.0	C7E	21-AUG-92	11:15	49	15.44	127	20.23	49	19.97	127	1.31
596.0	C8W	21-AUG-92	12:47	49	20.05	127	1.91	49	20.03	127	15.23
603.0	C8BW	21-AUG-92	15:34	49	20.03	127	15.28	49	19.99	127	18.68
606.0	C9E	21-AUG-92	15:53	49	20.33	127	18.53	49	25.12	127	4.20
611.0	C10W	21-AUG-92	17:05	49	25.10	127	4.40	49	24.99	127	42.82
620.0	C11E	21-AUG-92	20:10	49	25.31	127	42.58	49	26.84	127	31.67
628.0	C11AE	23-AUG-92	07:08	49	26.78	127	32.16	49	29.84	127	8.86
633.0	C11BE	23-AUG-92	08:48	49	29.84	127	8.86	49	30.13	127	2.53
638.0	C12W	23-AUG-92	09:25	49	30.16	127	3.74	49	29.87	128	29.25
660.0	C14E	23-AUG-92	16:09	49	34.96	128	29.28	49	35.34	127	23.52
705.0	C14AW	24-AUG-92	15:19	49	35.17	127	24.21	49	35.26	127	12.67
678.0	C16E	24-AUG-92	06:15	49	40.03	128	31.80	49	40.23	127	52.70
693.0	C16AE	24-AUG-92	11:56	49	40.18	127	52.46	49	40.20	127	15.70
711.0	C18W	25-AUG-92	06:13	49	45.09	127	27.02	49	45.22	128	6.92
734.0	C18E	25-AUG-92	12:33	49	45.00	128	40.99	49	45.12	128	6.69
723.0	C22W	25-AUG-92	09:42	49	50.41	128	7.91	49	50.10	128	41.27
747.0	C22E	25-AUG-92	15:28	49	50.41	128	9.29	49	50.22	127	39.71
757.0	C26W	25-AUG-92	18:06	49	55.26	127	41.88	49	55.02	128	17.95
769.5	C26AW	26-AUG-92	06:14	49	55.17	128	17.95	49	55.17	128	31.13
775.0	C30E	26-AUG-92	07:55	50	0.16	128	31.53	50	0.23	127	44.67
818.0	C32W	27-AUG-92	06:21	50	2.67	127	55.48	50	2.64	128	9.24
823.0	C33E	27-AUG-92	07:26	50	2.85	128	9.25	50	7.68	127	58.01
794.0	C34W	26-AUG-92	12:37	50	5.04	127	59.49	50	5.20	128	33.77
828.0	C36W	27-AUG-92	08:34	50	7.63	127	59.19	50	7.64	128	11.46
832.0	C37E	27-AUG-92	09:34	50	7.85	128	11.26	50	10.03	128	2.99
808.0	C38E	26-AUG-92	18:53	50	10.20	128	33.35	50	10.23	128	10.13
835.0	C38W	27-AUG-92	10:17	50	10.22	128	3.06	50	10.19	128	10.68
838.0	C39E	27-AUG-92	10:52	50	10.24	128	10.92	50	13.19	128	12.91
840.0	C39AE	27-AUG-92	11:17	50	13.19	128	12.91	50	15.05	128	6.99
844.0	C40W	27-AUG-92	11:48	50	15.23	128	7.11	50	15.18	128	12.93
847.0	C40AW	27-AUG-92	15:11	50	14.67	128	12.93	50	15.16	128	18.05
851.0	C41E	27-AUG-92	15:42	50	15.30	128	18.09	50	20.17	128	12.25
856.0	C42W	27-AUG-92	16:32	50	20.33	128	12.39	50	20.73	128	28.63
861.0	C43E	27-AUG-92	17:52	50	20.93	128	28.45	50	24.70	128	25.55
864.0	C44W	27-AUG-92	18:27	50	25.21	128	25.73	50	25.23	128	38.79
870.0	C45E	27-AUG-92	19:31	50	25.81	128	38.78	50	30.22	128	30.77
881.0	C46W	28-AUG-92	06:35	50	30.19	128	15.36	50	30.17	128	37.59
891.0	C46AW	28-AUG-92	12:30	50	30.27	128	37.98	50	30.39	128	42.57
894.0	C47E	28-AUG-92	12:52	50	30.51	128	42.25	50	35.24	128	27.34
900.0	C48W	28-AUG-92	14:08	50	35.26	128	28.46	50	35.33	128	57.30
908.0	C49E	28-AUG-92	16:20	50	35.93	128	57.68	50	43.50	128	59.73
912.0	C50W	28-AUG-92	17:18	50	43.66	129	0.15	50	38.75	129	19.18

Table 1. (cont'd.)

EVENT #	NAME	Date	Time	LATITUDE deg	LATITUDE min	LONGITUDE deg	LONGITUDE min	LATITUDE deg	LATITUDE min	LONGITUDE deg	LONGITUDE min
918.0	C51/5	28-AUG-92	18:40	50	38.94	129	19.69	50	40.39	129	22.21
919.0	C51E	28-AUG-92	18:55	50	40.39	129	22.21	50	49.81	129	19.59
923.0	C52W	28-AUG-92	19:59	50	50.14	129	19.81	50	50.04	129	30.93
929.0	C53E	29-AUG-92	06:18	50	47.78	129	46.35	51	4.63	129	29.10
1037.0	C59E	31-AUG-92	06:24	51	25.75	129	8.39	51	19.57	128	50.68
1042.0	C60N	31-AUG-92	07:50	51	19.77	128	50.37	51	28.23	128	45.41
1045.5	C61S	31-AUG-92	08:57	51	28.17	128	45.07	51	23.19	128	38.90
1048.5	C62N	31-AUG-92	09:39	51	23.22	128	38.70	51	34.82	128	30.67
1055.0	C63S	31-AUG-92	11:07	51	34.41	128	30.22	51	32.95	128	29.43
1058.0	C63AS	31-AUG-92	13:18	51	32.82	128	29.42	51	24.67	128	24.99
1063.0	C64W	31-AUG-92	14:21	51	24.45	128	25.48	51	22.60	128	31.87
1066.5	C64AW	31-AUG-92	16:51	51	22.45	128	31.75	51	12.11	129	3.02
1075.0	C66S	31-AUG-92	19:14	51	11.97	129	3.09	51	13.33	128	42.91
1083.0	C67S	01-SEP-92	05:57	51	10.08	128	19.76	51	3.44	128	11.53
1086.0	C68E	01-SEP-92	06:46	51	3.44	128	11.53	51	4.98	127	58.73
1089.0	C69S	01-SEP-92	07:37	51	4.98	127	58.73	50	59.81	127	50.44
938.0	Q1W	29-AUG-92	08:32	51	4.68	129	29.61	51	4.51	129	45.16
946.0	Q2E	29-AUG-92	10:12	51	6.01	129	47.47	51	11.96	129	38.87
953.0	Q3W	29-AUG-92	14:44	51	11.97	129	38.69	51	12.01	129	54.59
958.0	Q3/4N	29-AUG-92	16:01	51	12.16	129	54.96	51	15.12	130	1.37
960.0	Q3/4S	29-AUG-92	16:38	51	15.12	130	1.37	51	12.05	130	0.82
962.0	Q3AW	29-AUG-92	17:00	51	12.05	130	0.82	51	11.99	130	10.64
966.0	Q4E	29-AUG-92	17:47	51	12.25	130	10.67	51	27.65	129	54.39
975.0	Q5W	29-AUG-92	20:01	51	27.87	129	54.84	51	27.74	130	3.64
984.0	Q5AW	30-AUG-92	06:33	51	27.75	130	3.50	51	27.83	130	21.21
989.1	Q6N	30-AUG-92	07:56	51	28.11	130	21.06	51	37.27	130	2.12
995.0	Q7W	30-AUG-92	09:44	51	37.50	130	2.53	51	37.60	130	29.44
1003.0	Q8N	30-AUG-92	11:40	51	37.90	130	29.42	51	45.49	130	17.65
1007.0	Q9W	30-AUG-92	12:49	51	45.59	130	18.18	51	45.58	130	54.02
1016.1	Q10N	30-AUG-92	15:40	51	45.60	130	54.00	52	4.93	130	43.56
1024.0	Q11E	30-AUG-92	17:49	52	4.97	130	43.21	52	4.92	130	4.03
74.0	T01E	10-AUG-92	11:52	48	45.12	126	22.74	48	45.15	126	10.77
79.0	T02W	10-AUG-92	12:55	48	45.61	126	10.99	48	45.63	126	24.35
86.0	T03E	10-AUG-92	14:17	48	45.36	126	22.99	48	45.29	126	10.97
91.0	T04W	10-AUG-92	15:29	48	45.41	126	11.25	48	45.41	126	24.58
96.0	T05E	10-AUG-92	16:46	48	44.99	126	24.14	48	45.10	126	10.69
104.0	T06W	10-AUG-92	18:00	48	45.60	126	10.88	48	45.61	126	26.28
113.0	T07E	10-AUG-92	19:38	48	45.45	126	24.88	48	45.30	126	11.30
119.0	T08W	10-AUG-92	20:54	48	44.93	126	11.40	48	44.94	126	22.55
126.0	T09E	10-AUG-92	22:09	48	45.14	126	20.37	48	45.12	126	10.47
131.0	T10W	10-AUG-92	23:12	48	45.50	126	10.72	48	45.66	126	23.32

Table 2. Total and hake biomass for transects south of 49° latitude from the *CSS W.E. RICKER* Pacific hake survey, August 8 - September 2, 1992. Transect length, surface density cell area, volume and surface densities, and biomass by transect are given. Transects marked with '*' are omitted from totals to eliminate 'double-counting' which can result from overlap of coverage area when using conventional analysis (see text).

TRANSECT				BIOMASS: TOTAL			BIOMASS: HAKE		
EVENT #	NAME	Len km	Area km^2	Vol D kg/m^3	Surf D kg/m^2	ALL FISH t	Vol D kg/m^3	Surf D kg/m^2	HAKE t
13.0	A1E	10.9	50.5	8.37E-03	1.60E-01	6.75E+03	4.98E-03	1.07E-01	5.41E+03
16.0	A1.5W	11.0	50.8	6.55E-03	9.54E-02	4.15E+03	5.14E-03	6.77E-02	3.44E+03
21.0	A2E	5.7	26.4	7.10E-03	7.15E-02	1.89E+03	7.10E-03	7.15E-02	1.89E+03
23.0	A3E	14.4	66.7	5.64E-04	5.64E-03	1.88E+02	0.00E+00	0.00E+00	0.00E+00
27.0	A4W	18.5	85.6	1.67E-04	2.23E-03	9.55E+01	0.00E+00	0.00E+00	0.00E+00
32.0	A5E	30.4	140.9	8.72E-04	3.92E-02	4.54E+03	2.81E-03	2.53E-02	3.56E+03
53.0	A6W	33.1	153.2	1.37E-03	5.14E-02	7.47E+03	8.46E-04	4.60E-02	7.05E+03
62.0	A6AW	10.8	50.0	5.29E-04	2.71E-02	9.21E+02	3.08E-04	9.63E-03	4.82E+02
65.0	A6BW	19.8	91.8	8.34E-04	2.98E-02	1.65E+03	2.29E-04	6.27E-03	5.75E+02
139.0	A7E	48.8	226.0	1.44E-03	3.34E-02	7.22E+03	2.07E-03	3.05E-02	6.89E+03
150.0	A8W	46.1	213.6	1.39E-03	2.65E-02	4.31E+03	1.27E-03	1.38E-02	2.95E+03
160.0	A9E	64.1	296.6	6.09E-04	8.38E-03	1.25E+03	0.00E+00	0.00E+00	0.00E+00
174.0	A10W	10.7	49.8	3.80E-03	5.66E-02	1.41E+03	0.00E+00	0.00E+00	0.00E+00
179.0	A10AW	33.8	156.3	7.25E-04	3.99E-02	4.77E+03	3.66E-03	2.11E-02	3.30E+03
187.0	A10BW	4.2	19.3	5.79E-04	2.46E-02	2.37E+02	0.00E+00	0.00E+00	0.00E+00
188.0	A10CW	9.0	41.8	6.03E-03	2.79E-01	6.41E+03	3.79E-03	2.93E-02	1.22E+03
192.0	A11E	71.7	331.8	2.41E-03	1.50E-01	3.54E+04	3.95E-03	6.37E-02	2.11E+04
208.0	A12W	78.0	299.5	2.36E-03	2.01E-01	4.17E+04	2.97E-03	1.41E-01	3.10E+04
225.0	A13E	27.3	126.4	2.35E-04	1.66E-02	1.96E+03	4.68E-04	1.43E-02	1.81E+03
237.0	A13AE	1.0	4.5	1.70E-03	1.62E-01	7.27E+02	4.61E-03	1.61E-01	7.25E+02
239.0	A13BE	16.5	76.2	1.21E-03	1.01E-01	7.69E+03	2.47E-03	1.00E-01	7.66E+03
TOTAL			2519.2			1.37E+05			9.90E+04
47.0	BRK3	14.2	65.5	1.01E-03	4.24E-02	1.70E+03	4.57E-04	9.35E-03	6.13E+02
40.0	BRK2E	18.0	83.1	8.18E-04	2.97E-02	1.29E+03	1.27E-04	1.41E-03	1.17E+02
TOTAL			148.6			2.99E+03			7.30E+02
284.0	B1W	20.0	92.5	6.38E-04	7.97E-02	7.38E+03	6.38E-04	7.97E-02	7.38E+03
297.5	B2W	26.3	121.9	7.65E-05	6.86E-03	8.36E+02	7.65E-05	6.86E-03	8.36E+02
333.0	B2AW	1.0	4.8	3.37E-05	6.75E-04	1.61E+00	0.00E+00	0.00E+00	0.00E+00
334.0	B2BW	0.7	3.0	3.81E-05	3.81E-04	5.75E-01	0.00E+00	0.00E+00	0.00E+00
335.0	B2CW	36.6	169.6	2.55E-03	1.92E-01	2.28E+04	9.89E-04	7.65E-02	1.30E+04
306.0	B3E	25.6	118.3	1.97E-04	1.90E-02	2.25E+03	1.97E-04	1.90E-02	2.25E+03
313.0	B3AE	47.3	219.2	2.39E-03	1.65E-01	1.99E+04	4.28E-04	1.70E-02	3.72E+03
266.0	B4E	69.5	321.9	1.37E-03	1.08E-01	3.22E+04	1.18E-03	9.22E-02	2.97E+04
323.0	B4AW	17.0	78.6	6.11E-04	3.23E-02	1.67E+03	3.28E-04	1.01E-02	7.97E+02
245.0	B5W	93.1	430.9	9.41E-04	6.46E-02	2.27E+04	8.98E-04	4.03E-02	1.74E+04
356.0	B6E	61.8	286.0	5.37E-04	3.79E-02	9.05E+03	4.40E-04	2.55E-02	7.30E+03
369.0	B7W	67.1	310.9	2.33E-04	2.21E-02	6.17E+03	2.44E-04	1.75E-02	5.46E+03
389.0	B8W	65.8	304.7	4.30E-04	4.54E-02	1.28E+04	3.75E-04	3.88E-02	1.18E+04
409.0	B9E	52.2	241.7	6.61E-04	5.20E-02	1.22E+04	6.26E-04	4.82E-02	1.17E+04
421.0	B10W	53.3	246.9	1.01E-03	6.20E-02	1.36E+04	8.41E-04	4.81E-02	1.19E+04
435.0	B11E	25.4	117.6	9.81E-04	5.89E-02	6.92E+03	9.81E-04	5.89E-02	6.92E+03
445.0	B11AE	29.4	136.2	1.81E-03	1.44E-01	1.93E+04	1.76E-03	1.39E-01	1.89E+04
452.5	B12W	54.8	253.9	1.02E-03	7.41E-02	1.84E+04	1.02E-03	7.08E-02	1.80E+04
460.0	B13E	52.3	242.0	1.18E-03	7.43E-02	1.80E+04	1.18E-03	7.40E-02	1.79E+04
68.0	B13W*	20.6	95.4	3.54E-03	2.10E-01	2.00E+04	3.54E-03	2.10E-01	2.00E+04
472.0	B14W	54.4	251.8	9.70E-04	8.35E-02	2.07E+04	1.16E-03	8.06E-02	2.03E+04
493.0	B15E	18.4	85.3	5.47E-04	4.54E-02	3.87E+03	5.47E-04	4.54E-02	3.87E+03
498.0	B15AE	3.1	14.4	1.19E-03	1.40E-01	2.01E+03	1.19E-03	1.40E-01	2.01E+03

Table 2 (cont'd.)

TRANSECT				BIOMASS: TOTAL			BIOMASS: HAKE		
EVENT #	NAME	Len km	Area km^2	Vol D kg/m^3	Surf D kg/m^2	ALL FISH t	Vol D kg/m^3	Surf D kg/m^2	HAKE t
499.0	B15BE	20.5	95.1	2.14E-03	1.59E-01	1.38E+04	2.63E-03	1.30E-01	1.24E+04
503.0	B16W	42.3	195.8	1.86E-03	1.57E-01	2.68E+04	1.97E-03	1.17E-01	2.29E+04
515.0	B17E	49.5	229.4	1.48E-03	8.98E-02	1.71E+04	1.04E-03	5.94E-02	1.36E+04
526.0	B18W	54.4	251.7	6.81E-04	6.06E-02	1.19E+04	5.68E-04	3.34E-02	8.42E+03
538.0	B19W	48.3	223.4	1.05E-03	1.16E-01	2.28E+04	1.03E-03	8.79E-02	1.96E+04
TOTAL			5142.9			3.65E+05			3.08E+05
			5047.5*			3.45E+05*			2.88E+05*
74.0	T01E	14.6	67.7	3.64E-03	1.66E-01	1.12E+04	3.64E-03	1.66E-01	1.12E+04
79.0	T02W	16.3	75.5	4.41E-03	1.87E-01	1.41E+04	4.41E-03	1.87E-01	1.41E+04
TOTAL			143.2			2.53E+04			2.53E+04
86.0	T03E	14.7	68.0	3.96E-03	1.35E-01	9.19E+03	3.96E-03	1.35E-01	9.19E+03
91.0	T04W	16.3	75.4	3.83E-03	1.82E-01	1.37E+04	3.83E-03	1.82E-01	1.37E+04
TOTAL			143.4			2.29E+04			2.29E+04
96.0	T05E	16.4	76.0	2.56E-03	1.15E-01	8.76E+03	2.56E-03	1.15E-01	8.76E+03
104.0	T06W	18.8	87.1	1.76E-03	1.19E-01	1.04E+04	1.76E-03	1.19E-01	1.04E+04
TOTAL			163.1			1.92E+04			1.92E+04
113.0	T07E	16.6	76.8	1.02E-03	8.82E-02	6.77E+03	1.02E-03	8.82E-02	6.77E+03
119.0	T08W	13.6	63.0	3.51E-04	4.01E-02	2.53E+03	3.51E-04	4.01E-02	2.53E+03
TOTAL			139.8			9.30E+03			9.30E+03
126.0	T09E	12.1	56.0	2.61E-04	3.16E-02	1.77E+03	2.61E-04	3.16E-02	1.77E+03
131.0	T10W	15.4	71.2	2.26E-04	2.98E-02	2.13E+03	2.26E-04	2.98E-02	2.13E+03
TOTAL			127.2			3.90E+03			3.90E+03

Table 3. Comparison of survey area, surface density and biomass for all species and for hake only for C and Q transects, *CSS W.E. RICKER* Pacific hake survey, August 8 to September 2, 1992 using a conventional area expansion algorithm (**CONV**) and GIS-based proximal analysis (**PROX**). Transects have been grouped in .5° latitude bins from 49.0° to 52.0° latitude for comparison of data set with earlier surveys (see text; p. 17).

					BIOMASS: ALL SPECIES				BIOMASS: HAKE ONLY			
EVE	TRANS	CONV LEN km	CONV AREA km²	PROX AREA km²	CONV SD kg/m²	PROX SD kg/m²	CONV ALL t	PROX ALL t	CONV SD kg/m²	PROX SD kg/m²	CONV HAKE t	PROX HAKE t
49.0° - 49.5°												
548.1	C1E	17.5	161.9	147.0	0.070	0.073	11400	10800	0.070	0.073	11400	10800
551	C1AE	3.8	35.5	25.2	0.003	0.003	57	38	0.000	0.000	0	0
554	C2W	23.2	214.5	133.0	0.052	0.056	10850	7240	0.049	0.053	10600	7060
561	C3E	14.9	138.0	89.1	0.055	0.053	7505	4685	0.054	0.053	7490	4680
570	C4W	29	268.3	169.0	0.101	0.104	17985	11470	0.033	0.032	8870	5340
577	C5E	21.2	195.9	123.0	0.093	0.083	10690	5950	0.016	0.014	3180	1700
581	C6W	32.6	301.4	191.0	0.067	0.071	14980	10100	0.033	0.035	9860	6700
589	C7E	24.3	225.4	124.0	0.063	0.057	14150	6910	0.062	0.055	14000	6840
596	C8W	16.1	148.9	77.6	0.138	0.136	18850	9700	0.115	0.113	17100	8800
603	C8BW	4.1	38.0	22.3	0.000	0.000	0	0	0.000	0.000	0	0
606	C9E	19.4	179.8	118.0	0.105	0.086	17050	9200	0.084	0.070	15200	8200
611	C10W	46.3	428.6	291.0	0.117	0.130	49300	37400	0.113	0.127	48500	36900
620	C11E	13.4	124.5	62.0	0.023	0.023	2820	1400	0.023	0.023	2820	1400
628	C11AE	28.6	264.9	132.0	0.175	0.175	40650	20550	0.132	0.135	35000	17900
633	C11BE	7.6	70.7	48.9	0.021	0.020	735	492	0.000	0.000	0	0
49.5° (Transect on latitudinal border; .5 of total to each bin North and South)												
638	C12W	103	952.4	856.0	0.060	0.050	52200	39750	0.049	0.043	47000	36800
49.5° - 50.0°												
660	C14E	78.7	728.5	744.0	0.032	0.031	23100	23300	0.032	0.031	23100	23300
705	C14AW	13.9	128.3	132.0	0.154	0.198	16500	19700	0.103	0.101	13200	13300
678	C16E	46.9	434.0	444.0	0.008	0.008	3360	3490	0.008	0.008	3360	3490
693	C16AE	44.1	408.0	409.0	0.148	0.147	58500	58200	0.139	0.137	56800	56200
711	C18W	47.5	439.5	443.0	0.080	0.077	33600	32750	0.073	0.070	32100	31200
734	C18E	41	380.1	392.0	0.006	0.006	2460	2500	0.006	0.006	2460	2500
723	C22W	39.9	369.0	357.0	0.025	0.025	9030	9030	0.025	0.025	9030	9030
747	C22E	35.3	327.2	331.0	0.091	0.090	29650	29500	0.090	0.089	29500	29300
757	C26W	43	398.3	399.0	0.088	0.087	34850	34400	0.087	0.085	34500	34100
769.5	C26AW	15.7	145.5	144.0	0.026	0.026	3820	3740	0.026	0.026	3820	3740
50.0° (Transect on latitudinal border; .5 of total to each bin North and South)												
775	C30E	55.8	516.5	469.0	0.063	0.061	30850	27150	0.057	0.054	29400	25500
50.0° - 50.5°												
818	C32W	16.4	151.6	85.6	0.198	0.197	29900	16900	0.198	0.197	29900	16900
823	C33E	16.1	148.8	46.2	0.232	0.204	33100	8945	0.213	0.184	31700	8480
794	C34W	40.7	377.2	299.0	0.198	0.113	70150	31250	0.174	0.096	65700	28700
828	C36W	14.6	134.9	61.3	0.271	0.239	34500	13800	0.241	0.212	32500	13000
832	C37E	10.6	98.3	32.4	0.255	0.240	23750	7080	0.227	0.198	22400	6400
808	C38E	27.5	255.0	220.0	0.039	0.033	9865	7125	0.038	0.032	9630	6980
835	C38W	9	83.7	42.9	0.245	0.223	10250	4795	0.000	0.000	0	0
838	C39E	6	55.1	27.3	0.078	0.085	2725	1620	0.021	0.034	1150	919
840	C39AE	7.8	72.4	37.8	0.401	0.315	29000	11900	0.401	0.315	29000	11900
844	C40W	6.9	63.8	34.9	0.226	0.231	13900	7805	0.210	0.216	13400	7540
847	C40AW	6.1	56.8	27.5	0.071	0.059	3845	1560	0.065	0.054	3680	1500
851	C41E	11.4	105.2	74.9	0.160	0.148	16100	10650	0.147	0.136	15400	10200
856	C42W	19.2	177.9	126.0	0.086	0.113	8325	7785	0.008	0.011	1450	1370
861	C43E	7.8	72.0	53.9	0.189	0.153	12200	7395	0.150	0.121	10800	6530
864	C44W	15.4	142.7	114.0	0.158	0.166	20550	17250	0.130	0.138	18600	15600
870	C45E	12.5	115.6	63.3	0.205	0.198	20250	10700	0.145	0.141	16800	8900
50.5° (Transects on latitudinal border; .5 of total to each bin North and South)												
881	C46W	26.2	242.5	185.0	0.140	0.143	24750	17495	0.064	0.046	15600	8490
891	C46AW	5.4	50.1	32.4	0.014	0.014	353	220	0.000	0.000	0	0

Table 3 (cont'd.)

EVE	TRANS	CONV LEN km	CONV AREA km²	PROX AREA km²	BIOMASS: ALL SPECIES CONV SD kg/m²	PROX SD kg/m²	CONV ALL t	PROX ALL t	BIOMASS: HAKE ONLY CONV SD kg/m²	PROX SD kg/m²	CONV HAKE t	PROX HAKE t
50.5° - 51.0°												
894	C47E	19.6	181.6	113.0	0.130	0.120	12905	7365	0.012	0.011	2110	1230
900	C48W	33.9	314.0	317.0	0.203	0.180	49400	47400	0.111	0.119	34900	37700
908	C49E	14.2	131.7	176.0	0.082	0.065	10500	11300	0.078	0.064	10200	11200
912	C50W	24.1	223.3	327.0	0.054	0.043	11150	13300	0.046	0.039	10200	12700
919	C51E	17.7	164.0	271.0	0.056	0.052	4585	7050	0.000	0.000	0	0
923	C52W	13	120.5	320.0	0.103	0.147	9535	38750	0.055	0.096	6670	30500
929	C53E	37.1	343.9	546.0	0.065	0.065	18500	31150	0.043	0.050	14700	27100
TOTAL			**11906.2**	**10507.5**			**995030**	**760035**			**864780**	**658619**
51° - 51.5° QCStr (Transects treated as separate group at entrance to Queen Charlotte Strait)												
1037	C59E	23.5	217.2	282.0	0.041	0.035	5055	5960	0.006	0.007	1230	1980
1042	C60N	16.7	154.5	148.0	0.032	0.028	4220	3665	0.023	0.021	3580	3160
1045.5	C61S	11.7	107.9	90.1	0.031	0.030	2885	2355	0.023	0.022	2460	1990
1048.5	C62N	23.4	216.6	168.0	0.024	0.021	4555	3000	0.018	0.015	3910	2550
1055	C63S	2.9	26.4	23.4	0.055	0.043	1410	967	0.052	0.040	1370	936
1058	C63AS	15.9	147.6	141.0	0.064	0.069	8680	9035	0.054	0.059	7940	8330
1063	C64W	8.1	75.4	80.1	0.067	0.060	5055	4730	0.067	0.059	5030	4700
1066.5	C64AW	41	379.4	348.0	0.029	0.029	9415	8675	0.021	0.021	7930	7370
1075	C66S	23.5	218.1	181.0	0.015	0.014	1605	1220	0.000	0.000	0	0
1083	C67S	15.6	144.3	152.0	0.041	0.041	3397	3556	0.006	0.006	833	871
1086	C68E	15.2	140.4	152.0	0.028	0.028	2285	2504	0.005	0.005	689	817
1089	C69S	13.6	125.9	123.0	0.057	0.057	5040	4940	0.023	0.023	2870	2880
TOTAL			**1953.7**	**1888.6**			**53601**	**50606**			**37842**	**35584**
51.0° - 52.0° (Transects treated as separate group within Queen Charlotte Sound; not surveyed prior to 1992)												
938	Q1W	18.1	167.6	190.0	0.007	0.002	550	234	0.000	0.000	0	0
946	Q2E	14.9	137.7	143.0	0.037	0.034	2570	2435	0.000	0.000	0	0
953	Q3W	18.5	170.9	245.0	0.008	0.004	685	457	0.000	0.000	0	0
958	Q3/4N	9.2	85.5	134.0	0.003	0.004	145	291	0.000	0.000	0	0
960	Q3/4S	5.7	53.0	35.0	0.000	0.000	0	0	0.000	0.000	0	0
962	Q3AW	11.4	105.5	82.2	0.000	0.000	0	0	0.000	0.000	0	0
966	Q4E	34.2	316.5	492.0	0.034	0.034	5450	8450	0.000	0.000	0	0
975	Q5W	10.2	94.0	101.0	0.045	0.031	2120	1580	0.000	0.000	0	0
984	Q5AW	20.4	189.2	266.0	0.000	0.000	0	0	0.000	0.000	0	0
989.1	Q6N	27.6	255.9	290.0	0.002	0.002	260	274	0.000	0.000	0	0
995	Q7W	30.9	286.5	296.0	0.002	0.001	226	177	0.000	0.000	0	0
1003	Q8N	19.5	180.5	178.0	0.036	0.046	3215	4050	0.000	0.000	0	0
1007	Q9W	41.1	380.4	368.0	0.020	0.020	3840	3650	0.000	0.000	0	0
1016.1	Q10N	37.7	349.4	342.0	0.003	0.003	495	462	0.000	0.000	0	0
1024	Q11E	44.6	412.9	420.0	0.006	0.006	1195	1240	0.000	0.000	0	0
TOTAL			**3185.5**	**3582.2**			**20750**	**23299**			**0**	**0**

SUMMARY BY GEOGRAPHIC AREA:

TRANSECT AREA	GROUP	AREA CONV km²	AREA PROX km²	TOTAL CONV kt	TOTAL PROX kt	HAKE CONV kt	HAKE PROX kt
49-49.5	C2-12	3273	2181	243	156	208	135
49.5-50	C12-30	4493	4458	257	250	246	237
50-50.5	C30-46	2516	1690	366	189	325	162
50.5-51	C46-53	1444	2066	116	165	84	124
51-51.5	C59-69	1954	1889	54	51	38	36
51.5-52	Q1-11	3186	3582	21	23	0	0

Table 4. Bridge log and species composition, by haul, for the *CSS W.E. RICKER* Pacific hake hydroacoustic survey August 8 to September 2, 1992.

		1	2	3	4	5	6
SET NO.		1	2	3	4	5	6
DATE		AUG. 10	AUG. 15	AUG. 20	AUG. 20	AUG. 20	AUG. 24
AREA(MAJ. MIN. LOC.)		3-24-6	3-23-10	3-24-0	3-24-0	4-25-2	4-26-8
TIME START (PDT)		0948	1330	1047	1212	1431	0925
DURATION (MIN)		14	37	20	40	8	65
START N. LAT.	(DEG)	48	48	48	48	49	49
	(MIN)	44.9	19.9	51.7	54.0	20.5	39.9
W. LONG.	(DEG)	126	126	126	126	127	127
	(MIN)	19.3	6.6	15.2	16.8	11.3	53.3
FINISH N. LAT.	(DEG)	48	48	48	48	49	49
	(MIN)	44.8	20.0	52.5	52.3	20.4	40.1
W.LONG.	(DEG)	126	126	126	126	127	127
	(MIN)	18.5	9.6	16.1	15.5	11.0	58.4
BOTTOM DEP[a]	(MODAL)	-	665	134	132	210	1800
TARGET DEP	(MODAL)	190	220	-	-	190	192
	(MIN)	180	-	-	-	180	185
	(MAX)	200	-	-	-	200	200
CAPTURE DEP	(MODAL)	180	230	124	125	185	194
	(MIN)	200	245	-	125	-	183
	(MAX)	170	205	-	125	-	206
TYPE OF GEAR		.... CANADIAN DIAMOND NO. 7 MIDWATER TRAWL............					
MOUTH OPENING (m)		0	15	12	12	0	13
ROUNDFISH (kg)							
PACIFIC HAKE		1462	369	35	139	694	1008
WALLEYE POLLOCK		..	..	..	..	..	..
JACK MACKEREL		..	..	..	1	..	..
EULACHON		..	..	..	7	..	..
HERRING		..	..	..	2	..	..
ROCKFISH *(Sebastes)* (kg)							
S. reedi		..	..	..	..	..	..
S. flavidus		..	..	1872	2	2	..
S. alutus		..	..	..	..	..	..
S. proriger		..	..	..	..	..	..
S. entomelas		..	..	44	..	..	..
S. brevispinis		..	..	..	..	..	..
S. zacentrus		..	..	..	..	..	..
FLATFISH (kg)							
TURBOT		3	..	..	..	..	..
TOTAL CATCH (kg)		1465	369	1951	151	696	1008

Table 4. continued

SET NO.	7	8	9	10	11	12	13
DATE	AUG. 26	AUG. 27	AUG. 28	AUG. 28	AUG. 29	AUG. 31	AUG.31
AREA(MAJ.MIN.LOC)	4-27-7	4-27-6	4-27-3	4-27-3	5-11-12	6-8-7	6-8-13
TIME START (PDT)	1525	1301	0930	1117	1227	1222	1515
DURATION (MIN)	120	45	8	11	90	18	40
START N. LAT.(DEG)	50	50	50	50	51	51	51
(MIN)	4.9	14.9	29.9	30.3	9.2	37.8	23.3
W. LONG.(DEG)	128	128	128	128	129	128	128
(MIN)	32.6	13.2	34.5	27.5	40.0	28.8	29.9
FINISH N. LAT.(DEG)	50	50	50	50	51	51	51
(MIN)	4.9	12.2	29.9	30.3	11.0	33.7	23.9
W.LONG.(DEG)	128	128	128	128	129	128	128
(MIN)	23.7	12.2	33.9	28.2	37.0	29.2	27.3
BOTTOM DEP[a] (MODAL)	1500	800	800	185	268	170	176
TARGET DEP (MODAL)	140	240	220	180	220	150	145
(MIN)	130	200	180	-	-	140	140
(MAX)	150	240	220	-	-	155	150
CAPTURE DEP (MODAL)	155	240	190	177	220	155	140
(MIN)	120	240	195	-	-	-	150
(MAX)	160	260	185	-	-	-	150
TYPE OF GEAR	...............CANADIAN DIAMOND NO. 7 MIDWATERTRAWL...........						
MOUTH OPENING (m)	13	12	12	10	12	13	13
ROUNDFISH (kg)							
PACIFIC HAKE	489	649	1804	463	131	931	1520
WALLEYE POLLOCK	..	..	..	..	..	8	183
JACK MACKEREL	33	..	..	..	..	..	..
EULACHON	..	..	..	..	..	10	..
HERRING	..	..	..	..	..	..	..
ROCKFISH *(Sebastes)* (kg)							
S. reedi	..	..	115	..	3758	..	16
S. flavidus	..	..	..	..	..	4	80
S. alutus	..	..	383	..	523	264	158
S. proriger	..	..	30	82	..	..	37
S. entomelas	..	..	11	..	82	..	2
S. brevispinis	..	..	38	1	6	2	16
S. zacentrus	..	..	..	5	..	..	..
FLATFISH (kg)							
TURBOT	..	..	..	..	..	..	..
TOTAL CATCH (kg)	522	649	2381	551	4500	1219	2012

[a]DEPTHS ARE IN METERS

Table 5. Summary of total catch by species for the Pacific hake hydroacoustic survey, *CSS W.E. RICKER*, August 8 to September 2, 1992.

Species	Weight (kg)	Percent
Pacific hake	9694	55.48
Walleye pollock	191	1.09
Jack mackerel	34	0.19
Eulachon	17	0.10
Herring	2	0.01
S. reedi	3889	22.26
S. flavidus	1960	11.22
S. alutus	1328	7.60
S. proriger	149	0.85
S. entomelas	139	0.79
S. brevispinis	63	0.36
S. zacentrus	5	0.03
Turbot	3	0.02
Total	17474	100

Table 6. Summary of Pacific hake biological samples collected, by haul, during Pacific hake hydroacoustic cruise, *CSS W.E.RICKER*, August 8 to September 2, 1992.

Haul no	Location (code)	Length M	Length F	Length T	Maturity	Stomach contents	Body weights	Paired otoliths	Fish no	Remarks[a]
1	Father Charles (032406)	235	175	410	137	68	137	137	57066-57202	2 tubs l/s/m/o/st/wt 4 tubs l/s
2	Barkley Canyon (032310)	223	171	394	128	69	-	128	57203-57330	2 tubs l/s/m/o/st 4 tubs l/s
3	Lennard Island (032401)	4	36	40	40	40	-	40	57331-57370	total catch l/s/m/o
4	Lennard Island (032401)	20	136	156	105	53	-	105	57371-57475	total catch 2 tubs l/s/m/o 1 tub l/s/m/o/st
5	Nootka (042502)	181	199	380	130	66	-	130	57476-57605	2 tubs l/s/m/o/st 4 tubs l/s
6	Kyuquot (042604)	210	164	374	126	62	-	126	57606-57731	2 tubs l/s/m/o/st 4 tubs l/s
7	Brooks (042706)	196	186	382	192	64	-	128	57732-57859	2 tubs l/s/m/o 1 tub l/s/m/st 3 tubs l/s
8	Quatsino (042706)	193	174	371	181	62	-	119	57860-57978	2 tubs l/s/m/o 1 tub l/s/m/st 3 tubs l/s
9	Quatsino (042706)	215	192	409	177	58	60	176	57979-58155	1 tub l/s/m/o 1 tub l/s/m/st/o 1 tub l/s/m/wt/o 4 tubs l/s
10	Topknot (051104)	122	198	321	108	56	52	-		1 tub l/s/m/st 1 tub l/s/m/wt 4 tubs l/s

Table 6. cont'd

Haul no	Location (code)	Length M	Length F	Length T	Maturity	Stomach contents	Body weights	Paired otoliths	Fish no	Remarks[a]
11	Q C Sound (051112)	27	33	60	60	-	-	-		Total catch l/s/m
12	Q C Sound (060807)	67	239	306	135	44	91	135	58156-58290	1 tub l/s/m/st/o 2 tubs l/s/m/wt/o 4 tubs l/s
13	Q C Sound (060813)	97	217	314	134	42	-	134	58291-58424	1 tub l/s/m/st/o 2 tubs l/s/m/o 4 tubs l/s
	Totals	1790	2120	3917	1684	684	340	1358	57066-58424	

[a] l=fork length s=sex o=paired otoliths st=stomach contents m=maturity wt=body weights

Table 7. Summary of other biological samples collected, by haul, during Pacific hake hydroacoustic cruise, *CSS W.E.RICKER*, August 8 to September 2, 1992.

Species	Haul no	Location	Length M	Length F	Length U	Length T	Maturity	Paired otoliths	Fish no	Remarks[a]
Yellowtail rockfish	3	Lennard Island	44	42	-	86	-	86	1-86	4 tubs l/s/o
Widow rockfish	3	Lennard Island	7	19	11	37	-	-	-	Total catch l/s
Pacific Ocean perch	9	Quatsino	5	60	-	65	-	-	-	2 tubs l/s
Yellowmouth rockfish	11	Q C Sound	20	46	-	66	66	66	1-66	2 tubs l/s/o/m
Pollock	13	Q C Sound	50	103	-	153	68	68	1-68	2 tubs l/s/o/m 2 tubs l/s
		Total	126	270	11	417	134	220		

[a] l=fork length s=sex o=paired otoliths m=maturity

Table 8. Length frequency of Pacific hake, by haul, *CSS W.E. Ricker*, August 8 to September 2, 1992.

Haul #	1			2			3			4			5		
Fork Length (cm)	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40	1	-	1	1	-	1	-	-	-	-	-	-	-	-	-
41	2	-	2	0	1	1	-	-	-	-	-	-	1	-	1
42	2	-	2	9	3	12	-	-	-	-	-	-	2	2	4
43	15	7	22	27	11	38	-	-	-	-	-	-	11	12	23
44	25	19	44	22	25	47	-	-	-	-	1	1	26	22	48
45	81	25	106	49	30	79	-	1	1	1	4	5	47	27	74
46	42	36	78	57	24	81	1	3	4	2	9	11	48	39	87
47	34	34	68	36	33	69	1	6	7	7	16	23	23	39	62
48	22	24	46	14	22	36	1	4	5	3	12	15	11	34	46
49	6	16	22	7	15	22	0	2	2	1	17	18	8	11	19
50	2	6	8	1	4	5	0	5	5	2	21	23	3	3	6
51	0	3	3	-	2	2	0	5	5	2	15	17	0	3	3
52	0	3	3	-	1	1	1	2	3	1	12	13	1	2	3
53	2	2	4	-	-	-	-	2	2	1	7	8	-	1	1
54	0	-	0	-	-	-	-	1	1	-	6	6	-	1	1
55	0	-	0	-	-	-	-	2	2	-	3	3	-	2	2
56	1	-	1	-	-	-	-	1	1	-	2	2	-	-	-
57	-	-	-	-	-	-	-	1	1	-	4	4	-	-	-
58	-	-	-	-	-	-	-	1	1	-	3	3	-	-	-
59	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-
60	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-
61	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
62	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-
63	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-
64	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-
65	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	235	175	410	223	171	394	4	36	40	20	136	156	181	198	380

Table 8. continued

Haul #	6			7			8			9			10		
Fork Length (cm)	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
42	7	1	8	1	-	1	5	-	5	2	1	3	-	1	1
43	9	7	16	4	1	5	8	4	12	0	1	1	1	0	1
44	30	9	39	26	4	30	13	4	17	12	2	14	4	1	5
45	46	21	67	24	11	35	20	15	35	21	7	28	5	4	9
46	51	39	90	43	35	78	48	24	73	32	25	57	13	11	24
47	28	28	56	35	34	69	30	34	65	36	24	60	15	21	37
48	19	31	50	34	41	75	32	22	54	41	22	63	23	28	51
49	11	16	27	16	22	38	21	19	40	29	28	57	19	34	53
50	6	6	12	5	22	27	6	24	30	18	33	51	12	36	48
51	2	4	6	6	9	15	5	13	19	11	16	28	15	25	40
52	-	2	2	1	4	5	3	10	14	4	14	18	9	17	26
53	-	-	-	0	1	1	0	4	4	6	7	13	4	8	12
54	-	-	-	0	2	2	1	0	1	2	2	4	1	3	4
55	-	-	-	0	-	0	1	1	2	2	6	8	1	5	6
56	-	-	-	-	-	-	1	-	1	-	0	0	-	2	2
57	-	-	-	-	-	-	-	-	-	-	1	1	-	0	0
58	-	-	-	-	-	-	-	-	-	-	2	2	-	0	0
59	-	-	-	-	-	-	-	-	-	-	1	1	-	0	0
60	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
61	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
62	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
63	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
64	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
65	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
66	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	210	164	374	196	186	382	193	174	371	216	192	409	122	198	321

Table 8. continued

Haul #	11			12			13			total		
Fork Lentgh (cm)	M	F	T	M	F	T	M	F	T	M	F	T
38	-	1	1	-	-	-	-	-	-	-	1	1
39	-	0	0	-	-	-	-	-	-	-	0	0
40	-	0	0	-	-	-	-	-	-	2	0	2
41	-	0	0	-	-	-	-	-	-	4	1	5
42	-	0	0	-	-	-	-	-	-	28	8	36
43	2	0	2	-	-	-	-	-	-	77	43	120
44	0	0	0	1	2	3	-	-	-	159	89	248
45	2	2	4	3	3	6	-	1	1	299	151	450
46	4	2	6	2	3	5	6	3	6	349	253	603
47	2	4	6	2	8	10	10	8	6	259	289	550
48	5	3	8	12	18	30	13	10	8	230	271	502
49	4	4	8	9	20	29	9	18	8	140	222	362
50	4	9	13	10	27	37	8	24	13	77	220	297
51	2	5	7	9	26	35	11	22	7	63	148	213
52	1	2	3	6	28	34	8	25	3	35	122	158
53	1	0	1	2	23	25	10	20	1	26	75	101
54	-	0	0	4	25	29	2	17	19	10	57	67
55	-	0	0	3	12	15	9	15	24	16	46	62
56	-	1	1	1	13	14	6	17	23	9	36	45
57	-	-	-	1	10	11	0	10	10	1	26	27
58	-	-	-	2	7	9	1	9	10	3	22	25
59	-	-	-	-	2	2	2	7	9	2	12	14
60	-	-	-	-	5	5	2	1	3	2	7	9
61	-	-	-	-	0	0	-	2	2	-	3	3
62	-	-	-	-	1	1	-	1	1	-	2	2
63	-	-	-	-	0	0	-	4	4	-	4	4
64	-	-	-	-	2	2	-	2	2	-	4	4
65	-	-	-	-	1	1	-	0	0	-	2	2
66	-	-	-	-	0	0	-	0	0	-	1	1
67	-	-	-	-	2	2	-	0	0	-	2	2
68	-	-	-	-	0	0	-	0	0	-	0	0
69	-	-	-	-	1	1	-	0	0	-	1	1
70	-	-	-	-	-	-	-	1	1	-	1	1
TOTAL	27	33	60	122	198	321	97	217	314	1791	2119	3917[1]

Note 1. total length frequency includes unsexed fish in hauls 5, 8, 9 and 10.

Table 9. Other species length frequency by haul, *CSS W.E. RICKER*, August 8 to September 2, 1992.

	Species															
	Yellowtail			Widow				P.O.P.[2]			Yellowmouth			Walleye pollock		
Haul #	3			3				9			11			13		
Fork Length (cm)	M	F	T	M	F	U[1]	T	M	F	T	M	F	T	M	F	T
32	-	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
34	-	-	-	-	1	0	1	-	-	-	-	-	-	-	-	-
35	-	-	-	-	0	2	2	-	-	-	-	-	-	-	-	-
36	-	-	-	1	1	2	4	-	-	-	-	2	2	-	-	-
37	2	1	3	0	0	1	1	-	-	-	3	7	10	-	-	-
38	0	0	0	1	2	0	3	-	-	-	5	8	13	-	1	1
39	1	1	2	1	2	0	3	-	-	-	5	5	10	1	0	1
40	0	4	4	2	5	0	7	-	1	1	4	4	8	0	0	0
41	3	3	6	0	0	0	0	1	2	3	0	1	1	2	0	2
42	1	0	1	0	1	1	2	0	2	2	0	0	0	0	1	1
43	5	0	5	0	1	-	1	-	4	4	1	2	3	3	3	6
44	6	2	8	1	1	-	2	2	14	16	0	3	3	1	0	1
45	8	2	10	0	0	-	0	1	15	16	1	3	4	0	1	1
46	9	1	10	0	2	-	2	0	14	14	0	8	9	4	2	6
47	8	4	12	0	1	-	1	1	5	6	-	3	3	6	5	11
48	2	3	5	0	0	-	0	-	4	4	-	-	-	8	9	17
49	0	4	4	1	0	-	1	-	-	-	-	-	-	7	7	14
50	1	6	7	-	0	-	0	-	-	-	-	-	-	6	5	11
51	-	3	3	-	0	-	0	-	-	-	-	-	-	5	7	12
52	-	2	2	-	2	-	2	-	-	-	-	-	-	3	11	14
53	-	2	2	-	-	-	-	-	-	-	-	-	-	1	12	13
54	-	1	1	-	-	-	-	-	-	-	-	-	-	2	11	13
55	-	-	-	-	-	-	-	-	-	-	-	-	-	2	7	9
56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	11
57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	6
58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3
59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Total	46	40	86	7	19	11	37	5	61	66	20	46	66	51	102	153

Notes 1. Unidentified sex 2. Pacific Ocean Perch

Table 10. Summary of CTD stations occupied during the *CSS W.E. RICKER* Pacfic hake hydroacoustic survey, August 8 to September 2 1992.

Stn No.	Cast No.	Date (yymmdd)	Time (PDT)	Location (Lat.)	Location (Long.)	Ocean Depth (m)	Probe Depth (m)
LC01	44	920810	01:01	48 50.4N	125 27.8W	94	85
LC02	45	920810	01:30	48 48.7N	125 31.1W	110	100
LC03	46	920810	01:58	48 46.9N	125 34.5W	132	125
LC04	47	920810	02:47	48 43.5N	125 41.5W	167	155
LC05	48	920813	00:03	48 39.9N	125 47.9W	62	55
LC06	49	920813	00:44	48 36.5N	125 53.9W	92	85
LC07	50	920813	01:32	48 32.8N	126 00.4W	127	120
TOW2	51	920815	14:45	48 20.4N	126 11.0W	808	793
BIO1	52	920817	22:26	48 37.4N	125 59.3W	105	95
BIO2	53	920817	23:01	48 37.5N	126 04.3W	134	127
BIO3	54	920818	00:01	48 37.4N	126 12.5W	320	303
BIO4	55	920818	01:23	48 37.5N	126 24.5W	950	500
BIO5	56	920818	02:30	48 37.4N	126 32.2W	1100	500
BIO6	57	920818	04:03	48 37.4N	126 42.9W	1200	500
LF08	58	920818	22:50	48 49.9N	126 50.8W	1100	500
LF07	59	920818	23:34	48 53.9N	126 44.7W	850	500
LF06	60	920819	00:58	48 58.1N	126 38.9W	450	430
LF05	61	920819	23:01	48 01.9N	126 33.0W	148	130
LF04	62	920819	23:45	49 05.9N	126 27.4W	124	110
LH04	63	920820	23:21	49 24.9N	126 58.7W	130	122
LH05	64	920821	00:12	49 21.3N	127 04.5W	155	140
LH06	65	920821	00:58	49 17.6N	127 10.7W	502	490
LH07	66	920821	01:50	49 13.7N	127 16.4W	1424	500
TOW6	67	920824	11:03	49 40.1N	127 58.5W	1800	500
LL05	68	920825	22:12	49 48.3N	128 02.8W	1765	500
LL04	69	920825	23:10	49 52.1N	127 56.5W	1100	500
LL03	70	920826	00:04	49 55.7N	127 50.3W	580	500
LL02	71	920826	01:03	49 59.0N	127 44.0W	134	120
LM02	72	920826	21:21	50 09.3N	128 03.7W	150	140
LM03	73	920826	22:04	50 05.3N	128 10.4W	1100	500
LM04	74	920826	22:55	50 01.6N	128 17.1W	1800	500
LM05	75	920826	23:49	49 57.9N	128 23.5W	1800	500
CPE2	76	920827	22:52	50 43.0N	128 40.0W	122	110
LQ03	77	920828	00:55	50 40.1N	129 90.0W	1000	500
GI06	78	920829	22:39	51 15.2N	130 09.1W	875	500
GI05	79	920829	23:25	51 18.2N	130 02.8W	330	320
GI04	80	920830	00:10	51 21.3N	129 56.5W	249	239
GI03	81	920830	00:58	51 24.3N	129 50.0W	218	210
GI02	82	920831	01:23	51 30.3N	129 37.5W	142	130
TOW13	83	920831	16:15	51 24.1N	128 26.5W	172	160
CPE1	84	920901	08:50	51 00.0N	127 50.0W	137	120
CPF2	85	920902	01:33	49 28.0N	124 30.0W	324	310
CPF1	86	920902	03:59	49 22.0N	124 05.0W	238	220

Table 11. Summary of COPRA[1] stations occupied during the Pacific hake hydroacoustic survey, *CSS W.E. Ricker*, August 8 to September 2 1992.

Stn no.	Cast no.	Date (yymmdd)	Time (pdt)	Location Latitude	Longitude	Ocean depth (m)	Probe depth (m)	Bongo depth (m)
CPE2	76	920827	23:07	50 43.0N	128 40.0W	122	110	110
LQ03	77	920828	01:16	50 40.0N	129 00.0W	1000	500	500
GIO2	82	920831	01:38	51 30.3N	129 37.5W	142	130	110
CPE1	84	920901	09:02	51 00.0N	127 50.0W	137	120	100
CPF2	85	920902	01:46	49 28.0N	124 30.0W	324	310	270
CPF1	86	920902	04:12	49 22.0N	124 05.0W	238	220	200

Note 1. Cooperative plankton research program consisting of one CTD probe and one oblique bongo plankton tow at each station.

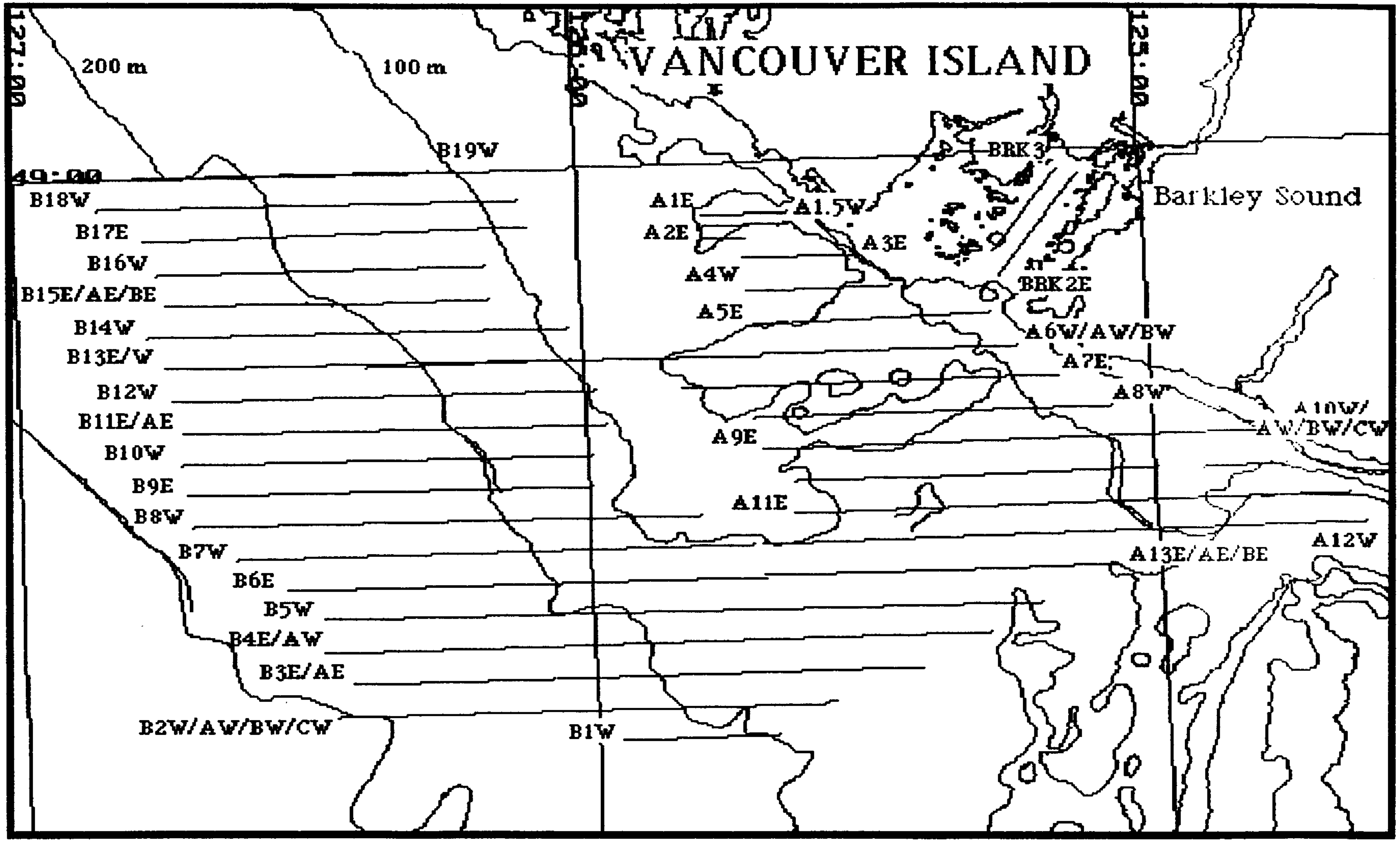


Figure 1a. A and B transects occupied during the Pacific hake hydroacoustic survey August 8 - September 2, 1992. A, B, and T series charts are on the same scale.

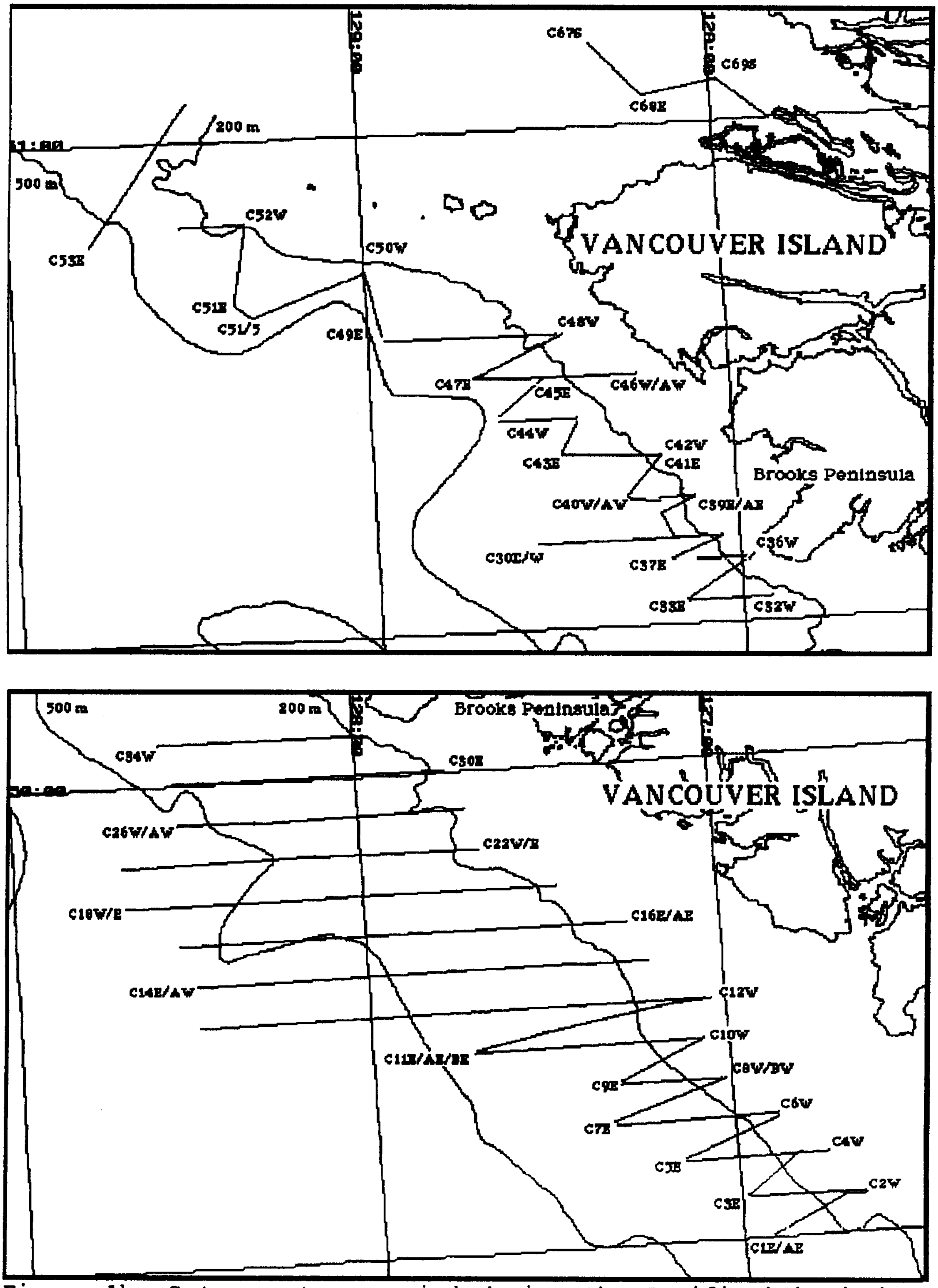


Figure 1b. C transects occupied during the Pacific hake hydro-acoustic survey August 8 - September 2, 1992. C and Q series charts are on the same scale.

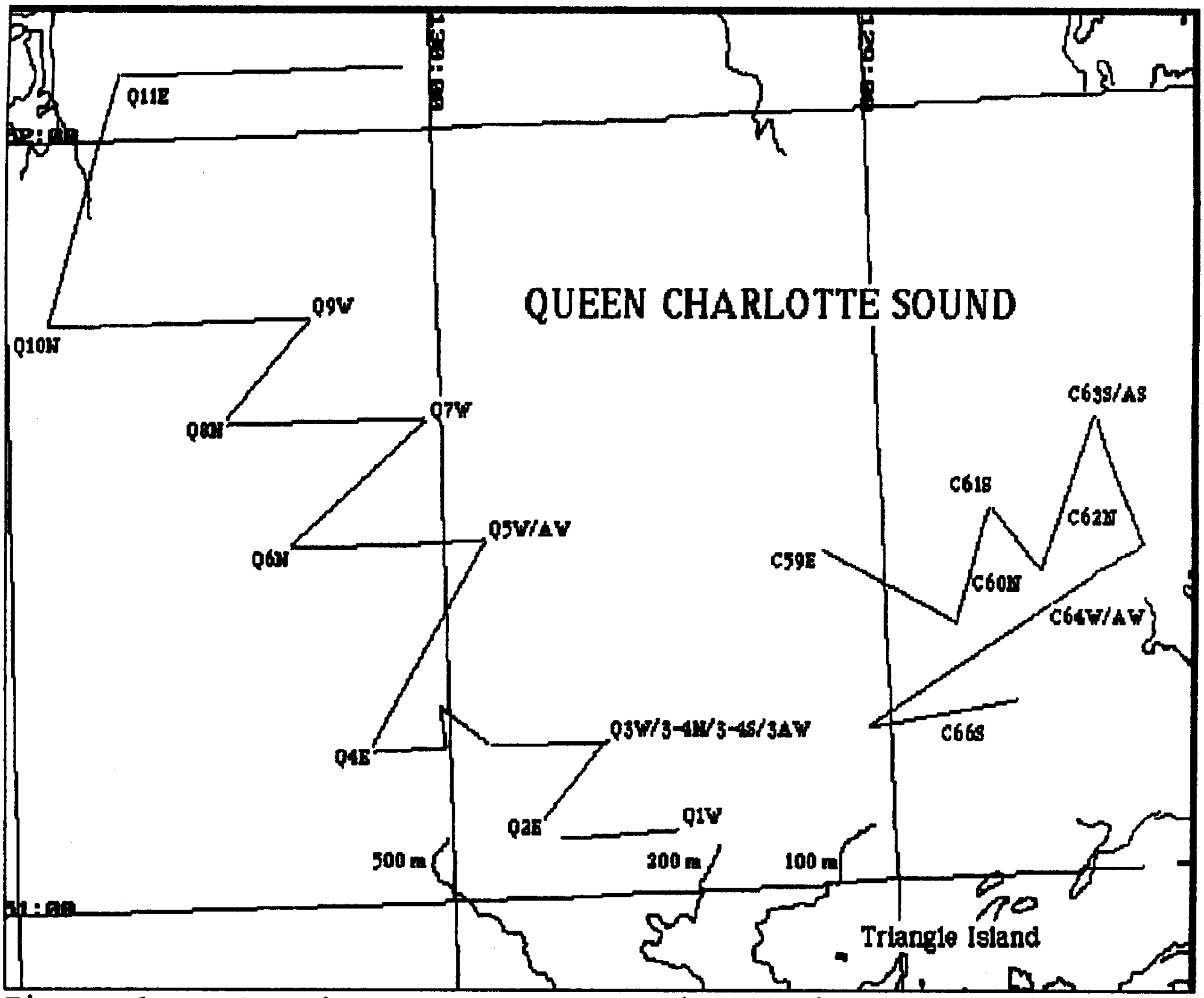


Figure 1c. C and Q transects occupied during the Pacific hake hydroacoustic survey August 8 - September 2, 1992. C and Q series charts are on the same scale.

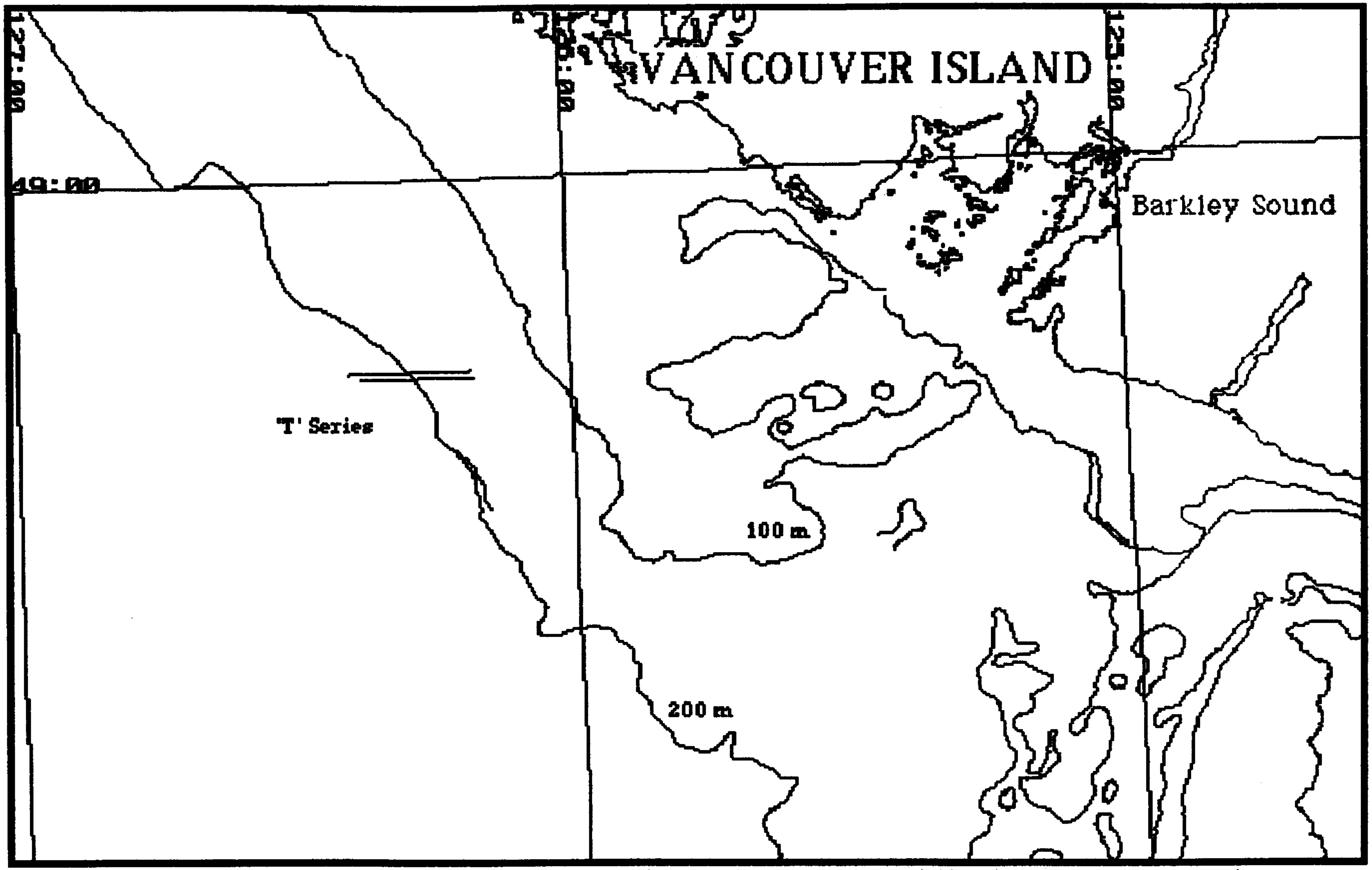
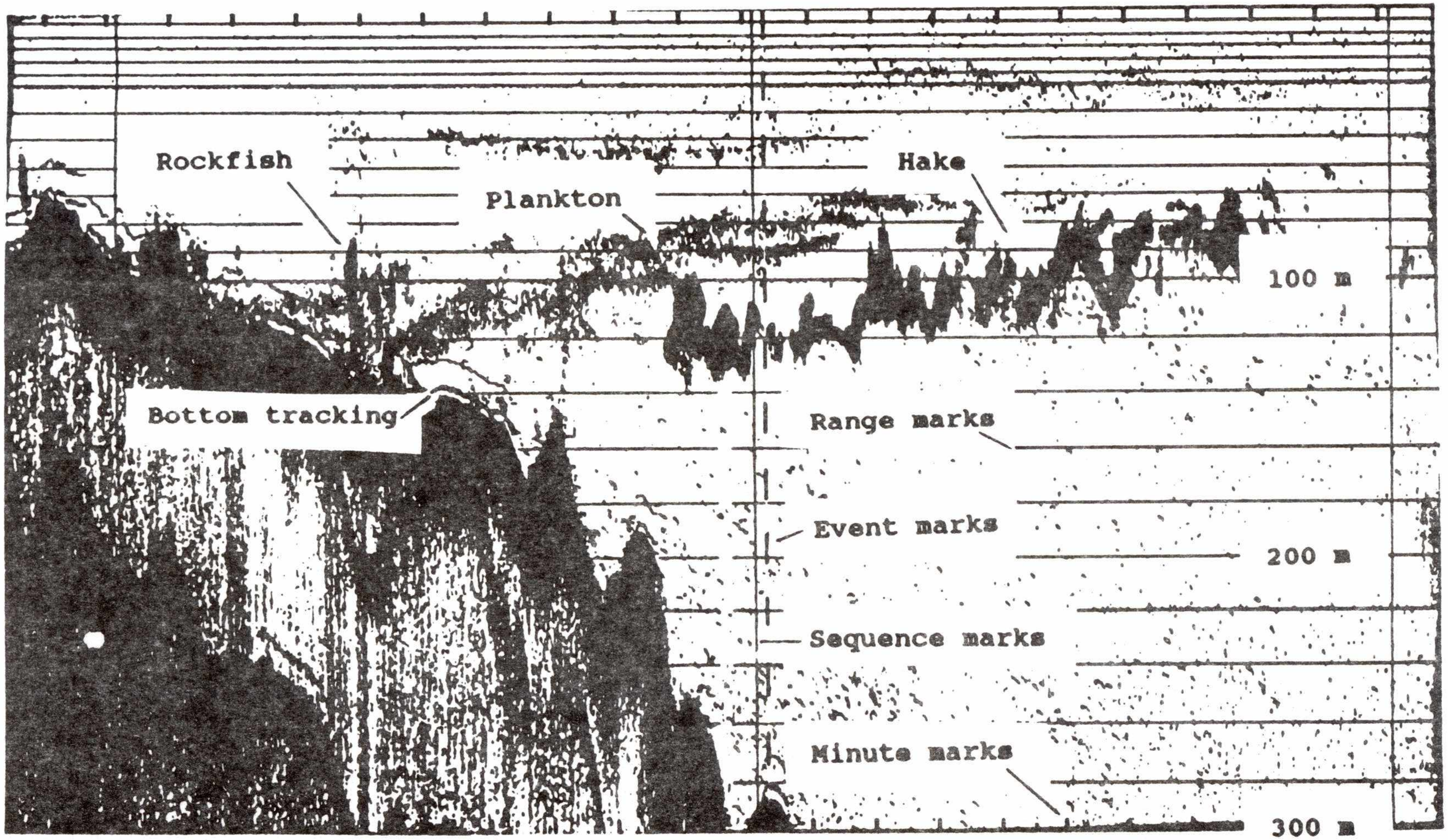


Figure 1d. T transects (first pass) occupied during the Pacific hake hydroacoustic survey August 10, 1992. A, B, and T series charts are on the same scale.

Figure 2. Typical echogram recorded at the shelf break. Horizontal range, vertical sequence and short minute marks are indicated by the solid lines. The dashed vertical line represents an event mark. Bottom tracking is monitored by a line that follows the bottom.



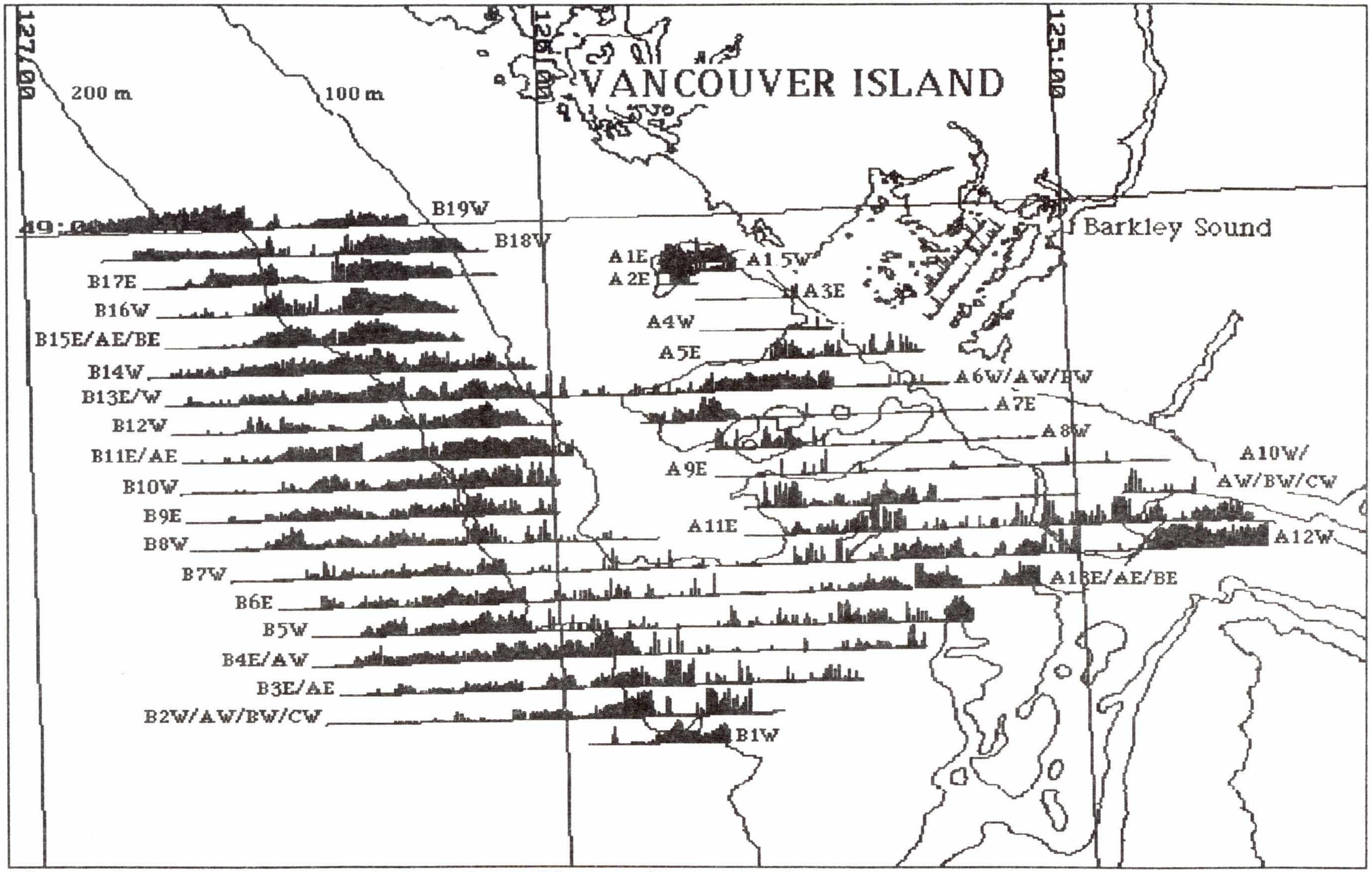


Figure 3a. Surface densities for all species, A and B transects, August 1992. Densities are represented by vertical bars on a log scale ranging from 0.01 to 1.0 kg/m^2.

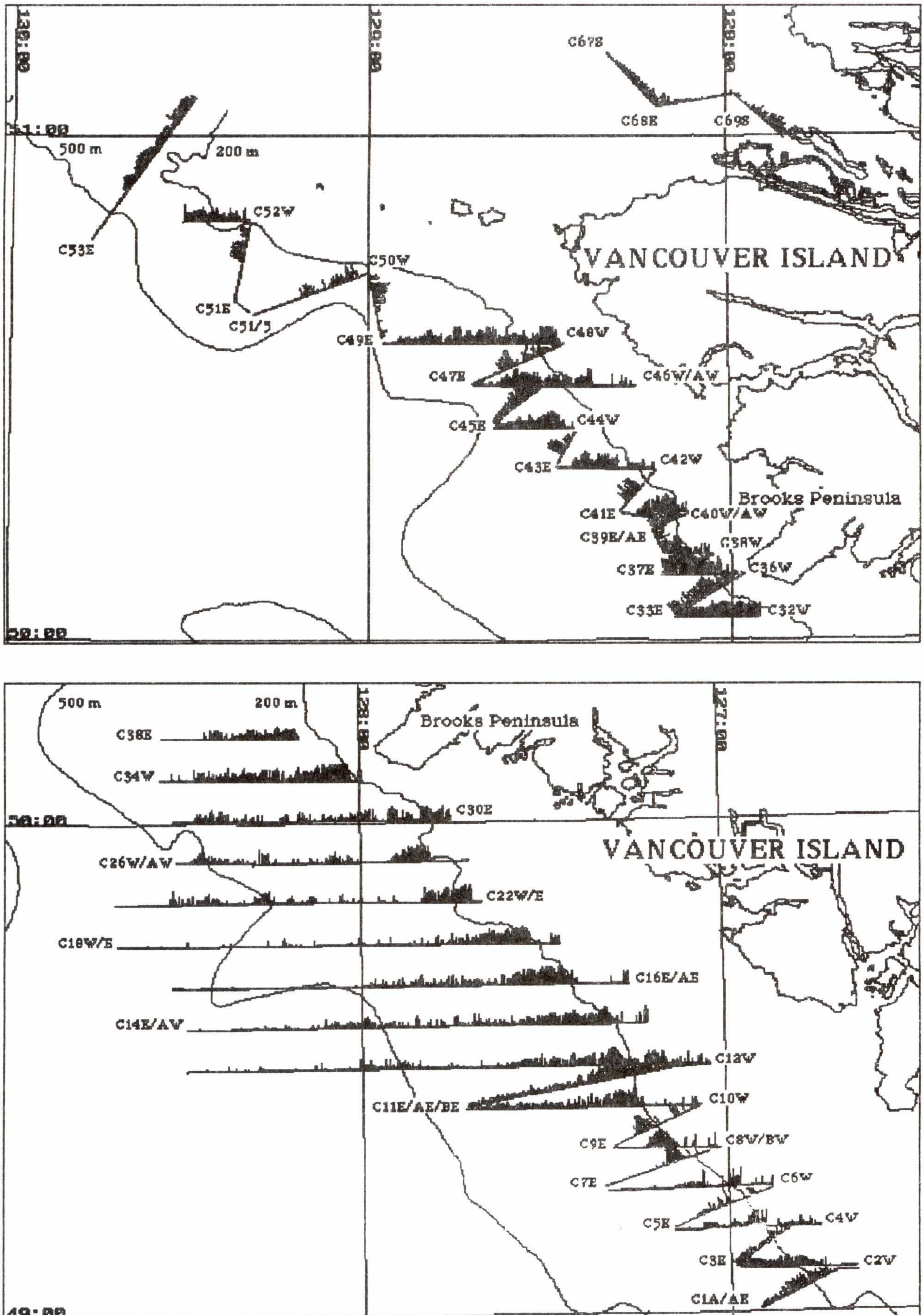


Figure 3b. Surface densities for all species, C transects, August 1992 survey. Densities are represented by vertical bars on a log scale ranging from 0.01 to 1.0 kg/m^2.

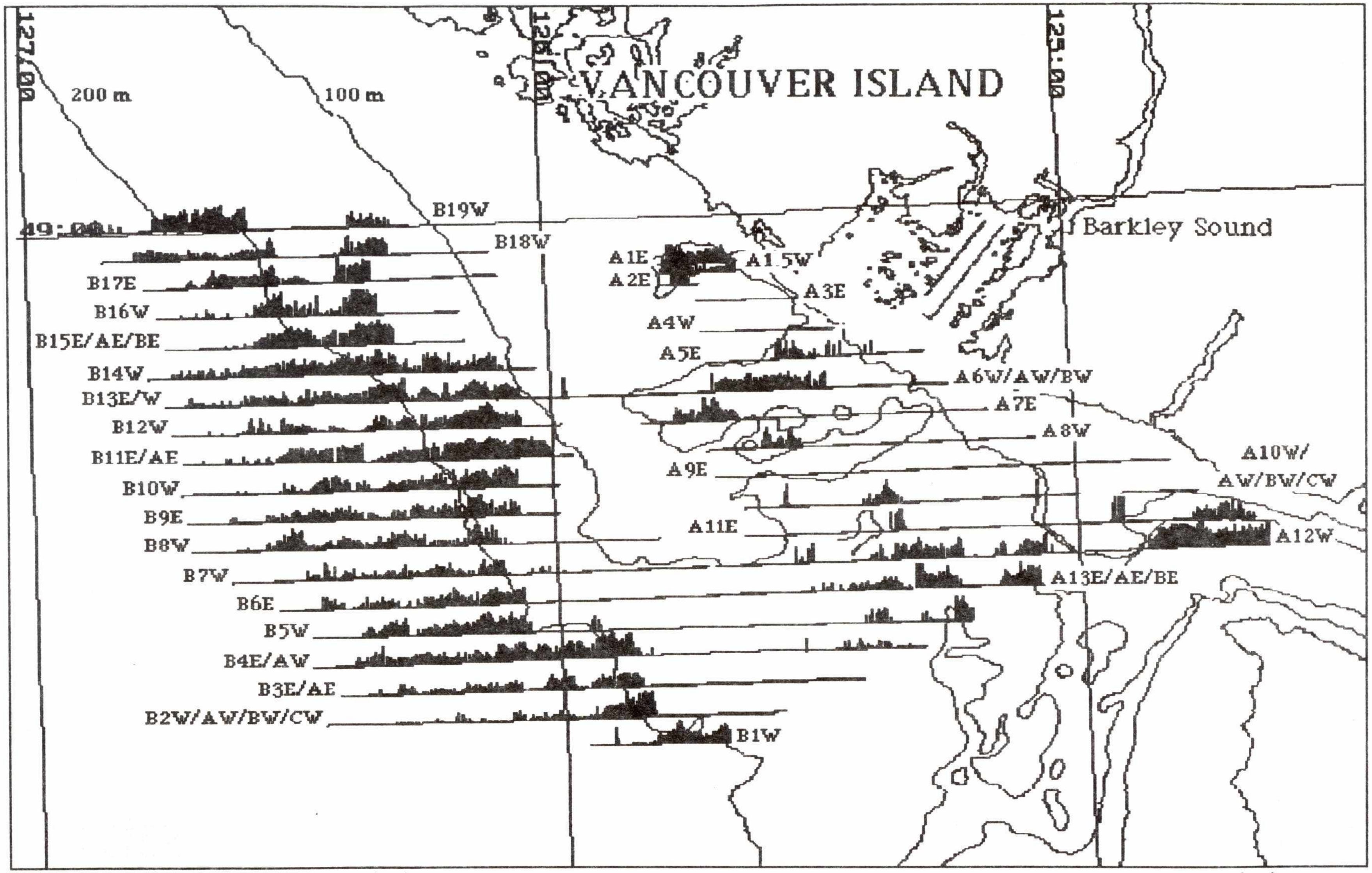


Figure 4a. Surface densities for hake only, A and B transects, August 1992. Densities are represented by vertical bars on a log scale ranging from 0.01 to 1.0 kg/m^2.

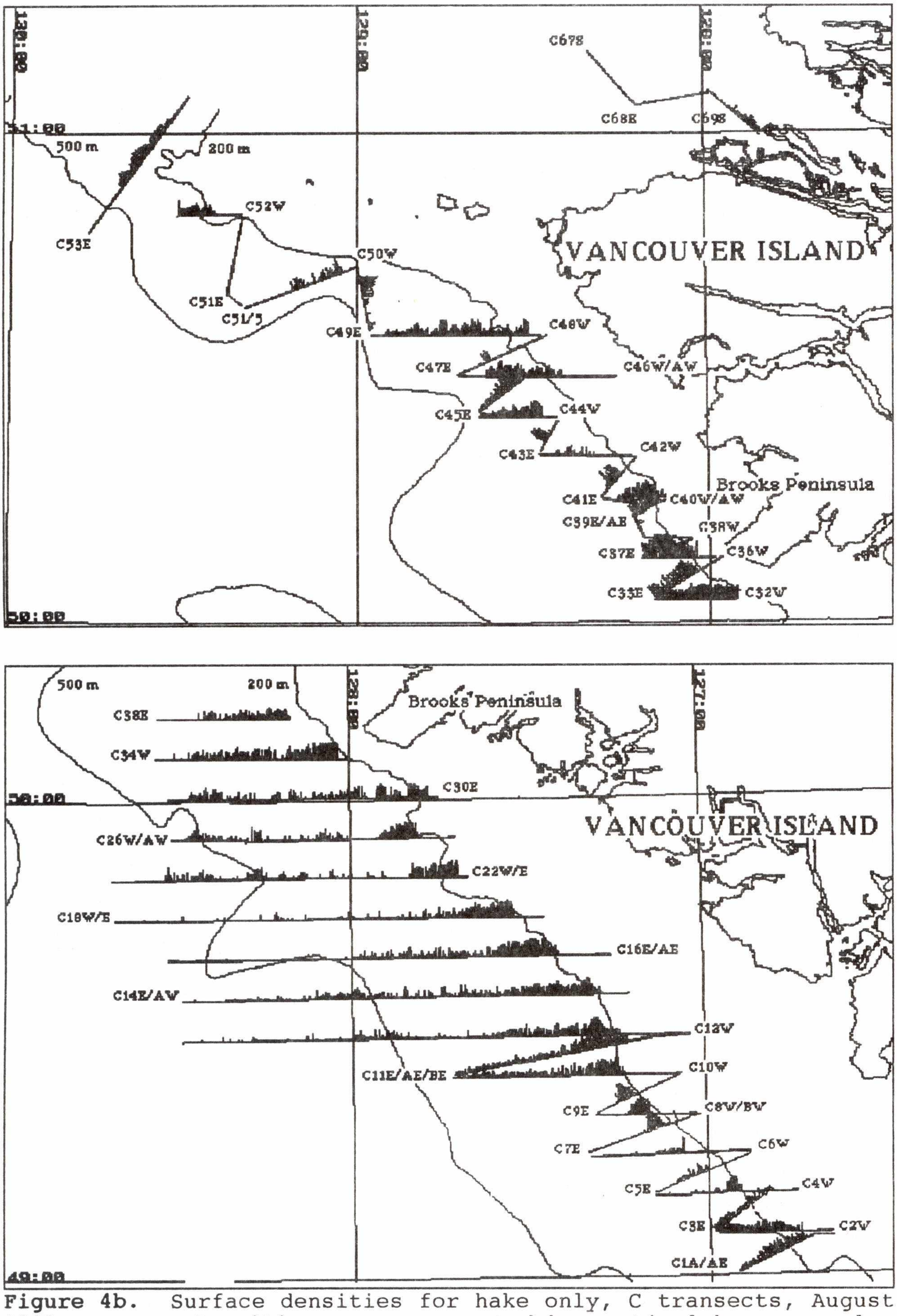


Figure 4b. Surface densities for hake only, C transects, August 1992 survey. Densities are represented by vertical bars on a log scale ranging from 0.01 to 1.0 kg/m^2.

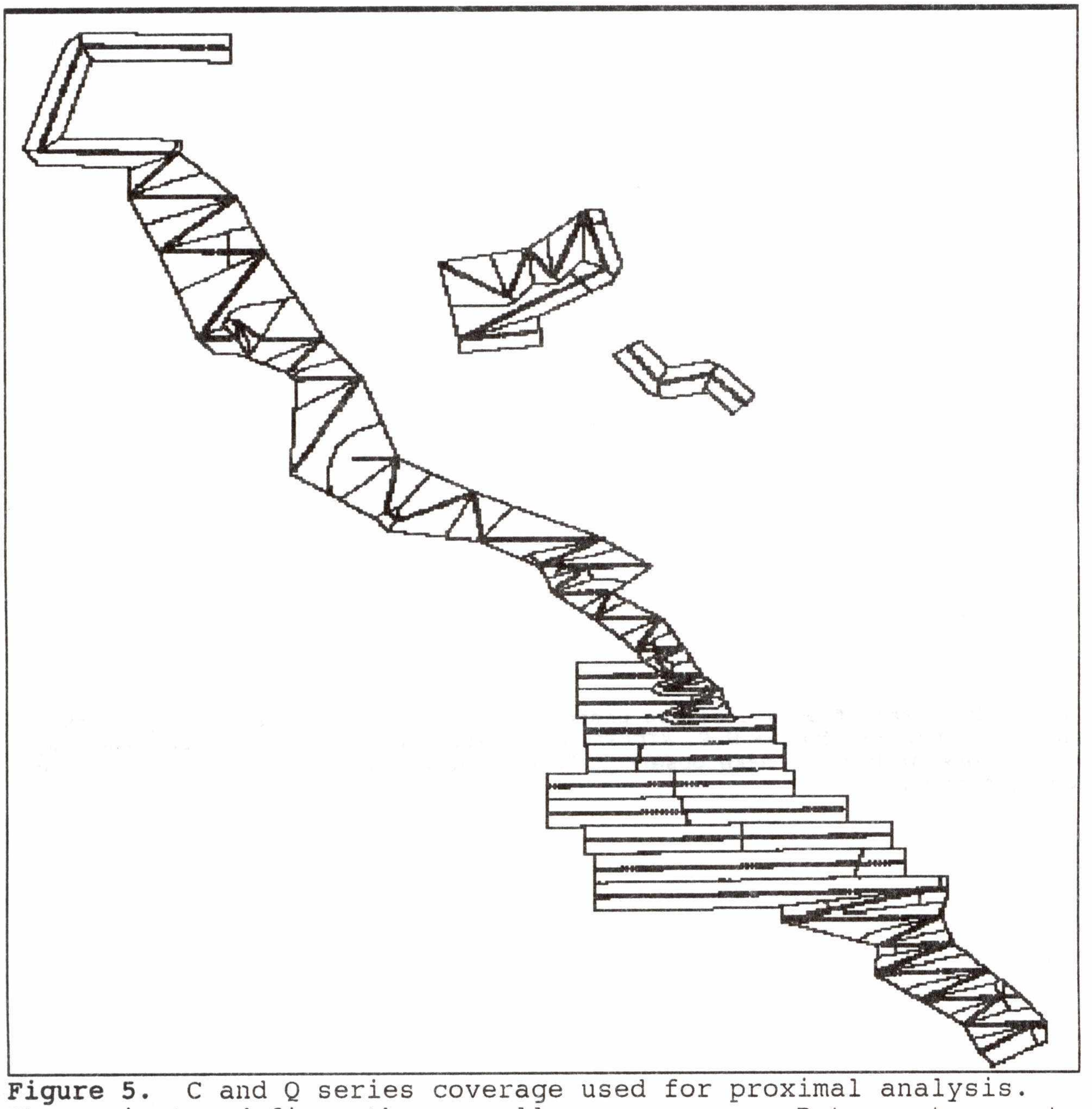
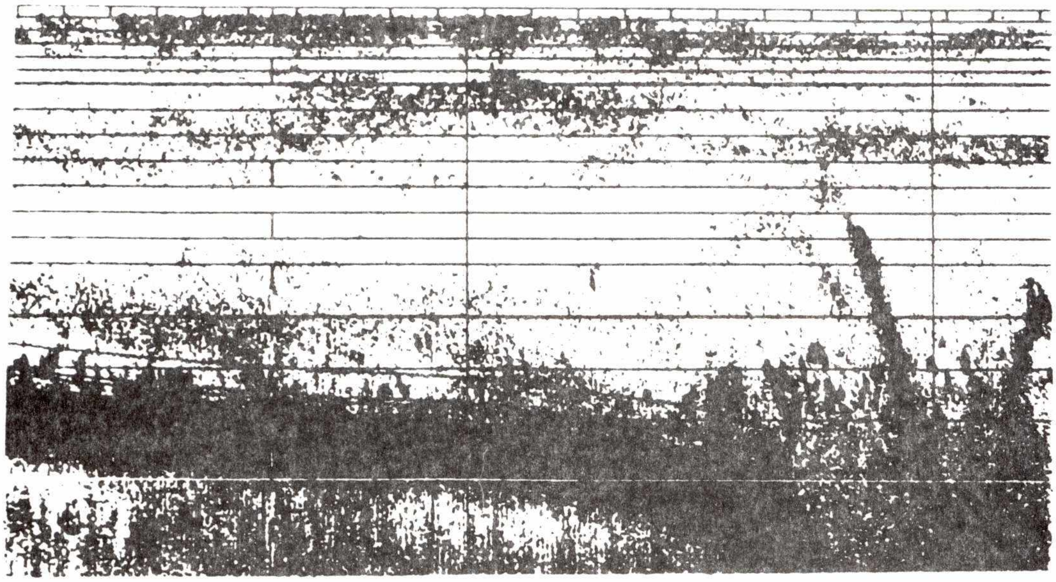
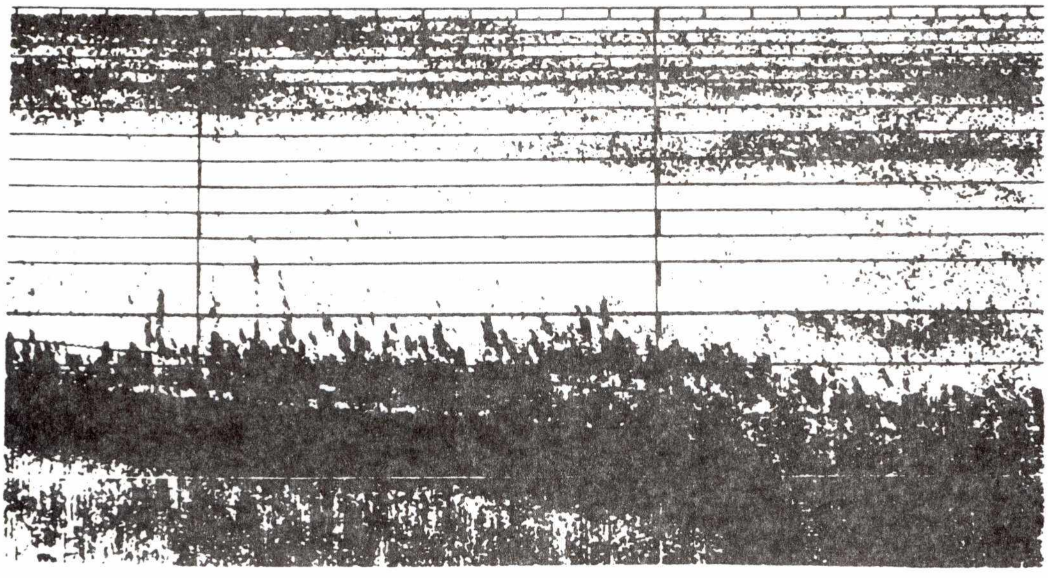
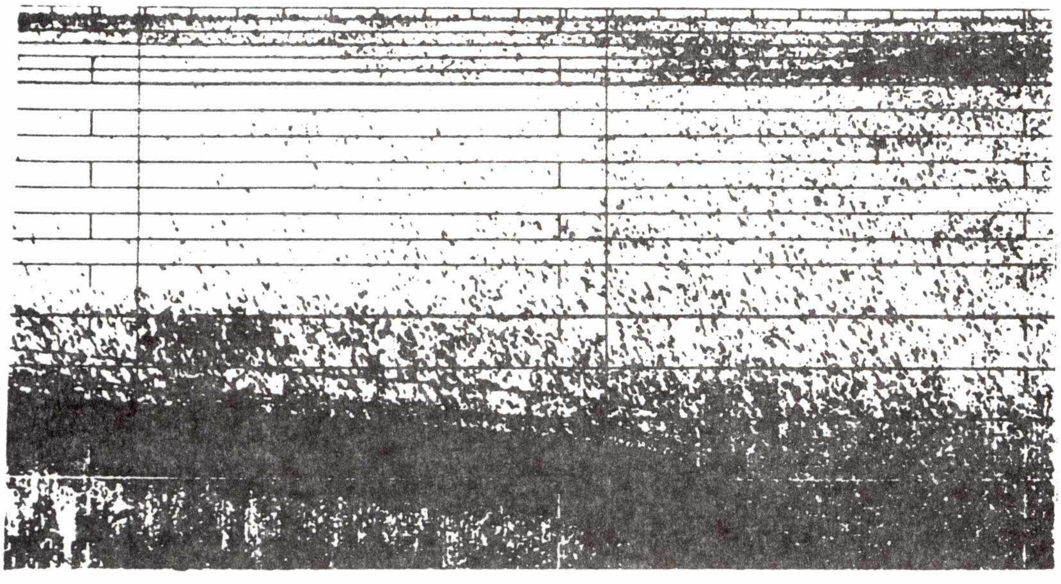


Figure 5. C and Q series coverage used for proximal analysis. The perimeter defines the overall survey area. Between transect boundaries determined with proximal analysis.

Fig. 6. Echograms from successive passes of the 'T' series transects collected August 10 , 1992 on the *CSS W.E. RICKER*. Diel distribution patterns are shown for aggregations of Pacific hake observed during the day (top), dusk (middle), and night (bottom).







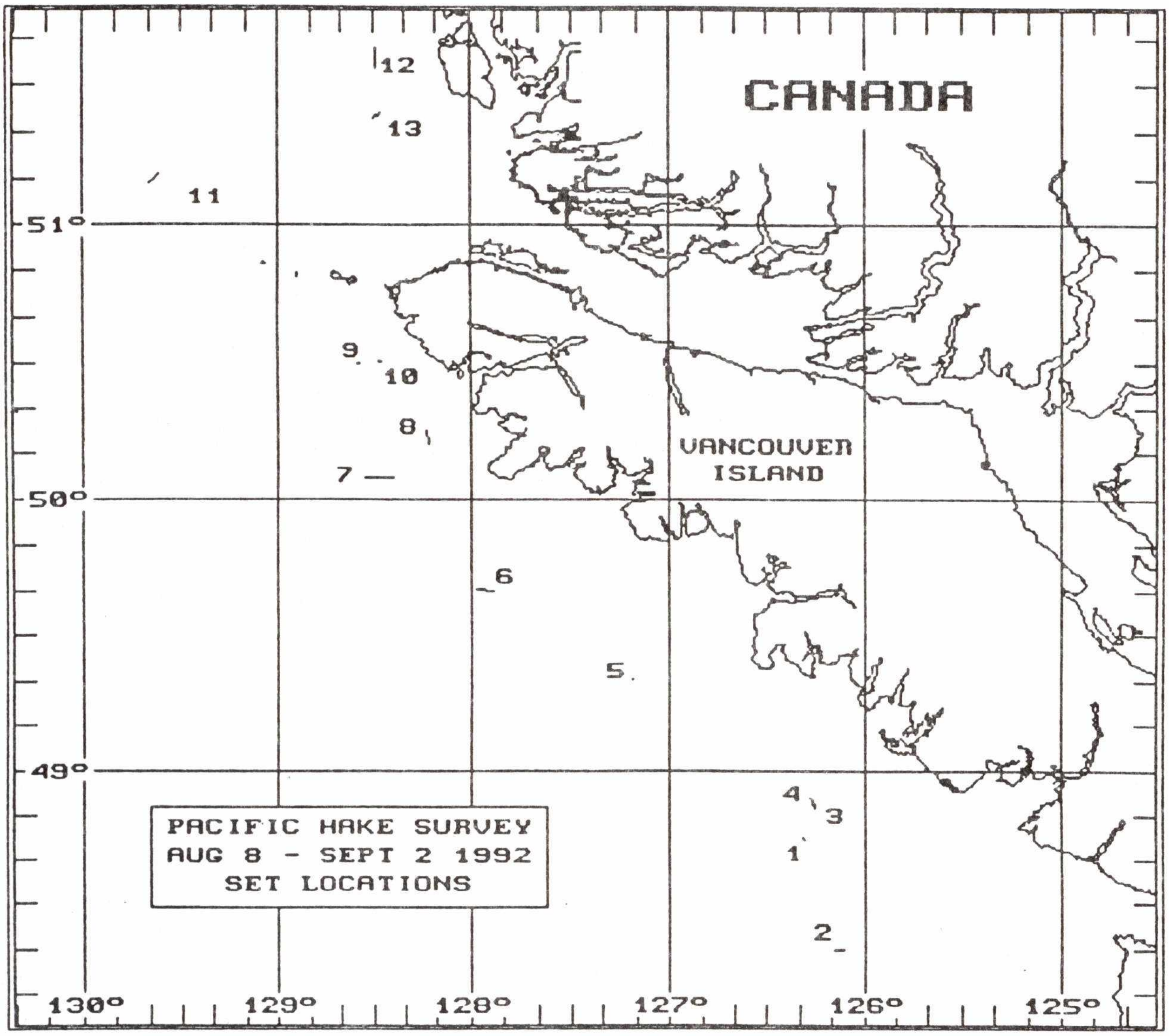


Figure 7: Fishing haul locations during the hydroacoustic survey conducted from August 8 to September 2, 1992 off the west coast of Vancouver Island.