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Hydroacoustic Herring Survey Results from Hecate Strait November 22- December 2, 1993. *W. E. Ricker* Cruise 93 HER

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HYDROACOUSTIC HERRING SURVEY RESULTS FROM HECATE STRAIT NOVEMBER 22-DECEMBER 2, 1993. *W. E. RICKER* CRUISE 93HER

by

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ABSTRACT

McCarter, P. B., D. E. Hay, P. Withler and R. Kieser. 1994. Hydroacoustic herring survey results from Hecate Strait, November 22-December 2, 1993. W. E. RICKER cruise 93HER. Can. Manuscr. Rep. Fish. Aquat. Sci. 2248: 40 p.

Pacific herring in Hecate Strait overwinter in two major areas: Browning Entrance on the mainland side of Hecate Strait and the inshore waters of Juan Perez Sound off the south-eastern Queen Charlotte Islands. We conducted an acoustic and fishing survey of these herring aggregations from November 22 - December 2, 1993 aboard the research vessel, W. E. RICKER. Total echo integration biomass estimates of midwater herring were 14,000 tonnes in the Browning Entrance area and 11,000 tonnes in the Juan Perez Sound area. These and previous year's estimates provide a temporal index of abundance. The December, 1993 Browning Entrance biomass estimate was approximately the same as that of 1992. The Juan Perez Sound biomass estimate decreased sharply. Preliminary size analyses indicates poor recruitment of small (young) herring to Juan Perez Sound but small (young) herring were plentiful in Browning Entrance. Survey design and error estimation are also discussed. A compilation of 1985-1994 model based stock forecasts and acoustic survey estimates are compared with catch plus spawner estimates.

Key words: Pacific herring, Hecate Strait, hydroacoustic, biomass estimate, survey

RESUME

McCarter, P. B., D. E. Hay, P. Withler and R. Kieser. 1994. Hydroacoustic herring survey results from Hecate Strait, November 22-December 2, 1993. W. E. RICKER cruise 93HER. Can. Manuscr. Rep. Fish. Aquat. Sci. 2248: 40 p.

Le hareng du Pacifique dans le détroit d'Hécate passe l'hiver dans deux principaux secteurs : l'entrée de Browning du côté des terres du détroit d'Hécate et dans les eaux intérieures de la baie Juan Perez au large des Îles de la Reine-Charlotte du sud-est. Nous avons pris des relevés acoustiques et des pêches de ces rassemblements de harengs du 22 novembre au 2 décembre 1993 à bord du bateau de recherche W.E. RICKER. Les estimations de la biomasse totale des harengs pélagiques par échointégration atteignaient 14 000 tonnes dans l'entrée de Browning et 11 000 tonnes dans la baie Juan Perez. Ces estimations et celles de l'an passé nous fournissent un indice temporel de l'abondance. L'estimation de la biomasse dans l'entrée de Browning en décembre 1993 était à peu près la même qu'en 1992. L'estimation de la biomasse dans la baie Juan Perez a diminué brusquement. Les analyses préliminaires de la taille indiquent un piètre recrutement de petits (jeunes) harengs dans la baie Juan Perez, mais les petits (jeunes) harengs étaient en grand nombre dans l'entrée de Browning. On discute également du protocole de l'étude et de l'évaluation de l'erreur. On compare une compilation des prévisions des stocks basées sur des modèles et des estimations des relevés acoustiques entre 1985 et 1994 avec les estimations des prises et des géniteurs.

Mots clés : Hareng du Pacifique, détroit d'Hécate, hydroacoustique, estimation de la biomasse, étude

INTRODUCTION

The objective of this survey was to continue development and refinement of methods for hydroacoustic estimation of Pacific herring (Clupea pallasi) abundance. Herring schools are sometimes difficult to integrate acoustically because of bottom echo interference and a limited echo integration range near the surface. Schools are frequently located close to the bottom during the day and near the surface at night. This behaviour makes it difficult to conduct continuous, 24 hour day echo integration surveys. We conducted several 6-8 hour sounding grids during the dawn and dusk periods to mitigate this problem. Midwater trawl fishing was conducted during midday and evening hours. Analysis of trawl catches confirmed the species identification of acoustic targets and provided herring size and age samples. Survey grid patterns were based on results from previous winter acoustic and fishing surveys in 1984 (Kieser et al. 1987), 1985-1992 (McCarter et al. 1987, 1988, 1989, 1991, 1992, 1993). The survey was conducted on the Fisheries Research vessel, W. E. RICKER. A schedule is given in Appendix Table 1.

The hydroacoustic biomass estimates determined during the survey are based on standard echo integration procedures (Kieser et al. 1987). We compared our acoustic estimates with statistical stock forecasts and estimates that use spawn surveys and analyses of catch and age structure (Schweigert et al. 1994). One noteworthy aspect of the hydroacoustic estimate is that it is independent of any other methods or fishery data.

METHODS

HYDROACOUSTIC EQUIPMENT

The hydroacoustic equipment was installed on the W. E. RICKER and configured for echo integration. Major components consist of a Biosonics model 101 (1985) echo sounder, Biosonics model 121 (1979) echo integrator and a Biosonics model 111 (1985) chart recorder. An 8 by 13 degree, Simrad 38 kHz ceramic transducer was mounted on a sled which was towed behind the vessel with a 60 m length of armoured cable. This configuration facilitated transducer calibration and minimized acoustic interference from the ship's propeller and hull. A Tektronix oscilloscope was used to monitor the echosounder output. Digital echo integrator output was stored on an IBM PC compatible microcomputer. Analog echo data were stored on a PCM/VCR digital audio recording system. The echo sounder, transducer and cable were calibrated at the hydroacoustic barge of the University of Washington, Seattle in July, 1993. A post-survey calibration was completed December 10, 1993 from the W. E. RICKER while docked at the Pacific Biological Station but was not utilized in this analysis. A fish target strength of -32 dB/kg was used to convert the measured backscattering strength to fish density estimates. Biomass estimates were obtained by extrapolating the measured surface density over the area of interest.

SURVEY AREA

Parallel transects 5-20 km in length were spaced approximately 2.0 km apart covering four major herring overwintering areas in the Browning Entrance area (Figs. 1-4). The Freeman, Whiterocks, Bonilla and inshore

Browning Entrance transect grids were each surveyed twice. Transects were spaced 1.0 km apart in the confined waters of Juan Perez Sound (Figs. 5-7) where herring are often heavily concentrated. These transect grids were surveyed three times. Each transect grid was completed in a 6-8 hour period primarily at dusk and dawn when most herring were in midwater in 'off bottom schools'. This was especially important in the deeper waters of Juan Perez Sound where fish are difficult to distinguish from irregular bottom during the day. Transects were similar to those used during the 1990-1992 hydroacoustic surveys with the exception of shorten sounding grids for searching and targeting at the entrance to Juan Perez Sound (P-grid).

The bridled sled body enclosing the transducer was towed at a depth of approximately 5-10 metres while the ship's speed was maintained at 8-10 knots. The echo integration range or depth strata selected in the Browning Entrance area included the entire water column starting 25 m below the transducer to 5 m from the sea floor. In the deeper waters of Juan Perez Sound the integration range was set starting at 25 m below the transducer to a maximum range of 140 m from the transducer or to 12 m from the sea floor in shallow areas. A relatively large bottom buffer was chosen in this area to maintain bottom tracking over irregular bottom and to minimize bottom echo integration over steep edges.

FISHING AND SAMPLING

Fishing equipment on the W. E. RICKER included a Canadian Diamond 5 midwater trawl with 40 fathom sweeplines and 4 m^2 Suberkrub otter boards. Catches were brought aboard and species weights estimated. Herring samples were placed in buckets and frozen. Scales for age determinations were removed from 100 herring in each sample. Herring standard length measurements were recorded to the nearest millimetre, fish weights and gonad weights to the nearest gram, and sex and maturity determined whenever possible.

PROCESSING OF HYDROACOUSTIC DATA

Average echo intensity values measured by the echo integrator over one minute intervals (sequences) and by selected depth strata were logged by a microcomputer. An event file was logged concurrently on a second microcomputer by entering a consecutive event number, time, position, sequence number, analog tape number and operator's comments at the start and end of each transect. A data logging program written in Turbo Pascal provided direct entry of the ship's Loran position and time. A set of hydroacoustic programs written in BASIC were used to generate biomass estimates and to produce transect plots. The calculated parameters included transect length (km), transect bearing, average speed (kn), area covered (km^2), average distance of biomass from surface and bottom (m), volume density (kg/m^3), surface density (kg/m^2) and extrapolated biomass (t). Species identification of acoustic targets was based on information from the echograms and the catch compositions of midwater trawl tows. During the analysis, echo integration range strata and sequences were carefully selected to only include herring in the biomass estimate and to exclude noise and other targets and interferences. The parameter portion of the biomass control file used for this analysis is given at the beginning of Appendix Table 2.

Histograms of fish densities (kg/m^2) were plotted on digitized Canadian hydrographic charts 3927 and 3808 using geo-referencing software (Langford, 1993). The histograms were plotted along transects at one minute intervals using a linear scale of 0.01 to 1.0 kg/m^2. Further detail regarding the analysis and programs are given by Kieser et al. (1987).

RESULTS AND DISCUSSION

BIOMASS ESTIMATES

We pooled biomass estimates according to groups of transects or grids (Table 1). The highest estimates among repeated grids were chosen because herring schools are sometimes too close to the surface or sea floor to be fully integrated. Browning Entrance transect grids, including Browning inshore, Freeman, Whiterocks and Bonilla trawling grounds, comprised a total area of 770 km^2. Maximum biomass estimates from Table 1 were 7,850 tonnes on the Freeman grid, 601 tonnes on the Whiterocks grid, 4,580 tonnes on the Bonilla grid and 956 tonnes on the inshore Browning Entrance grid. Queen Charlotte Island transect grids comprised a total area of 150 km^2. Maximum biomass estimates were 6,240 tonnes in Juan Perez Sound and 4,710 tonnes at the entrance to the Sound. A detailed summary of the hydroacoustic estimates by individual transect and grid pattern is given in Appendix Table 2.

REPETITIVE HYDROACOUSTIC SURVEYS AND DISTRIBUTION PLOTS

Several herring schools, 2 km in length were sounded 0-10 m from the sea floor during the first coverage of the Freeman grid. A 2,820 t biomass estimate was obtained. Many echoes from these schools were not fully integrated because they could not be clearly distinguished from bottom echoes. The schools were located on transects F2 and F3 (Fig. 1). During the second coverage of the Freeman grid, herring schools appeared as numerous, small, aggregations 5-35 m from the bottom and 60-90 m from the surface and were distributed along transects F2 and F3 (Fig. 2). The majority of these schools were fully integrated. A 7,850 t biomass estimate was obtained. Few schools were sounded on the Browning inshore grid (E1-E6 on Figs. 1 & 2) where a first and second coverage produced a 956 t and 537 t estimate respectively.

Schools sounded on the Bonilla transect grid (B1-B9 on Figs. 3 & 4) were similar in configuration to those sounded on the Freeman grid. Some schools were incompletely integrated resulting in minimum biomass estimates. The first coverage produced a 4,580 t estimate and the second coverage a 4,120 t estimate. Few schools were sounded on the Whiterocks transect grid (W10-W16 on Figs. 3 & 4) where a first and second coverage produced a 601 t and 227 t estimate respectively. Noise interference produced by Pacific white sided dolphins occurred occasionally on the Freeman, Whiterocks and inshore Browning entrance transect grids but this did not significantly influence estimates.

Three completed surveys of the transect grid in Juan Perez Sound (J1-J14 on Figs. 5-7) identified areas of herring concentrations in Darwin Sound (J11B & J12), Sedgwick Bay (J1 & J2) and near All Alone Stone (J13 & J14). Schools were 30-60 m from the surface and clear from the bottom. Total biomass estimates ranged from 3,990 t to 6,240 t on the J-grid. P-grid transects located at the entrance to Juan Perez Sound were modified each time to target directly on herring concentrations due to time constraints. Biomass estimates ranged from 331 t to 4,710 t. This is the first year since 1984 that significant herring biomass has been sounded on the P-grid. Only a few dense, 0.5-2 km long schools located close to the sea floor were sounded.

TRAWL FISHING AND SAMPLING

We fished major acoustic targets with midwater trawls in the Browning Entrance and Juan Perez Sound areas (Table 2). The vertical opening of the trawl net was about 8 m during most tows. A 30 minute, evening tow in Juan Perez Sound (transect J12) yielded approximately 20 kg of herring and 40 kg of juvenile dogfish. Two, afternoon tows at the entrance to Juan Perez Sound (transects P7-P8) yielded 1500 kg of herring and a few rockfish, pollock and dogfish and two, evening tows on the Freeman's ground (transects F3-F4) yielded approximately 1350 kg of herring and a few English sole, pollock and dogfish. No other fish species were caught. Herring size and sex frequency data is recorded in Table 3. Herring length and age frequency histograms are shown in Figures 8 and 9, respectively.

COMPARISON OF HYDROACOUSTIC ESTIMATES WITH OTHER BIOMASS ESTIMATES

Schweigert et al. (1994) predicted stock biomass for the Queen Charlotte Islands District from age-structured and escapement models as 20,300 t and 9,600 t respectively. Both forecasts assume that new recruitment to these stocks will be similar to the "historical average". The average of both models produced a 14,900 t forecast. This compares with a hydroacoustic survey estimate of 11,000 t in the SE Queen Charlotte Islands area.

In the Prince Rupert District, the predicted stock biomass from age-structured and escapement models were 86,200 t and 33,400 t respectively. Only the escapement model estimate was used to forecast because of some uncertainty in the age-structured model stock estimate (Schweigert, el al. 1994). The hydroacoustic survey estimate was 14,000 t in the Browning Entrance area. Although the different annual estimates in Table 4 do not track precisely (Fig. 10), some estimates show similar trends (Prince Rupert District hydroacoustic estimate and the catch plus spawners estimate).

ERROR ESTIMATION OF HYDROACOUSTIC BIOMASS ESTIMATES

Error estimation was confined to sampling errors attributable to survey design. Target strength estimation error and system calibration error has been examined previously (Hay et al. 1992 and Kieser et al. 1987). Although these sources of error may be substantial, they merely scale the biomass in a relatively predictable manner and we can do little to mitigate them during a survey. We can, however, select among many different survey designs and observed many different herring school configurations. A simple procedure was needed for comparing the relative variation produced by different survey designs and herring school configurations.

Average surface density measurements determined every minute along the transects were used to calculate standard deviations for each transect grid. Standard deviations were calculated in Appendix Table 2 as a percentage of the total biomass estimate (coefficient of variation) and ranged from 5-33 percent of the biomass estimates. Coefficients varied according to the configuration of herring schools sampled by the transect pattern. Small coefficients ocurred when numerous, small agregations were sounded while large coefficients ocurred when only a few large schools were sounded within a transect grid.

It was first thought that accurate confidence intervals could not be produced using averaged surface density measurements. A single transect (F3, second coverage) was therefore selected and re-integrated so that unaveraged surface density measurements could be generated for **every** ping (1/sec). Bootstrap-based confidence intervals were produced from this data, however there remains some uncertainty as to whether this method is appropriate. The 1/sec density measurements are not entirely independent, as variable overlap can occur depending on the distance of herring schools from the transducer, the vessel speed and the beam angle. Some measurements of deep schools would have to be discarded from the analysis. Also, each entire survey grid would have to be re-integrated at one second resolution and this was not a option. It was concluded that for simple biomass estimation models which only use mean densities, bootstrapping techniques were not necessary.

Standard errors and confidence intervals for each biomass grid were consequently determined using averaged density measurements and simple parametric methods. The coefficients of variation and biomass estimates in Appendix Table 2 were calculated on the basis of stratified sampling as each density measurement was weighted by the area it represented. The standard errors and confidence intervals, however, were calculated by equal weighting (unstratified) to simplify computations. The assumption is valid as the area represented by each density measurement was approximately constant (transect spacing and vessel speed during a transect grid was kept constant). The method of biomass extrapolation is as follows:

$$B = \Sigma \ (d_i a_i)$$

where:

B = Biomass (kg) for a grid area
d_i = density (kg/m^2) for a one minute interval
a_i = area (m^2) sampled by a one minute interval

In this equation, a_i is effectively constant. Variation in B, between consecutive surveys of a grid is attributable to variation in d_i. Therefore, an alternate equation is:

$$B = A * (\Sigma \ d_i)/n$$

where:

A = $\Sigma \ a_i$ = total area (m^2) of a grid
n = number of one minute density measurements within a grid

We used the estimate of the standard error of d_i to make estimates of error of B. The mean density, standard error and 95 percent confidence limits were calculated for each grid and these values were then multiplied by the total survey area of the grid. The resulting biomass estimates and their standard errors (Table 5) were plotted in Figure 11. Biomass estimates came to within 0.3-3.0 percent of those calculated in Appendix Table 2 using stratified sampling.

The confidence intervals around the **total** biomass estimates for each of the Queen Charlotte Islands and Browning Entrance areas were calculated by summing the weighted density variances (Bevington, 1969) of each of the respective maximum biomass grids in those areas. The basic equation is as follows:

$$\Sigma \ (D_i * (A_i/A_t)) = D_t$$

where:

D_i = $(\Sigma \ d_i)/n$ = mean density (kg/m^2) of one grid
A_i = total area (m^2) of one grid
A_t = total area (m^2) of all maximum biomass grids

D_t = density (kg/m^2) of all maximum biomass grids

The weighted variances of the densities in the above equation were summed as follows:

$$\Sigma \ (\sigma^2_{Di} * (A_i/A_t)^2) = \sigma^2_{Dt}$$

where:

σ^2_{Di} = variance of D_i for one grid
σ^2_{Dt} = variance of D_t for all maximum biomass grids

Standard errors (Fig. 11) and 95 percent confidence intervals were computed from the total density variances. The biomass estimates and 95 percent CI's were 10,600 t ± 2,432 t for the Queen Charlotte Islands area and 14,000 t ± 1,550 t for the Browning Entrance area.

CONCLUSIONS

Overwintering Hecate Strait herring were in the same areas as previous winter surveys: 1984 (Kieser et al. 1987) and 1985-1992 (McCarter et al. 1987, 1988, 1989, 1991, 1992, 1993). In the Prince Rupert District, annual acoustic biomass estimates have fluctuated between 12,500 t and 32,000 t based on 1984-1993 winter hydroacoustic surveys (Table 4). In the Queen Charlotte Island area these estimates fluctuated between 10,000 t and 33,000 t during the same period. Other assessment methods based on spawn surveys and analyses of catch and age structure (Schweigert, et al. 1994) show similar fluctuations during these years (Fig. 10). Error analysis of hydroacoustic estimates has shown that much of the fluctuation, particularly in the Queen Charlotte Islands, may be attributable to sampling errors due to variable herring school configurations. More effort must be expended to ensure complete and consistent coverage of overwintering herring schools. Transect grids should be predetermined and well thought out, in advance of a survey. The high standard errors resulting from selected and shortened transects (i.e. the second and third coverage of the modified P-grid) in Table 5 shows the fallacy of setting a small transect grid (3-4 hour duration) over a small target area. Another source of variability is the availability of herring for acoustic detection. Depth coverage limitations of the present echo integration system require a survey design that coincides with the diurnal migration patterns of herring at all locations. It is not always possible to plan a survey so that herring schools are consistently in an amenable configuration for echo integration. For this reason we rely on repeated and timely surveys of several, small transect grids (6-8 hour durations) as opposed to single, large coverage surveys (day and night continuous sounding).

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Table 1. Summary of herring biomass estimates (t) for each survey grid conducted during W. E. RICKER cruise, November 22-December 2, 1993.

Grid	Event Number	Transects	Survey Area (km^2)	Estimated Biomass (t)	Time (PST)	Date (D/M/Y)
Juan Perez Sound (incomplete)	23-37	J1-J9	54.1	944	10:23-14:25	24.11.93
Juan Perez Sound	38-62	J1-J14	101.2	4,590	16:06-23:19	24.11.93
Juan Perez Sound	65-89	J1-J14	105.1	3,990	00:31-07:54	25.11.93
Juan Perez Entr.	89-100	P7,6,4,2,1	26.3	736	07:54-10:29	25.11.93
Juan Perez Sound	103-128	J1-J14	104.0	6,240[a]	23:50-24:00 00:00-06:59	25.11.93 26.11.93
Juan Perez Entr.	131-144	P6,7,8,9,5,10	45.6	4,640	07:49-11:41	26.11.93
Juan Perez Entr.	145-156	P9-P4	42.7	4,710[a]	18:47-22:30	26.11.93
Juan Perez Entr.	157-169	P9-P4	41.7	331	22:49-24:00 00:00-02:06	26.11.93 27.11.923
Bonilla ground	2-19	B9-B1	146.8	4,580[a]	10:41-16:20	27.11.93
Whiterocks ground	20-34	W10-W16	158.2	601[a]	16:40-22:47	27.11.93
Browning inshore	35-46.1	E6-E1	163.5	956[a]	22:56-24:00 00:00-04:40	27.11.93 28.11.93
Freeman ground	47-63	F1-F8	250.9	2,820	04:40-13l26	28.11.93
Bonilla ground	65-83	B9-B1	187.3	4,120	18:41-24:00 00:00-01:41	28.11.93 29.11.93
Whiterocks ground	84-907	W10-W16	162.1	227	01:59-07:52	29.11.93
Freeman ground	98-115	F1-F8	259.2	7,850[a]	08:35-17:34	29.11.93
Browning inshore	117-129	E6-E1	167.5	537	23:56-24:00 00:00-06:18	29.11.93 30.11.93

[a]Maximum biomass estimate (summed to estimate total biomass for area)

Table 2. Midwater trawling locations and species compositions of catches made by the W. E. RICKER, November 22 - December 2, 1993.

Tow number	1	2	3	4	5
Date (Day/Mo.)	25/11	26/11	26/11	29/11	29/11
Time (P.S.T.)	20:38	12:53	14:40	19:00	21:38
Duration (min)	30	7	45	13	35
Location	Juan Perez	Juan Perez	Juan Perez	Freeman	Freeman
Start					
Latitude (o ')	52 33.4	52 29.6	52 29.9	53 50.0	53 48.5
Longitude (o ')	131 33.9	131 18.2	131 18.7	130 48.5	130 50.9
Finish					
Latitude (o ')	52 32.9	52 29.5	52 29.7	53 49.4	53 49.9
Longitude (o ')	131 31.3	131 17.5	131 14.3	130 49.4	130 48.9
Bottom depth (m)					
Start	180	127	140	93	96
Finish	212	112	106	94	94
Net depth (m)					
Start	80	95	95	60	60
Finish	85	100	100	70	70
Speed (kts)	3-4	3-4	3-4	3-4	3-4
Warp length (m)	180	250	250	200	200
Spiny dogfish (juven)	40	-	-	-	-
Spiny dogfish (adult)	-	-	20	3	-
Pacific herring	20	1200	300	350	1000
Walleye pollock	4	10	-	10	-
Rockfish	2	10	15	-	-
English sole	-	-	-	-	8
Total catch (kg)	66	1220	335	363	1008

Table 3. Size (mm) and sex frequency of Pacific herring samples from midwater trawl catches achieved during W. E. RICKER cruise, November 22 - December 2, 1993.

Sample	#1		#2		#3		#4		#5	
Location	Juan Perez		Juan Perez		Juan Perez		Freeman		Freeman	
Date	25.11.93		26.11.93		26.11.93		29.11.93		29.11.93	
Time	20:38		12:53		14:40		19:00		21:38	
Length (mm)	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
135-158	-	-	-	-	1	1	2	-	2	1
159-161	-	-	-	-	1	0	0	1	0	0
162-164	-	1	-	-	4	1	0	1	0	0
165-167	-	0	-	-	1	0	0	0	1	0
168-170	-	0	-	-	1	2	0	0	0	0
171-173	-	0	-	-	2	2	1	0	1	2
174-176	-	0	-	-	0	1	1	0	1	0
177-179	-	0	-	-	0	0	1	1	1	2
180-182	-	0	-	-	2	0	5	3	2	1
183-185	-	0	-	-	0	1	4	2	2	2
186-188	-	0	1	-	0	0	5	6	5	4
189-191	-	0	0	-	2	2	3	2	8	6
192-194	-	0	0	-	1	1	6	4	2	3
195-197	-	0	2	-	2	0	6	4	5	11
198-200	3	1	4	2	6	2	7	8	3	6
201-203	3	4	4	0	8	3	4	1	1	9
204-206	1	7	3	3	3	4	4	5	2	2
207-209	3	6	14	7	4	10	4	3	2	2
210-212	6	5	2	5	7	1	3	3	1	4
213-215	9	5	4	3	8	9	-	1	2	0
216-218	1	5	2	7	2	2	-	0	0	0
219-221	5	9	7	6	-	0	-	0	1	2
222-224	0	1	4	1	-	0	-	1	-	1
225-227	2	5	2	5	-	0	-	1	-	-
228-230	1	3	2	3	-	2	-	-	-	-
231-233	0	4	1	2	-	1	-	-	-	-
234-236	2	3	1	1	-	-	-	-	-	-
237-239	2	0	1	1	-	-	-	-	-	-
240-242	0	1	-	-	-	-	-	-	-	-
243-245	0	0	-	-	-	-	-	-	-	-
246-248	1	0	-	-	-	-	-	-	-	-
249-251	-	1	-	-	-	-	-	-	-	-
Total	39	61	54	46	55	45	53	47	52	48

Table 4. Comparison of 1985-1994 stock size and forecasted stock size using age-structured and escapement models with the stock estimate using winter hydroacoustic surveys. A dash indicates no winter hydroacoustic surveys conducted. All estimates are in tonnes. The winter surveys are conducted during November-December in the previous year (i.e. 1994 winter survey was conducted in Nov-Dec 1993). Biomass estimates are plotted in Figure 10.

Year	Queen Charlotte Islands				Prince Rupert District			
	Forecast		Stock size		Forecast		Stock size	
	age	escap.	winter survey	catch+ spawners	age	escap.	winter survey	catch+ spawners
1985	31000	31700	-	23830	33000	26400	31500	38740
1986	21300	8000	9500	10222	38000	32888	32000	38865
1987	20700	5500	-	17338	31300	21000	-	44411
1988	15000	11000	15500	16802	44500	31800	15300	40060
1989	19100	11700	16200	27283	47100	28100	25900	21405
1990	48400	22100	-	32076	57400	14800	-	24087
1991	25600	20900	32600	19954	60700	19400	15200	24141
1992	19600	16600	9800	13230	87700	30500	31500	42254
1993	22600	12800	21400	9500	126800	55100	12500	27594
1994	20300	9600	11000	?	86200	33400	14000	?

Table 5. The number, mean, standard deviation and standard error of averaged density measurements (g/m^2) from each grid coverage during W. E. RICKER cruise, November 22-Decemember 2, 1993. The grid area (m^2), extrapolated biomass (t) and standard error (t) of the biomass are calculated. Maximum biomass estimates and associated standard errors are plotted in Figure 11.

Grid	Coverage	n	Mean g/m^2	Std g/m^2	SE g/m^2	Area m^2	Biomass t	SE t
J[a]	-	222	17.100	74.510	5.000	54233156	927.39	271.17
J	first	402	46.130	140.380	7.000	101091696	4663.36	707.64
J	second	416	38.210	142.610	6.990	105124256	4016.80	734.82
P[a]	first	120	28.000	91.070	8.310	26434522	740.17	219.67
J	third	410	58.370	185.120	9.140	103908640	6065.15[b]	949.72
P[a]	second	187	102.000	319.800	23.400	45638836	4655.16[b]	1067.95
P[a]	third	213	106.200	568.600	39.000	42677588	4532.36	1664.43
P[a]	fourth	177	7.920	29.900	2.250	41780264	330.90	94.01
B	first	282	30.910	118.020	7.030	146664640	4533.40[b]	1031.05
W	first	317	3.790	27.980	1.570	157814768	598.12[b]	247.77
E	first	316	5.791	15.723	0.884	163421520	946.37[b]	144.46
F	first	477	10.870	56.510	2.590	250693760	2725.04	649.30
B	second	357	21.640	115.560	6.120	187120688	4049.29	1145.18
W	second	292	1.447	4.258	0.249	161919664	234.30	40.32
F	second	488	30.400	90.670	4.100	259028864	7874.48[b]	1062.02
E	second	350	3,183	4.367	2.333	167288048	532.48	38.98

[a]Incomplete coverage of transect grid
[b]Maximum biomass estimate (summed to estimate total biomass for area)

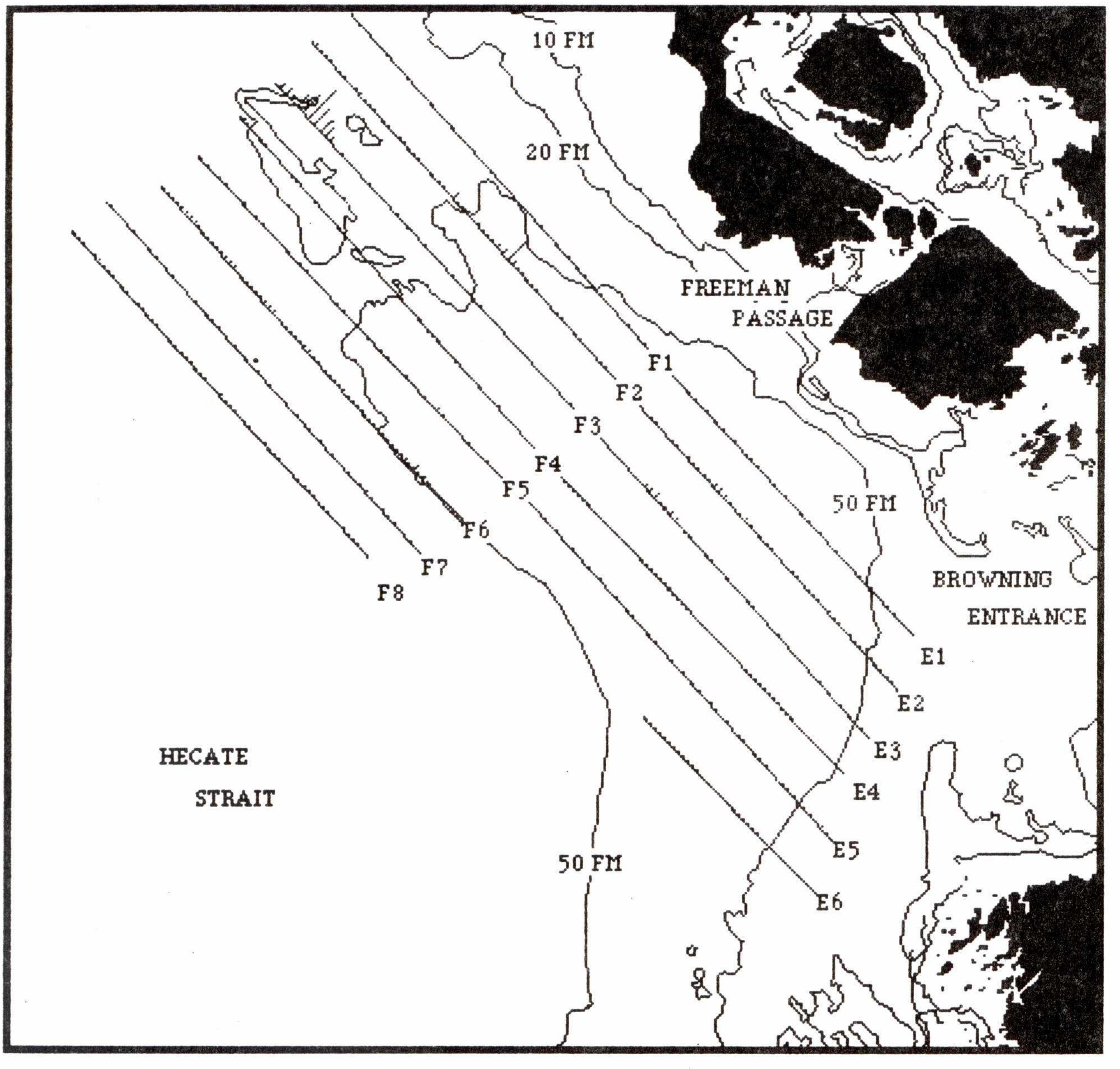


Fig. 1. Transect locations and histograms of herring distributions in northern Browning Entrance during W. E. RICKER cruise 93HER, November 22 - December 2, 1993. The histograms were plotted along transects at one minute intervals using a linear scale of 0.01 to 1.0 kg/m^2. F1-F8 Freeman grid and E1-E6 Browning Entrance inshore grid (first coverages).

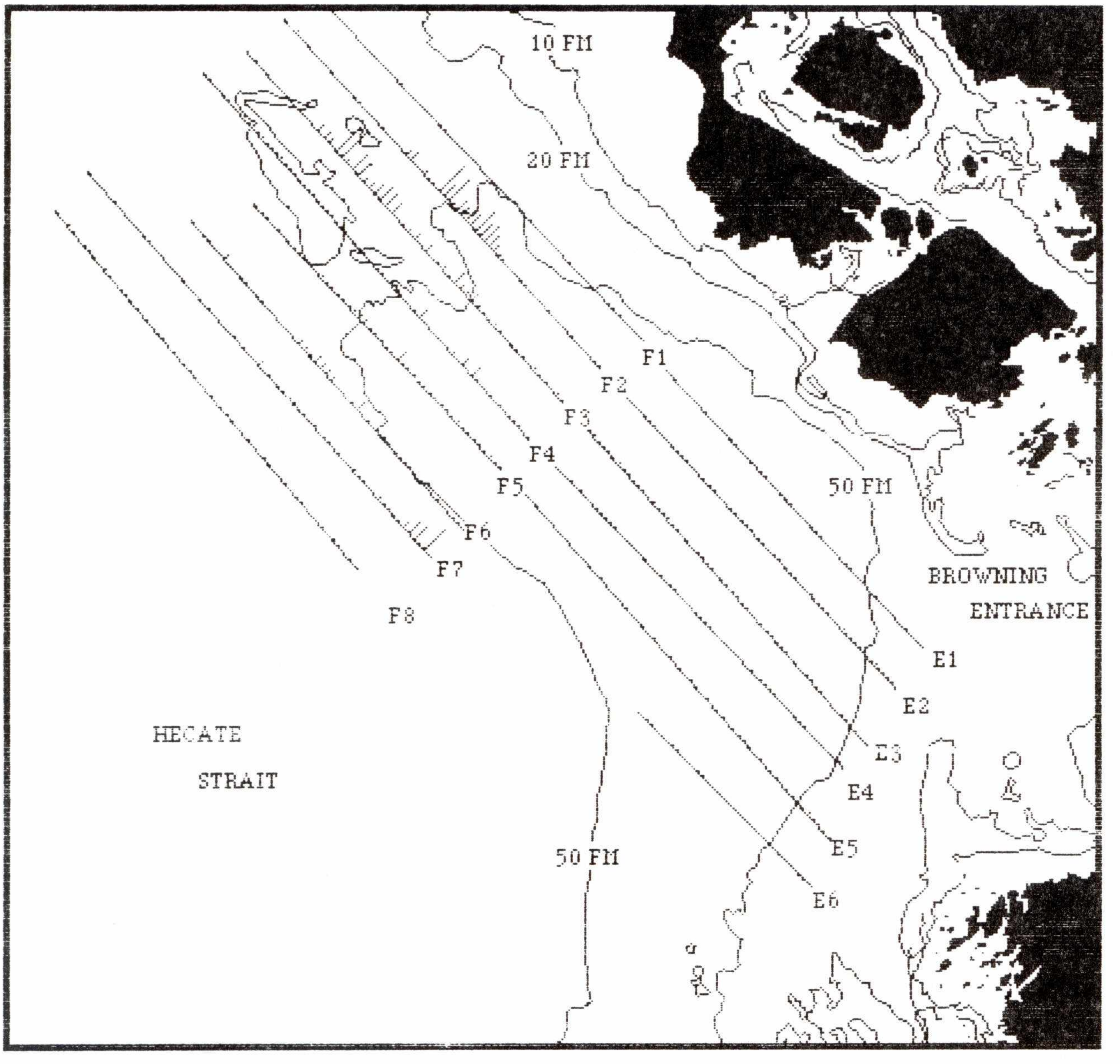


Fig. 2. Transect locations and histograms of herring distributions in northern Browning Entrance during W. E. RICKER cruise 93HER, November 22 - December 2, 1993. The histograms were plotted along transects at one minute intervals using a linear scale of 0.01 to 1.0 kg/m^2. F1-F8 Freeman grid and E1-E6 Browning Entrance inshore grid (second coverages).

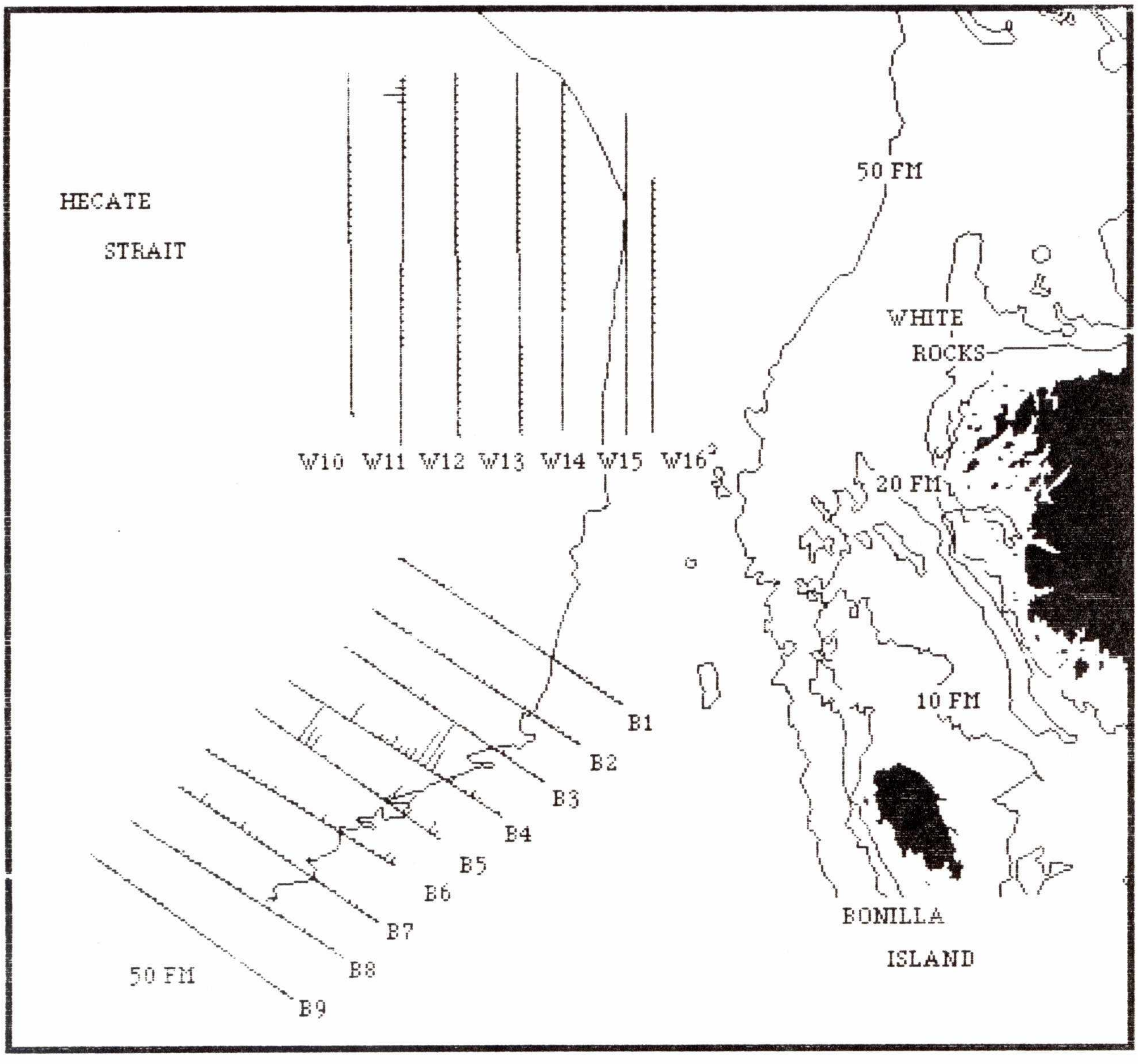


Fig. 3. Transect locations and histograms of herring distributions in southern Browning Entrance during W. E. RICKER cruise 93HER, November 22 - December 2, 1993. The histograms were plotted along transects at one minute intervals using a linear scale of 0.01 to 1.0 kg/m^2. B1-B9 Bonilla grid and W10-W16 Whiterocks grid (first coverages).

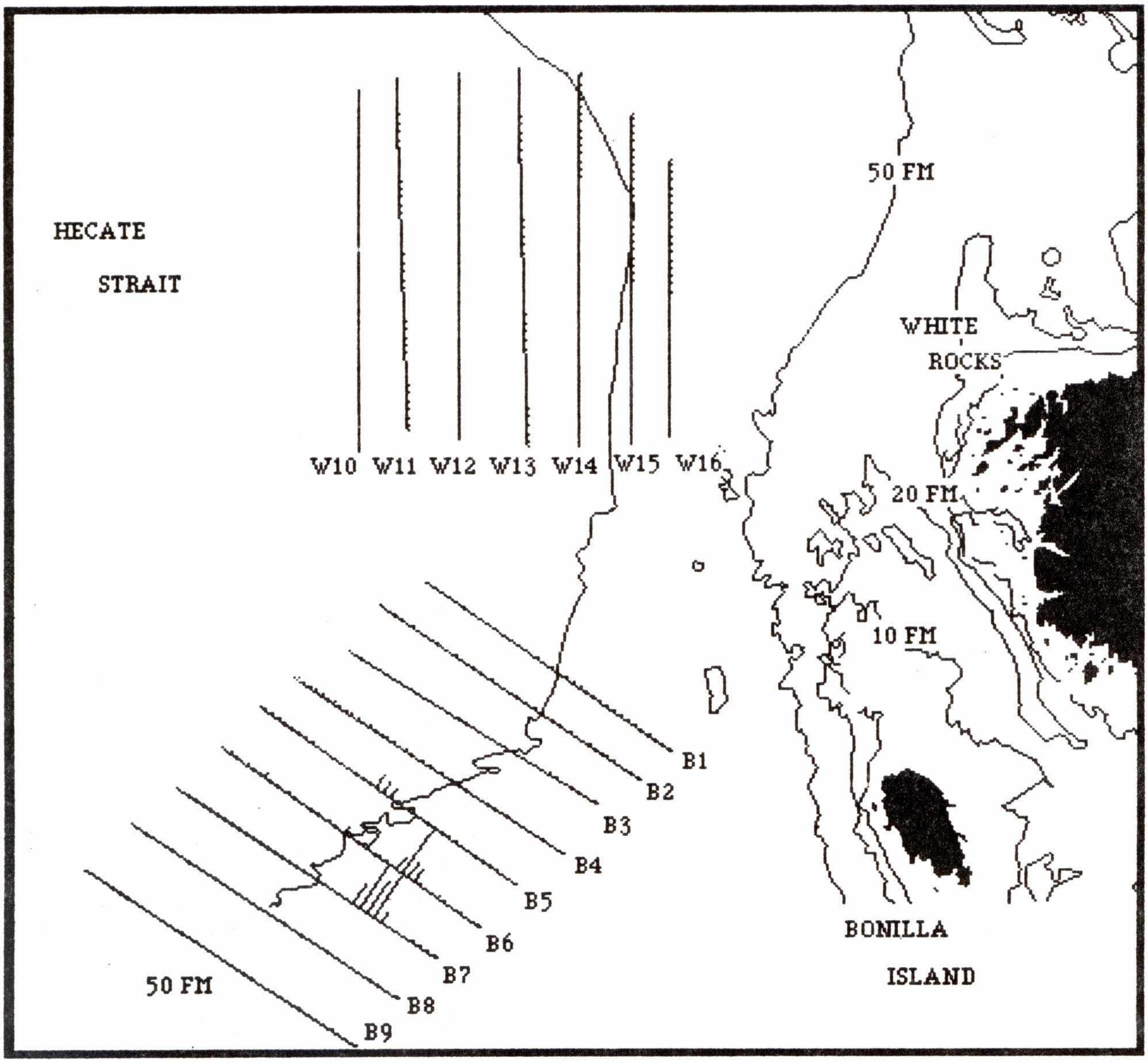


Fig. 4. Transect locations and histograms of herring distributions in southern Browning Entrance during W. E. RICKER cruise 93HER, November 22 - December 2, 1993. The histograms were plotted along transects at one minute intervals using a linear scale of 0.01 to 1.0 kg/m^2. B1-B9 Bonilla grid and W10-W16 Whiterocks grid (second coverages).

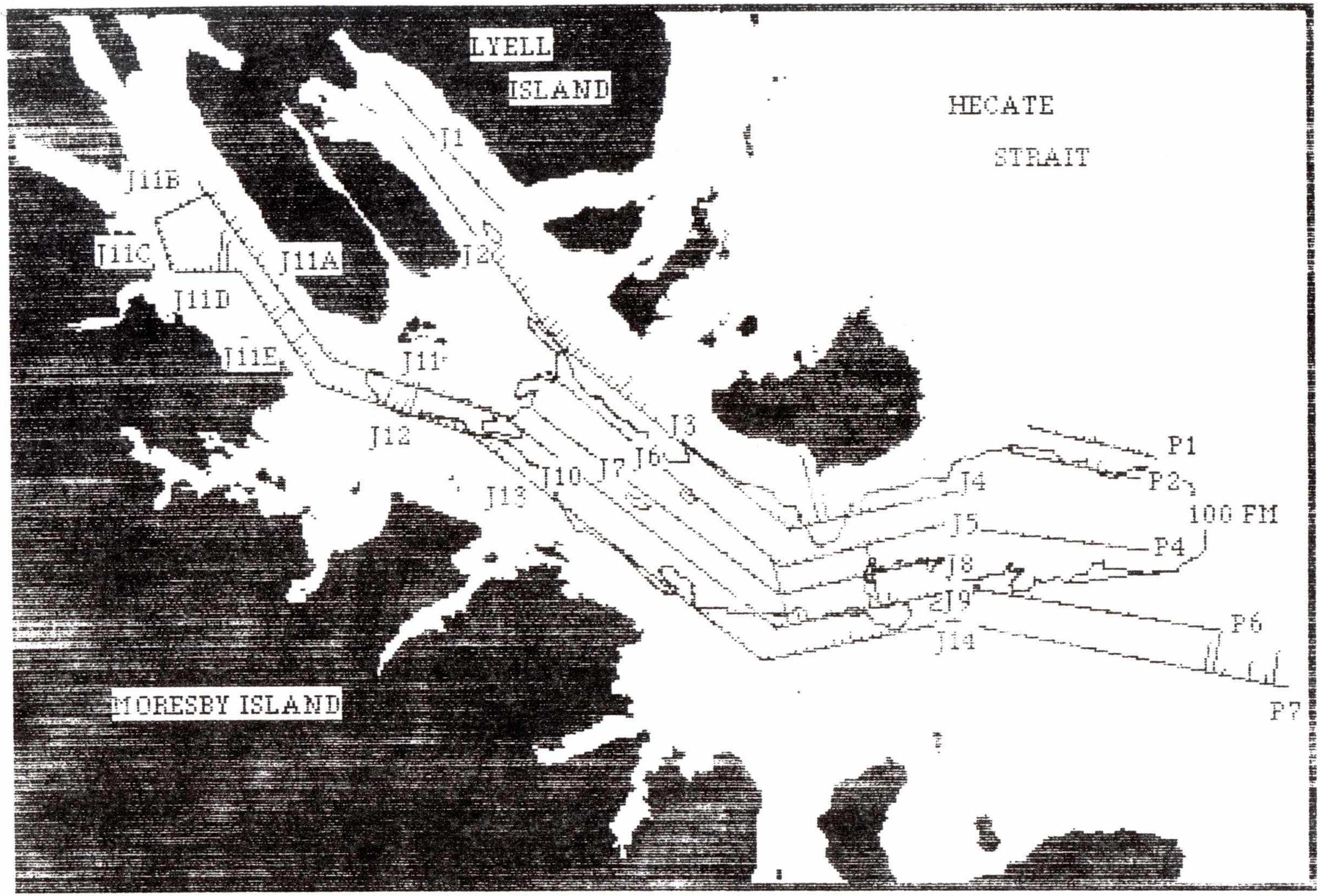


Fig. 5. Transect locations and histograms of herring distributions in Juan Perez Sound during W. E. RICKER cruise 93HER, November 22 - December 2, 1993. The histograms were plotted along transects at one minute intervals using a linear scale of 0.01 to 1.0 kg/m^2. J1-J14 Juan Perez Sound grid and P7,6,4,2,1 Juan Perez Sound entrance grid (first coverages).

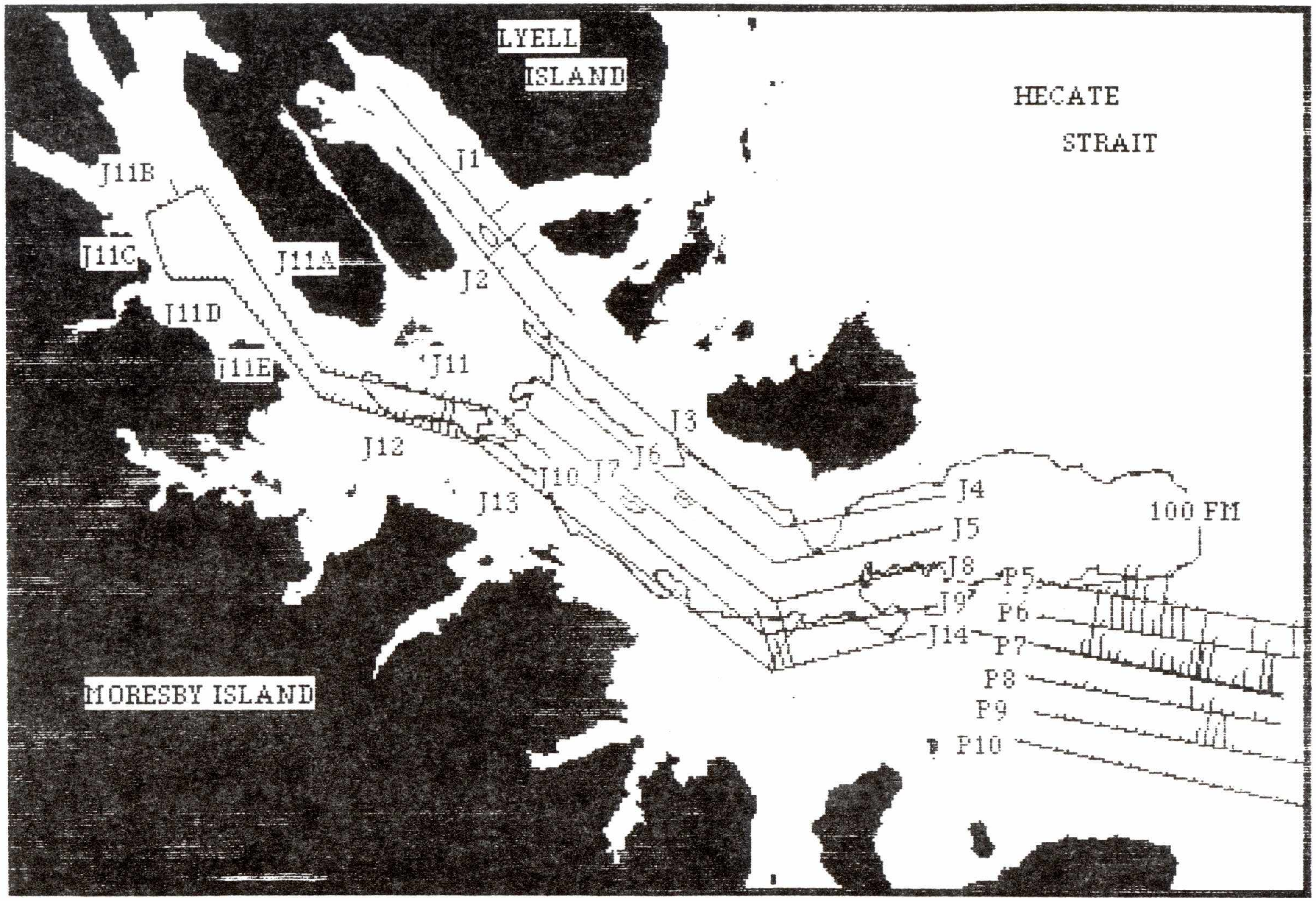


Fig. 6. Transect locations and histograms of herring distributions in Juan Perez Sound during W. E. RICKER cruise 93HER, November 22 - December 2, 1993. The histograms were plotted along transects at one minute intervals using a linear scale of 0.01 to 1.0 kg/m^2. J1-J14 Juan Perez Sound grid and P6,7,8,9,5,10 Juan Perez Sound entrance grid (second coverages).

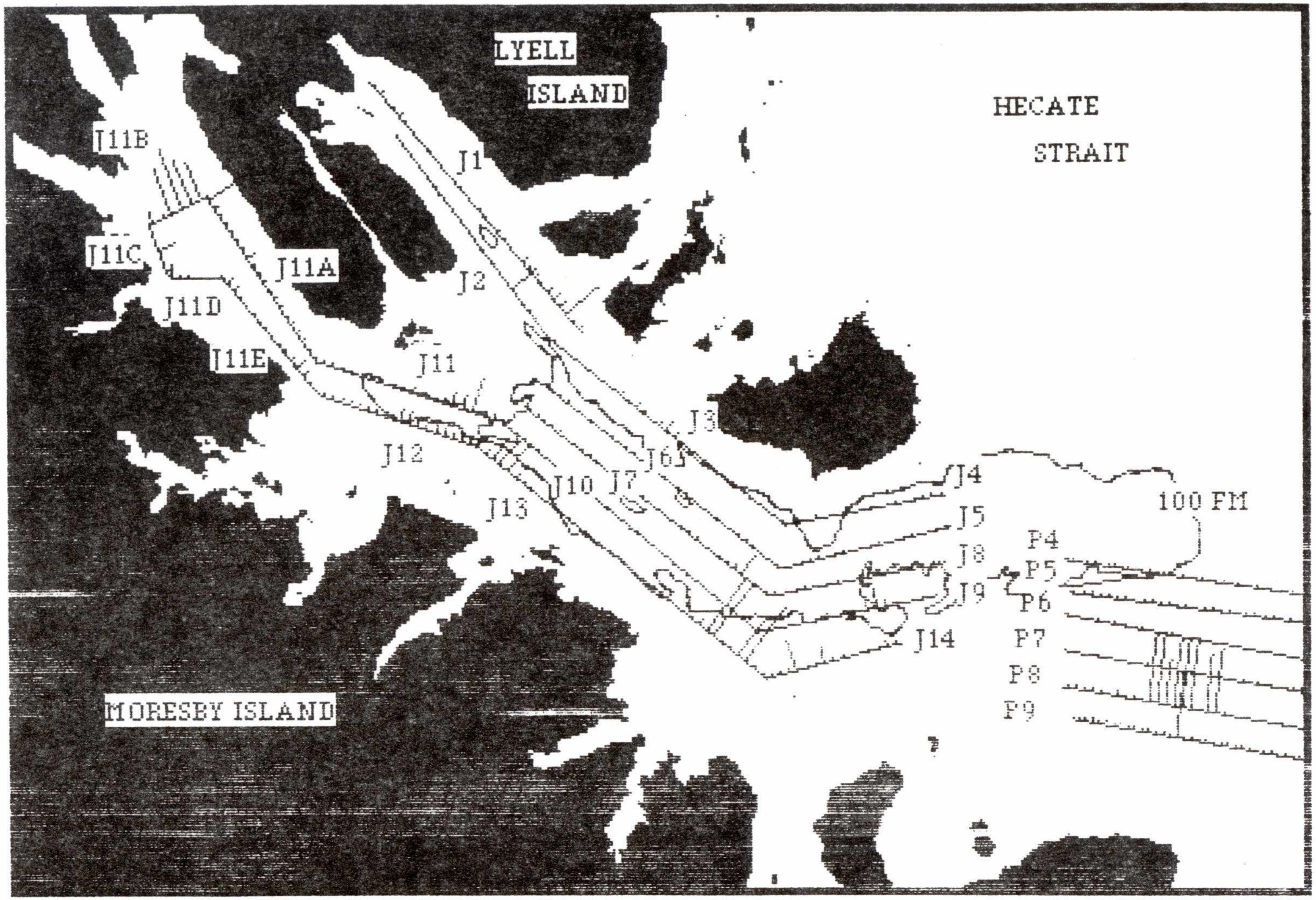
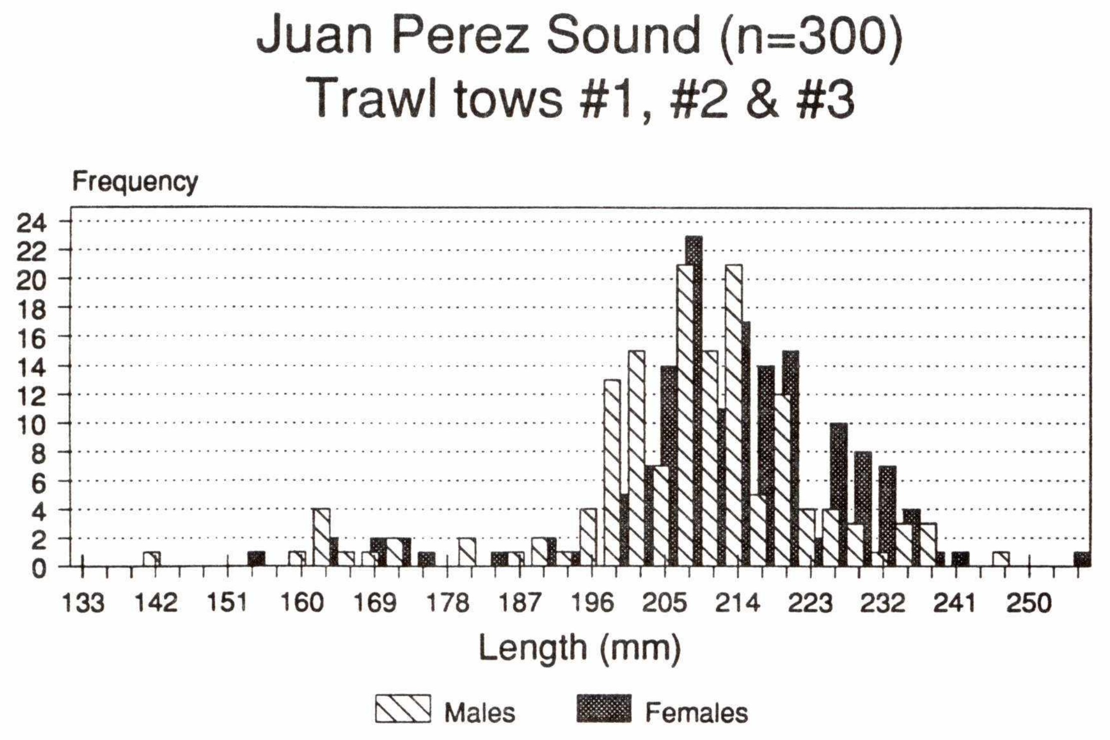


Fig. 7. Transect locations and histograms of herring distributions in Juan Perez Sound during W. E. RICKER cruise 93HER, November 22 - December 2, 1993. The histograms were plotted along transects at one minute intervals using a linear scale of 0.01 to 1.0 kg/m^2. J1-J14 Juan Perez Sound grid and P7-P4 Juan Perez Sound entrance grid (third coverages).



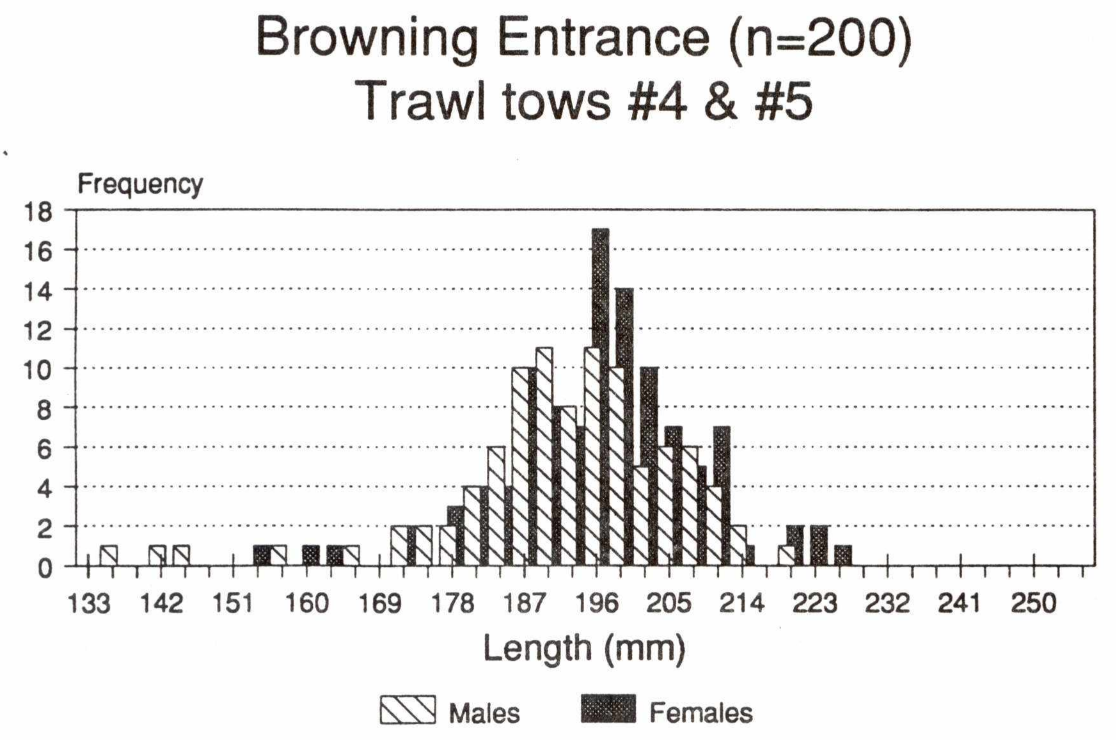


Fig. 8. Length frequency histograms of Pacific herring samples collected during W. E. RICKER cruise 93HER, November 22 - December 2, 1993.

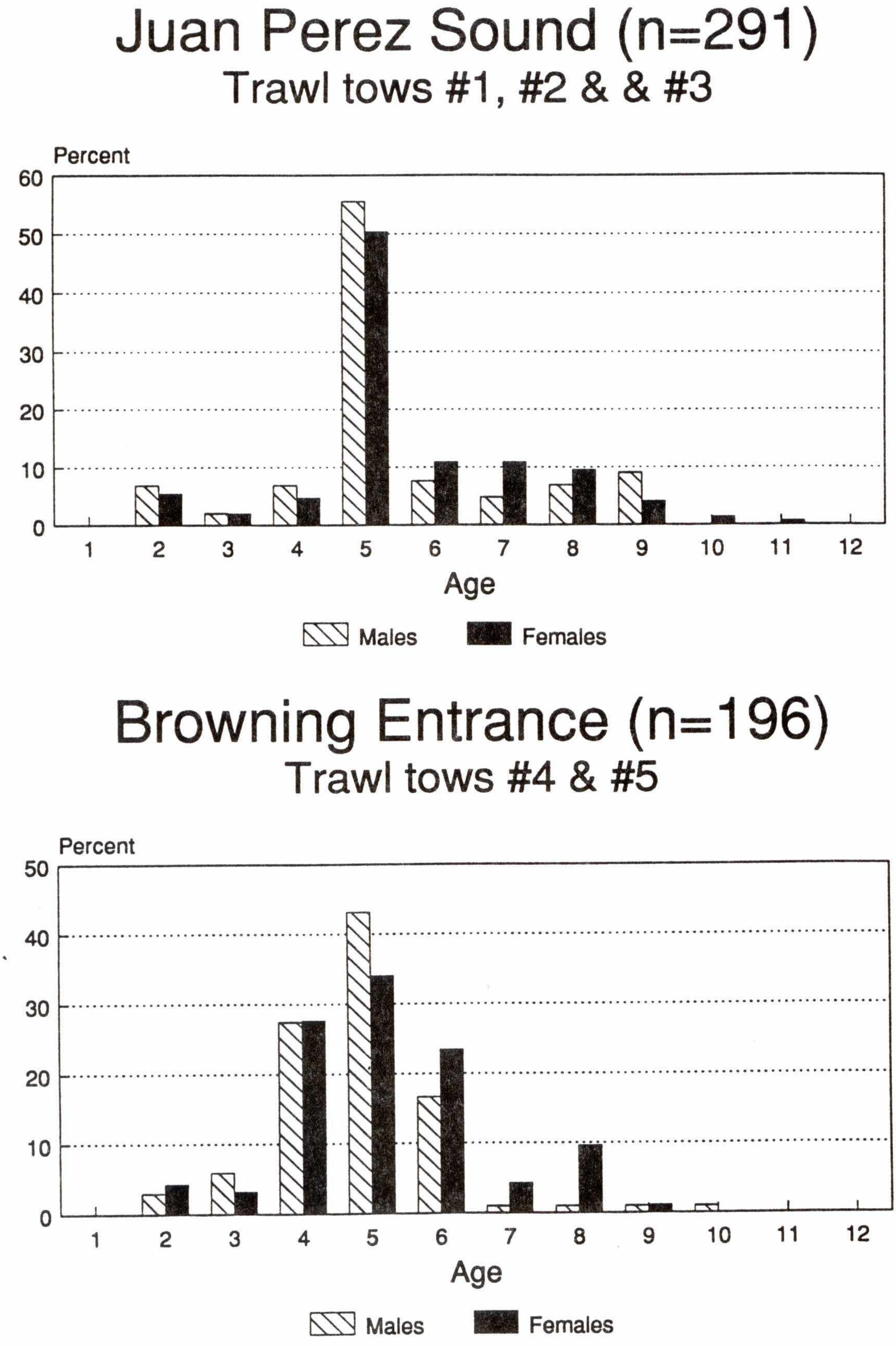
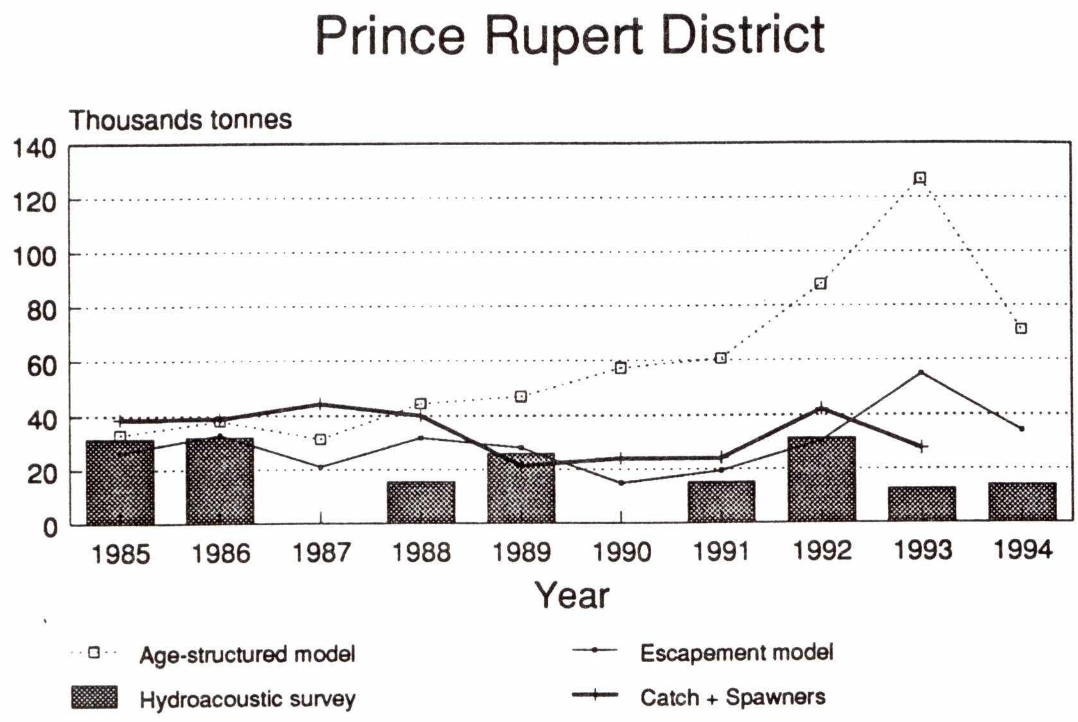


Fig. 9. Age composition of Pacific herring samples collected during W. E. RICKER cruise 93HER, November 22 - December 2, 1993.



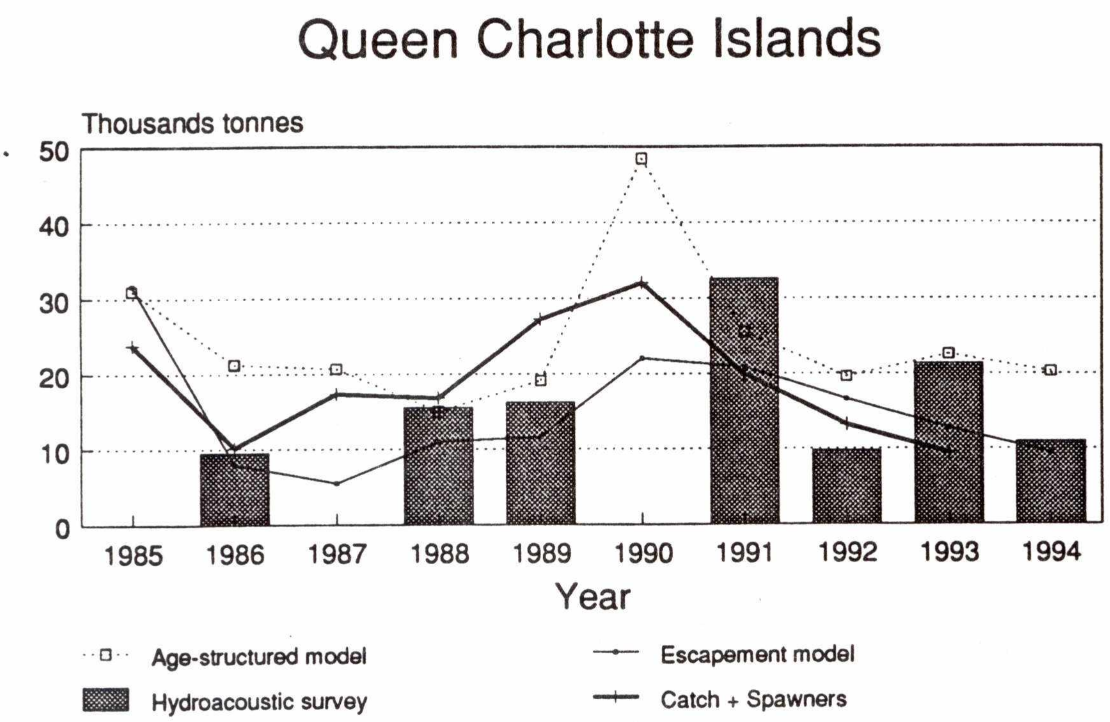
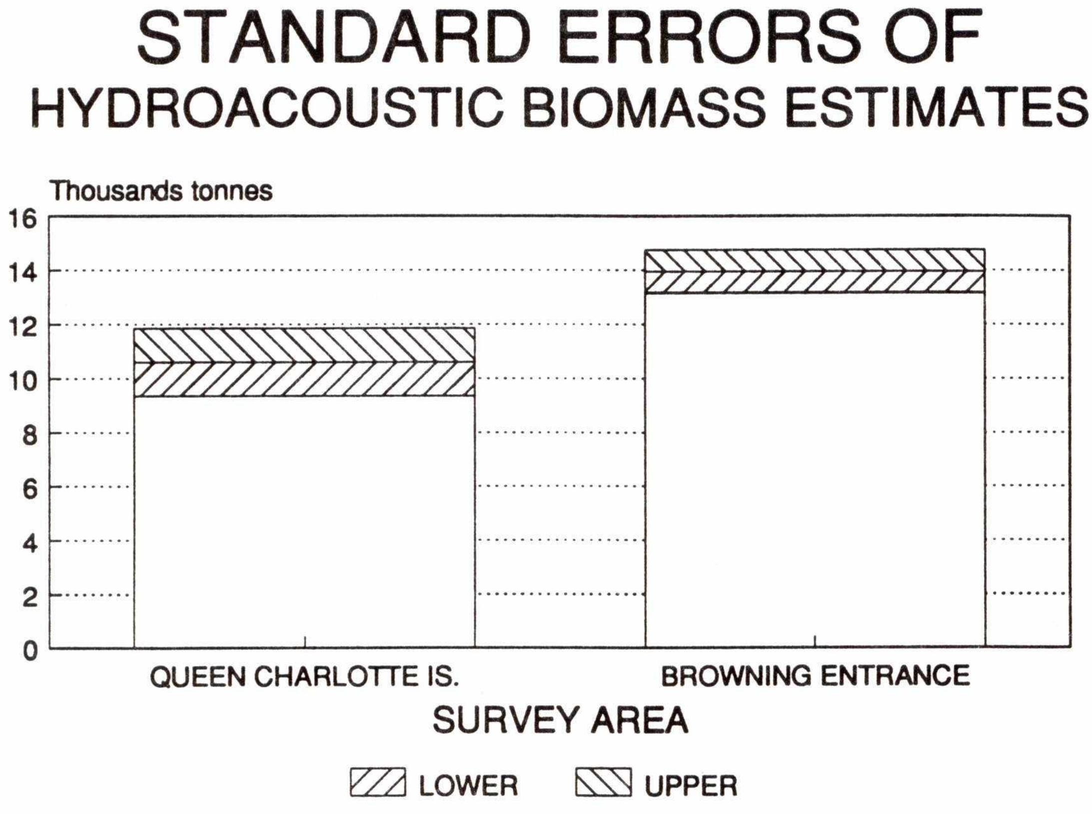


Fig. 10. A comparison of hydroacoustic biomass estimates with **forecasted** stock biomass from age-structured and escapement models in the Prince Rupert and Queen Charlotte Island Districts for 1985-1994.



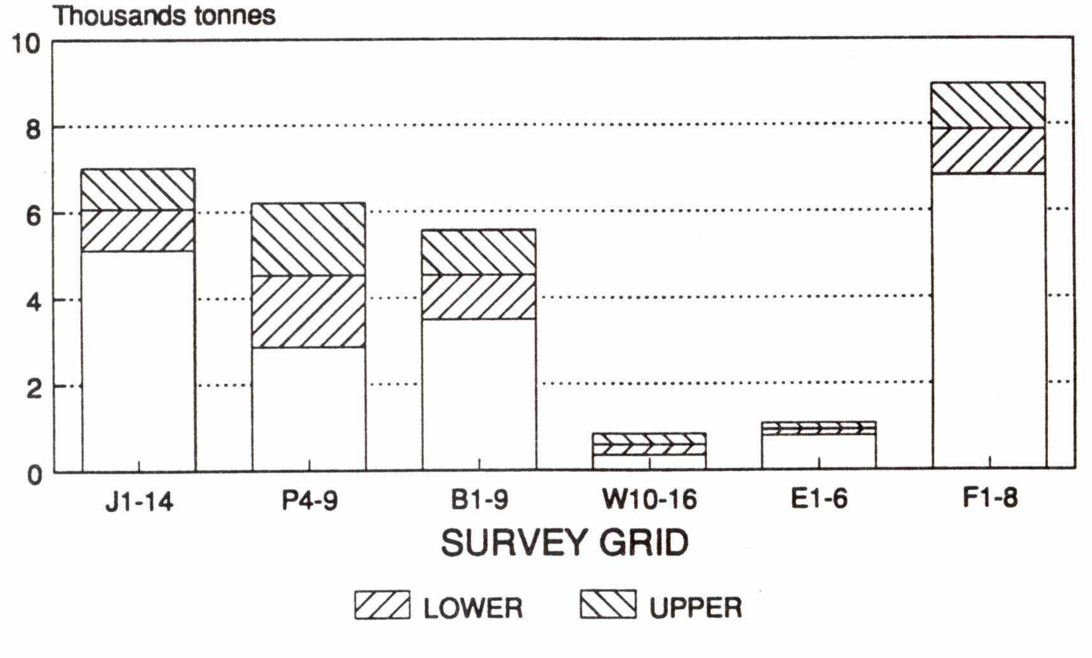


Fig. 11. Hydroacoustic biomass estimates and standard errors for each maximum biomass grid and survey area during W. E. RICKER cruise 93HER, November 22 - December 2, 1993. Standard errors calculated are **only** those associated with random sampling and do not include those attributable to uncertainties of target strength and system calibration.

Appendix Table 1. Cruise schedule of the W. E. RICKER, November 22 - December 2, 1993.

Date	Time	Activity
22 Nov	08:00	Load D-5 midwater trawl net, sweeplines and supplies
	11:00	K. Cooke prepares for transducer calibration
	12:30	Scientific party, D. Hay, B. McCarter, P. Withler and J. Proctor board W. E. RICKER at PBS, Nanaimo
	12:45	Start dockside transducer calibration attempt
	15:30	W. E. RICKER depart Departure Bay, Nanaimo
24	08:15	Deploy towed sled transducer in Juan Perez Sound
	10:23	Commence transects J1-J9 (Juan Perez Sound)
	16:06	Commence transects J1-J14 (Juan Perez Sound)
25	00:31	Commence transects J1-J14 (Juan Perez Sound)
	07:54	Commence transects P7,6,4,2,1 (Juan Perez - entrance)
	20:38	Commence trawling fishing tow #1 in Juan Perez Sound
	23:50	Commence transects J1-J14 (Juan Perez Sound)
26	07:49	Commence transects P6,7,8,9,5,10 (Juan Perez - entrance)
	12:53	Commence trawling fishing tow # 2 (Juan Perez - entrance)
	14:40	Commence trawling fishing tow # 3 (Juan Perez - entrance)
	18:47	Commence transects P9-P4 (Juan Perez - entrance)
	22:49	Commence transects P9-P4 (Juan Perez - entrance)
27	02:25	Proceed to Browning Entrance
	10:41	Commence transect B9-B1 (Bonilla ground)
	16:40	Commence transects W10-W16 (Whiterocks ground)
	22:56	Commence transects E6-E1 (Browning Entrance - inshore)
28	04:40	Commence transects F1-F8 (Freeman ground)
	18:41	Commence transects B9-B1 (Bonilla ground)
29	01:59	Commence transects W10-W16 (Whiterocks ground)
	08:35	Commence transects F1-F8 (Freeman ground)
	19:00	Commence trawl fishing tow #4 on the Freeman ground
	21:38	Commence trawl fishing tow #5 on the Freeman ground
	23:56	Commence transects E6-E1 (Browning Entrance - inshore)
30	07:00	Proceed to PBS via inside Passage
01	13:00	Re-run several portions of analog data through integrator
02	08:00	W. E. RICKER return Departure Bay, Nanaimo
		Offload fishing gear, equipment and samples

Appendix Table 2. Parameter and biomass summary of W. E. RICKER cruise, November 22 - December 2, 1993. The event number, transect name, transect length, extrapolated area, volume density, surface density and total biomass are given for each transect. The total number of transects, total extrapolated area and total biomass is summed for each transect grid pattern. A Coefficient of variation is given for each grid. Parameters used for biomass estimation are described as follows:

Current parameters	Description
IDA 93HER01.N89	Input echo integration file (file name)
TLL 87.98	Transmit level (dB) re 1 uPascal (combined)
	! Univ. of Wash. calibrations, July, 1993.
RSS 0	Receiver sensitivity (dB) re 1 Volt/uPascal
BFF -17.55	Beam factor (dB)
REF 1.0	Reference range for receiver TVG (m)
ALP .0099	Absorption coefficient for receiver TVG (dB/m)
SOU 1490.0	Speed of sound in water (m/sec)
TAU 0.6	Pulse length (m/sec)
GAI -0.51 -12.0	Bandpass (dB) Receiver gain (dB)
TVC 0,0	Near range and TVG correction factor (dB)
TVG 20,0.0099 20,0.0099	Time varied gain = 20 log R + 2*ALP*R
TSS -32.0	Target strength (dB/Kg)
MME 0,100	Min. & max. accepted integration value (V^2)
DEP 25,200	Min. & max. depth strata or window (m)
	! Also used DEP 25,140 in Juan Perez Sound
UNI NM	Units for DPP and WID: km or nm
DPP 0.001	Distance per ping (UNI/ping)
WID 1.0	Width of transects (nm)
	! Also used widths of 0.5, 0.3 and 0.25
FRA 1	Fraction of total biomass for species
AVE 1	Number of Sequences to be averaged
! FIR	First Sequence chosen
! LAS	Last Sequence chosen
EVE 3 13:54 53 41.0 130 40.4	Event number, Time, Position (Lat./Long.)
DAT 30-NOV-93	Date DD-MMM-YY
TRA E5 48 95 2880 7.5 317 0.7 9	T-name Seq1 Seq2 Pit Dis Bea TimeD Speed
LOU	Zero 1. cumulative biomass output
ZER	Zero 1. and 2. cumulative biomass output
EXI	Close files, exit

Appendix Table 2 (cont'd).

EVE #	TRA $	Len km	Area km^2	Vol D kg/m^3	Surf D kg/m^2	Biomass t	# #	Area km^2	Biomass t	C.V. %
23.0	J1	8.7	8.0	1.64E-04	1.68E-02	1.35E+02	JUAN PEREZ SOUND			
25.0	J2	7.0	6.5	6.25E-04	5.84E-02	3.80E+02	INCOMPLETE COVERAGE			
28.0	J3	8.7	8.1	3.24E-04	3.26E-02	2.63E+02				
29.0	J4	4.7	4.3	8.73E-05	8.63E-03	3.74E+01				
30.0	J5	5.3	4.9	1.55E-05	1.72E-03	8.38E+00				
31.0	J6	8.0	7.4	6.57E-05	7.28E-03	5.37E+01				
33.0	J7	8.8	8.1	5.87E-05	6.50E-03	5.29E+01				
34.0	J8	5.1	4.7	1.92E-05	2.13E-03	1.00E+01				
36.0	J9	2.3	2.1	1.66E-05	1.83E-03	3.93E+00	9	54.1	944	14
38.0	J1	5.1	4.7	1.99E-04	1.99E-02	9.44E+01	JUAN PEREZ SOUND			
40.0	J2	7.4	6.9	7.02E-04	6.27E-02	4.31E+02	FIRST COVERAGE			
41.0	J3	8.4	7.8	4.30E-04	4.94E-02	3.86E+02				
42.0	J4	4.9	4.6	1.07E-03	1.16E-01	5.32E+02				
44.0	J5	4.8	4.5	5.02E-05	6.56E-03	2.94E+01				
45.0	J6	8.7	8.1	1.66E-04	2.17E-02	1.75E+02				
47.0	J7	8.6	8.0	7.08E-05	9.25E-03	7.40E+01				
48.0	J8	5.0	4.6	3.53E-05	4.62E-03	2.12E+01				
50.0	J9	5.0	4.7	1.42E-03	1.68E-01	7.86E+02				
51.0	J10	9.8	9.1	6.87E-05	8.87E-03	8.05E+01				
52.0	J11	5.2	4.8	3.16E-04	3.96E-02	1.92E+02				
53.0	J11A	6.1	5.6	4.71E-04	5.53E-02	3.13E+02				
54.0	J11B	1.7	1.6	7.53E-04	4.10E-02	6.37E+01				
55.0	J11C	1.5	1.4	1.23E-04	1.10E-02	1.56E+01				
56.0	J11D	2.0	1.9	1.99E-03	1.53E-01	2.85E+02				
57.0	J11E	4.0	3.7	8.30E-04	9.59E-02	3.52E+02				
58.0	J12	4.6	4.2	1.01E-03	1.04E-01	4.37E+02				
60.0	J13	10.5	9.7	1.72E-04	2.04E-02	1.98E+02				
61.0	J14	5.7	5.3	2.44E-04	2.37E-02	1.25E+02	19	101.2	4591	5
65.0	J1	8.8	8.1	8.02E-04	2.81E-02	2.28E+02	JUAN PEREZ SOUND			
67.0	J2	7.1	6.6	6.09E-04	5.53E-02	3.63E+02	SECOND COVERAGE			
68.0	J3	8.5	7.9	1.86E-04	2.02E-02	1.59E+02				
69.0	J4	4.7	4.3	1.38E-04	1.27E-02	5.53E+01				
71.0	J5	4.9	4.5	9.42E-05	1.22E-02	5.48E+01				
72.0	J6	8.5	7.8	8.90E-05	1.15E-02	9.03E+01				
74.0	J7	8.7	8.0	6.96E-05	9.01E-03	7.23E+01				
75.0	J8	5.1	4.7	7.96E-05	1.03E-02	4.88E+01				
78.0	J9	5.6	5.2	1.22E-04	1.49E-02	7.67E+01				
79.0	J10	9.9	9.2	7.21E-05	9.24E-03	8.49E+01				
80.0	J11	5.1	4.8	3.87E-04	4.16E-02	1.98E+02				
81.0	J11A	6.4	5.9	3.52E-04	3.91E-02	2.30E+02				
82.0	J11B	1.8	1.7	2.03E-03	7.30E-02	1.23E+02				
83.0	J11C	2.0	1.8	1.25E-04	1.41E-02	2.55E+01				
84.0	J11D	1.7	1.6	3.17E-04	2.41E-02	3.90E+01				
85.0	J11E	4.4	4.0	3.88E-04	3.95E-02	1.59E+02				
86.0	J12	4.8	4.5	1.46E-03	1.35E-01	6.03E+02				
87.0	J13	10.4	9.6	4.42E-04	5.04E-02	4.86E+02				
88.0	J14	5.3	4.9	2.01E-03	1.84E-01	8.95E+02	19	105.1	3992	6

Appendix Table 2 (cont'd).

EVE #	TRA $	Len km	Area km^2	Vol D kg/m^3	Surf D kg/m^2	Biomass t	# #	Area km^2	Biomass t	C.V. %
89.0	P7	9.2	8.5	7.40E-04	6.33E-02	5.41E+02	JUAN PEREZ ENTRANCE			
92.0	P6	7.2	6.6	8.71E-05	8.48E-03	5.63E+01	FIRST COVERAGE			
95.0	P4	4.8	4.4	4.47E-05	5.79E-03	2.57E+01				
97.0	P2	3.7	3.4	1.60E-04	1.96E-02	6.70E+01				
99.0	P1	3.6	3.4	1.78E-04	1.35E-02	4.56E+01	5	26.3	736	30
103.0	J1	9.5	8.8	5.62E-04	5.65E-02	4.99E+02	JUAN PEREZ SOUND			
107.0	J2	7.4	6.9	6.96E-04	2.44E-02	1.67E+02	THIRD COVERAGE			
108.0	J3	8.5	7.9	2.60E-04	2.97E-02	2.35E+02				
109.0	J4	4.6	4.3	1.52E-04	1.65E-02	7.04E+01				
111.0	J5	5.0	4.6	9.22E-05	1.20E-02	5.50E+01				
112.0	J6	8.6	7.9	1.01E-04	1.30E-02	1.03E+02				
114.0	J7	8.8	8.1	1.84E-04	2.39E-02	1.94E+02				
115.0	J8	5.1	4.7	1.44E-04	1.86E-02	8.74E+01				
117.0	J9	5.2	4.8	3.27E-04	3.83E-02	1.84E+02				
118.0	J10	9.5	8.8	9.32E-05	1.20E-02	1.05E+02				
119.0	J11	5.6	5.1	6.98E-04	8.22E-02	4.23E+02				
120.0	J11A	5.8	5.4	5.12E-04	6.05E-02	3.25E+02				
121.0	J11B	1.9	1.8	1.06E-02	5.48E-01	9.60E+02				
122.0	J11C	1.6	1.5	5.12E-04	5.73E-02	8.39E+01				
123.0	J11D	1.7	1.6	4.85E-04	3.66E-02	5.76E+01				
124.0	J11E	4.3	4.0	3.63E-04	3.93E-02	1.57E+02				
125.0	J12	4.7	4.4	7.50E-04	7.08E-02	3.10E+02				
126.0	J13	10.5	9.7	1.86E-03	2.09E-01	2.03E+03				
127.0	J14	4.0	3.7	9.89E-04	5.34E-02	1.95E+02	19	104.0	6241	7
131.0	P6	7.2	6.7	3.97E-03	2.83E-01	1.90E+03	JUAN PEREZ ENTRANCE			
134.0	P7	6.7	6.2	4.15E-03	3.13E-01	1.95E+03	SECOND COVERAGE			
136.0	P8	7.0	6.5	7.02E-04	4.46E-02	2.90E+02				
138.0	P9	9.1	8.4	9.73E-04	4.66E-02	3.91E+02				
140.0	P5	9.9	9.1	1.20E-04	1.27E-02	1.16E+02				
142.0	P10	9.4	8.7	1.92E-05	4.64E-04	4.04E+00	6	45.6	4651	19
145.0	P9	7.7	7.1	2.08E-03	8.26E-02	5.89E+02	JUAN PEREZ ENTRANCE			
147.0	P8	7.4	6.8	1.09E-02	5.80E-01	3.95E+03	THIRD COVERAGE			
149.0	P7	7.9	7.3	1.15E-04	6.89E-03	5.02E+01				
151.0	P6	7.8	7.2	7.26E-05	4.59E-03	3.31E+01				
153.0	P5	7.6	7.1	7.26E-05	7.50E-03	5.31E+01				
155.0	P4	7.7	7.2	3.78E-05	4.50E-03	3.22E+01	6	42.7	4708	33
157.0	P9	7.4	6.8	7.75E-05	3.22E-03	2.20E+01	JUAN PEREZ ENTRANCE			
159.0	P8	7.3	6.7	3.56E-04	2.13E-02	1.44E+02	FOURTH COVERAGE			
161.0	P7	7.4	6.9	1.27E-04	8.02E-03	5.52E+01				
164.0	P6	8.0	7.4	9.88E-05	7.05E-03	5.21E+01				
166.0	P5	7.7	7.1	5.30E-05	5.38E-03	3.82E+01				
168.0	P4	7.3	6.8	2.43E-05	2.95E-03	2.01E+01	6	41.7	332	14

Appendix Table 2 (cont'd).

EVE #	TRA $	Len km	Area km^2	Vol D kg/m^3	Surf D kg/m^2	Biomass t	# #	Area km^2	Biomass t	C.V. %
2.0	B9	9.0	16.6	3.21E-05	1.53E-03	2.54E+01	BONILLA GROUND			
4.0	B8	9.0	16.6	6.31E-05	3.20E-03	5.32E+01	FIRST COVERAGE			
6.0	B6	8.8	16.3	1.99E-04	1.16E-02	1.89E+02				
8.0	B6	8.0	14.8	4.60E-04	2.35E-02	3.48E+02				
10.0	B5	8.1	15.0	1.85E-03	1.03E-01	1.54E+03				
12.0	B4	9.1	16.8	2.39E-03	1.28E-01	2.16E+03				
14.0	B3	8.8	16.3	2.04E-04	1.17E-02	1.91E+02				
16.0	B2	8.9	16.5	1.01E-05	5.69E-04	9.41E+00				
18.0	B1	9.6	17.9	5.16E-05	3.57E-03	6.38E+01	9	146.8	4580	17
20.0	W10	12.4	23.0	8.33E-07	1.01E-05	2.32E-01	WHITEROCKS GROUND			
22.0	W11	13.4	24.8	1.15E-03	1.84E-02	4.57E+02	FIRST COVERAGE			
24.0	W12	13.1	24.4	3.18E-05	5.59E-04	1.36E+01				
26.0	W13	13.1	24.2	3.09E-05	7.46E-04	1.81E+01				
28.0	W14	12.6	23.3	7.74E-06	4.25E-04	9.89E+00				
30.0	W15	11.6	21.4	2.09E-05	2.12E-03	4.54E+01				
33.0	W16	9.2	17.1	3.13E-05	3.34E-03	5.71E+01	7	158.2	601	27
35.0	E6	9.5	17.5	7.87E-06	5.89E-04	1.03E+01	BROWNING ENTR. (inshore)			
37.0	E5	17.8	32.9	1.67E-05	1.44E-03	4.75E+01	FIRST COVERAGE			
40.0	E4	16.3	30.1	4.66E-05	4.25E-03	1.28E+02				
42.0	E3	15.5	28.8	1.69E-04	1.42E-02	4.07E+02				
44.0	E2	15.3	28.3	1.47E-04	1.10E-02	3.12E+02				
46.0	E1	14.0	25.9	3.11E-05	1.97E-03	5.11E+01	6	163.5	956	17
47.0	F1	17.0	31.5	1.00E-04	2.78E-03	8.75E+01	FREEMAN GROUND			
49.0	F2	17.1	31.6	3.31E-04	1.68E-02	5.33E+02	FIRST COVERAGE			
51.0	F3	17.1	31.7	8.93E-04	5.49E-02	1.74E+03				
53.0	F4	16.7	30.9	6.08E-05	3.86E-03	1.19E+02				
55.0	F5	16.7	31.0	7.70E-05	5.45E-03	1.69E+02				
57.0	F6	16.8	31.2	7.62E-05	4.33E-03	1.35E+02				
59.0	F7	17.6	32.6	2.74E-05	1.22E-03	3.99E+01				
61.0	F8	16.4	30.4	5.36E-07	1.74E-05	5.29E-01	8	250.9	2824	21
65.0	B9	11.7	21.7	3.72E-05	1.98E-03	4.29E+01	BONILLA GROUND			
67.0	B8	11.5	21.3	4.81E-05	2.54E-03	5.41E+01	SECOND COVERAGE			
69.0	B7	11.2	20.8	1.64E-03	9.87E-02	2.05E+03				
71.0	B6	11.4	21.1	1.10E-03	6.36E-02	1.34E+03				
73.0	B5	11.2	20.7	3.28E-04	2.08E-02	4.30E+02				
76.0	B4	11.6	21.4	1.17E-05	6.97E-04	1.49E+01				
78.0	B3	10.5	19.4	3.41E-05	2.40E-03	4.67E+01				
80.0	B2	11.3	20.9	4.24E-05	3.11E-03	6.48E+01				
82.0	B1	10.8	20.0	4.64E-05	3.86E-03	7.74E+01	9	187.3	4121	18

Appendix Table 2 (cont'd).

EVE #	TRA $	Len km	Area km^2	Vol D kg/m^3	Surf D kg/m^2	Biomass t	# #	Area km^2	Biomass t	C.V. %
84.0	W10	12.9	24.0	1.13E-05	1.80E-04	4.33E+00	WHITEROCKS GROUND			
86.0	W11	12.6	23.3	1.05E-05	2.20E-04	5.14E+00	SECOND COVERAGE			
88.0	W12	13.1	24.3	4.78E-06	8.53E-05	2.07E+00				
90.0	W13	13.6	25.1	9.94E-05	3.13E-03	7.87E+01				
92.0	W14	13.4	24.9	2.08E-05	1.52E-03	3.79E+01				
94.0	W15	11.9	22.0	2.37E-05	2.49E-03	5.48E+01				
96.0	W16	10.0	18.5	2.23E-05	2.36E-03	4.36E+01	7	162.1	227	13
98.0	F1	17.9	33.2	5.86E-05	1.59E-03	5.28E+01	FREEMAN GROUND			
100.0	F2	18.3	33.9	1.26E-03	6.82E-02	2.32E+03	SECOND COVERAGE			
103.0	F3	18.3	33.9	1.48E-03	9.37E-02	3.17E+03				
105.0	F4	19.0	35.3	1.79E-04	1.20E-02	4.24E+02				
107.0	F5	14.2	26.3	1.53E-04	1.14E-02	3.01E+02				
109.0	F6	15.5	28.7	3.75E-04	2.27E-02	6.51E+02				
111.0	F7	19.2	35.6	5.38E-04	2.39E-02	8.51E+02				
113.0	F8	17.4	32.3	9.24E-05	2.47E-03	7.98E+01	8	259.2	7850	15
117.0	E6	9.6	17.8	7.89E-06	6.19E-04	1.10E+01	BROWNING ENTR. (inshore)			
120.0	E5	17.8	33.1	4.98E-05	4.40E-03	1.45E+02	SECOND COVERAGE			
122.0	E4	16.2	30.0	2.53E-05	2.30E-03	6.92E+01				
124.0	E3	16.3	30.2	5.00E-05	4.17E-03	1.26E+02				
126.0	E2	15.4	28.5	5.67E-05	4.06E-03	1.16E+02				
128.0	E1	15.1	27.9	4.19E-05	2.49E-03	6.95E+01	6	167.5	537	9