Exxon Valdez Oil Spill
Restoration Project Annual Report

Forage Species Studies in Prince William Sound

Restoration Project 97163 A

Annual Report

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INTRODUCTION

In Prince William Sound (PWS) apex predators, including piscivorous seabirds and marine mammals, were severely impacted by the EXXON VALDEZ oil spill (EVOS); and many have not recovered to pre-EVOS levels. Piscivorous seabirds and marine mammals in PWS are near the apex of food webs based on pelagic production of small fishes including Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus)*, walleye pollock (*Theragra chalcogramma*), capelin (*Mallotus villosus*) and eulachon (*Thaleichthys pacificus*); and macroinvertebrates, especially krill (Euphausiids) It is not clear if apex predators have failed to recover from EVOS-related reductions due to long-term changes in forage species abundance or to EVOS effects. In this report we describe research that provides quantitative descriptions of the forage community in PWS in 1997 as part of the APEX program.

OBJECTIVES

1. Provide an estimate of the distribution and abundance of forage species in three core areas of Prince William Sound, including inshore and offshore areas.

2. Describe the species composition of the forage base and size distributions of the most abundant forage species in the three core areas.

3. Gather basic oceanographic data describing conditions in the study area, and salinity, temperature, and sigma-t profiles of the water column and water depth at all sites of data collection the three core areas.

4. Describe and quantify zooplankton and zooplanktivorous species in three process study sites within Prince William Sound in Spring, Summer and Fall.

FIELD METHODS

Sampling was conducted in three cruises in 1997.

Cruise 97-1, 17 May - 23 May 1997

This cruise was part of process studies to quantify parts of the plankton community that may affect forage fish condition and distribution. The objectives of this cruise were to: 1) Conduct a hydroacoustic study of the two study areas. 2.) Collect samples of acoustic targets to describe species composition and size distributions. (3) Describe and quantify zooplankton and zooplanktivorous species in two study sites. 4.) Collect samples of zooplankton to describe species composition and to determine abundance and distribution. (5) Collect selected species for related studies by other investigators.

Vessel: R/V PANDALUS - Alaska Fish and Game research vessel

The R/V PANDALUS conducted a series of hydroacoustic transects in the northern and southern study area, respectively (Figure 1). The transects were in a pattern of parallel lines through each area, terminating as close as possible to the shore. Patterns run in each area followed a pre-selected series of north-south transects spaced at 1.5 mile intervals. The equipment used was a Biosonics DT 4000, 120 kHz down-looking system. Field calibration of the acoustic equipment was done on 18 May.

A series of midwater trawl samples were collected where acoustic signals indicated presence of forage species along the transects. Three sites were sampled in the north study area and 5 sites were sampled in the south study area (Table 1). A video-equipped ROV (Remote Operated Video) was used in attempt to identify a target in the south study area (Table 2). In addition, beach seining was conducted in both study areas (Table 1). Two sites were sampled in St. Matthew's Bay (north) and 3 sites were sampled in Whale Bay (south). Plankton were collected in these two bays by vertical tows with a ring net for NMFS food habits studies. Fish larger than about 50 mm were identified in the field. Samples were sorted to species, and all fish were measured. Fish species were preserved in 10% buffered formalin.

Macrozooplankton samples and oceanographic measurements were collected at 8 stations within each of the 2 study areas (Table 3). BONGO plankton nets with 243 micron mesh nets were used to collect small plankton with a vertical haul, and a 1m^2 NIO/Tucker trawl with 1mm mesh was used to collect large zooplankton and micronektonic species in a double oblique haul. Vertical tows and double-oblique tows were made to 60 m depth or to within 10 m of the bottom in shallower areas. All plankton nets were equipped with General Oceanics flow meters and the NIO/Tucker trawl was also equipped with a maximum depth recorder. Plankton samples were preserved in 5% buffered formalin. An extra NIO/Tucker trawl sample was collected where euphausiids were found. Euphausiids from those samples were sorted by species and frozen individually.

A Seabird SEACAT CTD equipped with a fluorometer measured temperature, salinity, and chlorophyll from the surface to 200 m depth, or to within 5 m of the bottom at shallower stations. CTD profiles were collected at each process study site to provide data for vertical profiles of temperature, salinity, density, and chlorophyll (Table 4).

Cruise 97-2 , 17 July - 7 August1997

The objectives of this cruise were to: (1) Conduct a hydroacoustic survey of three study areas within PWS; (2) Observe the distribution of birds in relation to forage species; (3) Collect samples of acoustic targets to describe species composition and size distributions; (4) Describe and quantify zooplankton and zooplanktivorous species in the three study areas; (5) Collect samples of zooplankton to describe species composition and to determine abundance and distribution; (6) Collect selected species for related studies by other investigators.

Vessels: MISS KAYLEY - Nearshore acoustic and process study vessel
PAGAN - Nearshore and offshore catcher, video, CTD, beach seine vessel
CAPE ELRINGTON - Offshore acoustic vessel
PANDALUS - ADF&G research vessel

The MISS KAYLEY conducted nearshore acoustic survey consisting of a series of hydroacoustic transects in four study areas (Figure 1), using a Biosonics DT 4000, 120 kHz down-looking system. The transects were in a pattern of zigzags within 12 km segments of shoreline. The 12 km study segments were laid out sequentially through the shoreline within each study area. The number of 12 km segments within each study area were: North - 26, Central - 8, South - 21, Montague - 2 Each 12 km segment was further divided into ten 1.2 km beach sections, with the starting and ending points of each beach section marking the shoreward turning point in a series of 20 transects (10 zigs and 10 zags). Each transect was about 1.2 km long. The study segments sampled in each area were:

North 1, 3, 5, 7, 9, 13, 15, 17, 19
Central 1-8
South 2, 4, 6, 8, 10, 14, 16, 20
Montague 1, 2

Field calibration of the acoustic equipment was done in the morning of July 21.

CTD profiles were collected at a location near the middle of each 12 km beach segment (Table 4). The water column was sampled to a depth of 150 m or within 20 m of the bottom.

Acoustic targets found by the survey vessel in the nearshore study areas were sampled by the PAGAN using a purse seine, dip net, cast net (Table 1), or a video-equipped ROV (Remote Operated Video, Table 2). Plankton samples were collected at locations where fish were sampled (Table 3). Beach seining was also conducted in each area at sites where aerial observations identified nearshore fish schools, including Bainbridge Passage (south study area), Green Island, Cabin Bay (central study area), and in the north study area (Table 1).

The CAPE ELRINGTON conducted a series of hydroacoustic transects in four areas (Figure 1), using a Biosonics DT4000 120 kHz down-looking system The transects were in a pattern of parallel transects through each area, terminating at shorelines as close as possible to the shore. Patterns to be run in each area followed a pre-selected series of transects spaced at two mile intervals. The acoustic system was field calibrated on 3 August.

A series of net samples were collected from the R/V PANDALUS with a mid-water trawl (Table 1). The location of net sampling was determined by acoustic and bird observations. Where acoustic signals or bird activity indicate the presence of forage species, scientists on the Acoustic/Bird vessel directed the midwater trawl vessel to the location and depth where collections were desired.

CTD profiles were collected on each transect line (Table 4). A Seabird SEACAT SBE 19 CTD was used to sample the water column from the surface to 150 m depth, or to within 20 m of the bottom at shallower stations.

A series of plankton samples were collected by the MISS KAYLEY in three process study areas - eight sampling locations were sampled at night with a 1 m^2 NIO/Tucker trawl with 505 micron mesh towed in a double oblique trajectory to a depth of 60 m, and with a 20 cm Bongo net with 243 micron mesh towed vertically from 60 m to the surface, or to within 10 m of the bottom in shalower areas (Table 3). CTD measurements of temperature, salinity and chlorophyll were measured at each of the eight sampling locations (Table 4). An additional horizontal tow of the NIO/Tucker trawl was made at the depth of maximum acoustic return at each station to collect euphausiids for laboratory analyses.

Cruise 97-3, 30 September - 10 October

The objectives of this cruise were to: (1) Conduct a hydroacoustic survey of three study areas within PWS; (2) Describe and quantify zooplankton and zooplanktivorous species in the three study areas; (3) Collect samples of zooplankton to describe species composition and to determine abundance and distribution; (4) Collect selected species for related studies by other investigators.

Vessel: R/V PANDALUS - ADF&G research trawl vessel

The R/V PANDALUS conducted sampling in three study areas (Figure 1). Plankton and CTD samples were collected at preselected stations within the three study areas . For plankton sampling, a 1 m^2 NIO/Tucker trawl fitted with a 505 micron mesh net and digitial flowmeter was towed in a double oblique trajectory to depths of about 60 m as measured by a maximum depth recorder (Table 3). In addition, a 25 cm bongo net fitted with 243 or 353 micron mesh nets (one 243 mesh net was lost and replaced with a 353 mesh net at station 8) and flowmeters were towed vertically from 60 m depth to the surface (Table 3) If the NIO/Tucker trawl sample had substantial numbers of euphausiids present, a second NIO/Tucker sample was taken in order to collect euphausiids for laboratory analyses.

A Seabird SEACAT SBE-19 CTD measured temperature, salinity and chlorophyll from the surface to 150 m depth, or to within 10 m of the bottom at shallower stations. CTD profiles were collected at each process study site (Table 4).

Acoustic transects were run in the North and South study areas to assess the abundance of pelagic fishes; the transects planned for the Central study area were cancelled due to bad weather . The equipment used was a Biosonics DT4000 digital system with a120 kHz transducer. Field calibration of the acoustic equipment was conducted on 8 October in Whale Bay.

A series of mid-water trawl samples were collected to identify targets in the acoustic survey and to collect samples for laboratory studies (Table 1).

ACOUSTIC DATA ANALYSES

The GPS produced errors in the distance estimations. The magnitude of the errors was a function of the distance between sampling points. As the vessel speed and direction varied substantially along the transects, uncorrected distances were estimated to be in error by as much as 800%. The error was estimated as follows: A straight trasect was selected (M0109a). Data were extracted without averaging from the raw data files. The distance between the start and end points was calculated and assumed to be the best overall estimate of the actual transect length (e.g. the error component was lowest relative to actual distance between points). Distances between successive points were then calculated and summed to produce an estimate of the transect length from individual increments. The correction factor was computed as the endpoint distance divided by the total increment distance. The lag between distances was incremented and the procedure repeated to produce estimates of the correction factor required for each distance increment. The results were plotted and a function was fit to the curve to produce an estimate of the correction required for any given distance. The corrected distance was equal to the uncorrected distance multiplied by the uncorrected distance divided by the uncorrected distance plus an error component. The error component varied substantially relative to distance between points. The error was modeled by log transforming the distance and error estimates and fitting the results to an eight degree polynomial. The beta parameters were computed using the program error. These parameters and the correction factor were applied to each distance increment in the data files to correct estimates of distance between successive points.

Each data record consisted of 1 m depth increments from 1 m below the transducer to the bottom or about 115 m depth, whichever was greater. Averaging was done using geometric means. The program returned volume scattering, depth, and latitude and longitude for each record. Various parameters in the bottom tracking software were modified to avoid integrating through the bottom. The bottom window was varied from 20 to 40 m, with larger values for files with steeper slopes. A cross section of the volume scattering for each transect was plotted using visual basic software. Files were scanned visually, and estimates of species identification and size class were made for all substantial acoustic targets . The bottom files were edited to remove any bottom integration left in the data.

Due to variations in vessel speed and direction, the distance included by successive integrations in the output file varied substantially. The portion of the total trasect abundance or biomass value contributed by each integration was estimated by multiplying the integrated value by the integration distance divided by the total transect length.

The volume scattering was corrected for calibration by the standard target. Calibration indicated that the recieve sensitivity and source levels were producing over-estimations of the volume scattering by about 3.39 dB.

The default sound scattering was assumed to be plankton with a target strength of -70 dB/g. Identified fish targets were scaled using target strength to length equations. Estimates of the number of individual fish per cubic meter were determined by equations relating acoustic target strength to fish length.

Herring: TS = 20*log10(length(cm)) -68 From Thorne
Pollock: TS = 20*log10(length(cm)) -66 From Thorne
Capelin: TS = 20*log10(length(cm)) -64.9 From Rose & Leggett
Rockfish: TS = 20*log10(length(cm)) - 67.1 From MacLennan & Simmonds

We could find no target strength-length relationships for sandlance at 120 kHz; therefore, a default target strength was used. We assumed all sandlance were 70 mm in length and assigned them a target strength of -67 db per fish. Rockfish length was assumed to be 250 mm based on video data.

Estimates of fish numbers were converted to an estimate of biomass per cubic meter using the length-weight relationship for the dominant species. Equations to compute biomass (W - in grams, L - in mm) were:

pollock	$W = (1.89 \times 10^{-6})\ L^{3.272}$
herring	$W = (5.007 \times 10^{-6})\ L^{3.196}$
sand lance	$W = (4.81 \times 10^{-7})\ L^{3.451}$
capelin	$W = (2.40 \times 10^{-6})\ L^{3.213}$
rockfish	$W = (7.5 \times 10^{-3})\ L^{3.2}$ (length in cm)

Biomass per cubic meter estimates were converted to biomass per square meter of surface by integrating the results over the depth of the sampled water column.

Geographic distributions of forage species were assessed by developing area plots of biomass density gradients determined through a kriging routine. The kriging method has a gridding algorithm (we used a minimum curvature algorithm) that estimates the data between transect lines based on spatial variation along the transect lines. Therefore, the most accurate point estimates are those occurring closest to the lines in regions where transect density is highest. Land masses were overlaid on the area plots after the gridding algorithm had been run.

Biomass estimates for each of the nearshore 12 km sampling sites were developed by calculating the mean for all transects in the site. All transects within a sampling site that had acoustic backscatter above a minimum threshhold were examined in detail, and any concentration of acoustic backscatter was identified based on target verification sampling. A biomass estimate for each transect was calculated by partitioning each transect by the target type with calculation using our best model of target strength.

The estimate of nearshore biomass in each of the three study areas (North, Central, and South) was produced by averaging the overall estimate the sampling sites in the study area.

The procedures used to estimate nearshore biomass density in 1997 differed in several ways from the 1996 procedures. In order to make the estimates from 1996 comparable to 1997 we reanalyzed all of the 1996 nearshore acoustic data using the procedures above.

LABORATORY ANALYSES

Subsamples of YOY herring and YOY sandlance collected in 1996 and 1997 were analyzed for energy content using whole body bomb calorimetry. Individual specimens were weighed (wet weight), dried to constant weight (dry weight), and analyzed for energy content using a Parr semi-microbomb calorimeter.

RESULTS

Hydrographic Observations.
In summer of 1997 there were numerous reports of unusually warm marine waters around Alaska, including Prince William Sound. Profiles of temperature and salinity in our study areas in 1997 were generally similar to 1995 and 1996, although temperature, especially near the surface, tended to be higher in 1997 (Figures 1, 2).

Acoustic Biomass Density
Biomass density estimates varied substantially among the three study areas in 1997, with highest density in the Central area and lowest in the North. The rank order of three areas, based on biomass density estimates, was reversed from 1996, when the North area had the highest density (Table 5). In 1997 identifications were made on many of the targets in the acoustic survey, with underwater video providing most postive identifications (Table 6). The breakdown of overall biomass density into target category gives a much better picture of the foraging environment available to avian predators, as several important species or species size groups are not vulnerable to birds - including rockfish and adult herring. There were several important differences in the densities of forage species among years and areas (Table 7). Of the seven categories of acoustic targets we analyzed, sandlance, YOY herring and 1+ herring are probably the most important prey for many avian predators.

The most pronounced change in forage fish density between 1996 and 1997 appears to be the large decrease in biomass density in the North in 1997. This decrease is due principally to the large decline in density of 1+ herring and sandlance. Those losses were partially offset by relatively high density of YOY herring in the North in 1997 (Table 7). The increase in biomass density in the Central area in 1997 was apparently due to an increase in adult herring. Those adult herring were probably unavailable to avian predators; however, in 1997 sandlance density also increased in the Central area, and could have contributed to better foraging conditions. The patterns of density changes observed in both the North and Central areas from 1996 to 1997 were also observed in the South, where density of YOY herring and sandlance both increased, whereas density of 1+ herring declined sharply (Table 7).

The distribution of biomass within the three study areas in 1996 and 1997 displayed some important differences and similarities. In the North, there appeared to be a shift in distribution of biomass in 1997 - including more concentrations of herring (mainly YOY) in the Valdez Arm/Galena Bay area, with a large decline in forage species in the Port Gravina area, especially for sandlance (Figures 3, 4). In the Central study area in 1997 there appeared to be fewer concentrations of forage species around the northern end of Knight Island, including Eleanor Island, with possibly more areas of high density around Naked Island. Sandlance occurred both in1996 and 1997 on the west side of the Naked Island complex (Figures 5, 6), however the density of sandlance apparently was higher in 1997 than 1996 (Table 7). In the South, distributions of biomass were generally similar in 1997 and 1996, with concentrations of adult herring in some of the southwest passages, such as Prince of Wales Passage. In 1997 sandlance concentations did occur in the South, whereas they were absent in 1996 (Figures 7, 8).

Process Studies.
In 1996 and 1997 we examined variation in condition of forage species within Prince William Sound, with emphasis on YOY herring and sandlance. YOY herring were relatively rare in 1996; however, we were able to collect sufficient samples at seven locations throughout the North study area to assess within area variability. We also collected one sample in the South. Within the North area, caloric content varied from less than 4500 cal/g at Bligh Island to over 4800 cal/g at Gravina Point. The one sample from the South, near Jackpot Island, had the highest energy density observed (Figure 9). In 1996 we collected YOY sandlance at three locations in the North, two in the Central and two in the South. As with herring, there was considerable variation in energy density within an area, for example, in the Central area the sample from Bay of Isles had mean energy density over 5200 cal/g, whereas the Cabin Bay sample had the lowest value (<4600 cal/g) observed (Figure 10). The two samples from the South study area had the highest energy densities observed in YOY sandlance in 1996. This was consistent with the pattern observed in YOY herring in 1996.

In 1997 YOY herring were more abundant than in 1996. We have measured energy density on only a small subset of samples to date. YOY herring from a station in the South had higher energy density than a sample from the North (Figure 9), and one sample of YOY sandlance from the South study area had the highest energy density we have observed in that species (Figure 10). Although these results are preliminary, there may be a pattern of higher energy density in YOY forage species in the South study area, relative to the Central and North.

ACKNOWLEDGEMENTS

We were assisted in field, laboratory and data analyses by University of Alaska Fairbanks graduate students Jennifer Boldt, Jill Mooney and Julia Mabry. Dave Nemazie from the University of Maryland was a valued participant in our field collections. We would also like to recognize the strong contributions made by vessel captains John Herslieb, Olaf Gildness and Paul Desjardin.

LIST OF TABLES

TABLE 1. Samples to identify acoustic targets and collect specimens for biological studies in 1997.

Table 2. Video samples colleted to identify acoustic targets in 1997

Table 3. Plankton samples collected in APEX process studies in 1997.

Table 4. CTD stations sampled on APEX research cruises in 1997.

Table 5. mean boimass density estimates for 1996 and 1997 nearshore acoustic surveys in North, Central and South study areas of Prince William Sound.

Table 6. Positive identifications of acoustic targets in the 1997 nearshore acoustic survey.

Table 7. Biomass density estimates from nearhsore acoustic surveys of North, Central and South study areas in 1996 and 1997.

LIST OF FIGURES

Figure 1. Locations of acoustic survey study areas for the APEX project, with locations of temperature projles comparing 1995, 96 and 97.

Figure 2. Temperature profiles for selected stations in the North, Central and South study areas in 1995, 1996 and 1997.

Figure 3. Geographic distribution of acoustic biomass in the North study area in 1996. Color scale units are grams/m^2. Codes for species are H - herring, Sn - sandlance, R - rockfish.

Figure 4. Geographic distribution of acoustic biomass in the North study area in 1997. Color scale units are grams/m^2. Codes for species are H - herring, Sn - sandlance, R - rockfish.

Figure 5. Geographic distribution of acoustic biomass in the Central study area in 1996. Color scale units are grams/m^2. Codes for species are H - herring, Sn - sandlance, R - rockfish.

Figure 6. Geographic distribution of acoustic biomass in the Central study area in 1997. Color scale units are grams/m^2. Codes for species are H - herring, Sn - sandlance, R - rockfish.

Figure 7. Geographic distribution of acoustic biomass in the South study area in 1996. Color scale units are grams/m^2. Codes for species are H - herring, Sn - sandlance, R - rockfish.

Figure 8. Geographic distribution of acoustic biomass in the South study area in 1997. Color scale units are grams/m^2. Codes for species are H - herring, Sn - sandlance, R - rockfish.

Figure 9. Energy content of YOY herring collected in Prince William Sound in 1996 and 1997.

Figure 10. Energy content of YOY sandlance collected in Prince William Sound in 1996 and 1997.

Table 1. Samples to identify acoustic targets and collect specimens for biological studies in cruise 97-2.

Gear Codes: A - Cast Net, B - Beach Seine, D - Dip Net, F - Fry Seine, J - Herring Jig, T - midwater trawl, U - Purse Seine, V - video.

DATE	TIME IN	STN #	HAUL #	GEAR	LOCATION	LAT		LONG		BOTTOM DEPTH (M)	GEAR DEPTH
CRUISE 97-1											
97/18/05	11:27	1	1	T	off St. Matthew's Bay; 971N7A	60	39.76	146	21.13	122	87
97/18/05	12:26	1	2	T	off St. Matthew's Bay; 971N7A	60	37.44	146	21.08	93	67
97/18/05	13:27	2	1	T	E. of St. Matthew's Bay; 971N8A	60	41.36	146	18.27	109	67
97/21/05	14:03	13	1	T	971S9A	60	7.84	148	1.91	140	82
97/21/05	14:50	13	2	T	971S9A	60	8.62	148	0.7	140	22
97/21/05	17:22	14	1	T	971S2A	60	10.94	148	11.62	100	57
97/21/05	17:43	14	2	T	971S2A	60	11	148	11.54	100	52
97/22/05	16:23	17	1	T	SW side of Chenega Is.	60	17.6	148	9.97	282	100
97/18/05		2	1	B	St. Matthew's Bay	60	44.75	146	19.26	0-2	0-2
97/18/05		2	2	B	"	"		"		"	"
97/22/05	10:30	15	1	B	Whale Bay	60	12.85	148	12.05	0-2	0-2
97/22/05	10:45	15	2	B	"	"		"		"	"
97/22/05	11:00	15	3	B	"	"		"		"	"
CRUISE 97-2											
22/07	11:00	32	2	A	C0105B	60	23.29	147	40.13	28	3
23/07	16:10	46	1	A	Storey Is.	60	43.97	147	25.11	15	5
24/07	07:30	48	1	A	NW bay of Naked Is.	60	41.31	147	27.79	10	4
19/07	14:15	14	1	B	Bainbridge P.	60	8.94	148	9.46	50	3
21/07	15:00	27	1	B	Green Is.	60	15.86	147	21.48	18	5
23/07	16:10	46	2	E	Storey Is.	60	43.97	147	25.11	15	5
24/07	11:00	51	1	B	Naked Is.	60	38.75	147	29.71	5	5
25/07	11:45	59	1	B	Map 82; T21 (E.B.)	60		146		5 to 0	5 to 0
01/08	10:20	125	1	B	N. end of Storey Is.	60	43.4	147	23.65	2-3	
27/07	15:57	88	1	D	Olsen Bay	60	43.39	146	12.78	48	surface
31/07	11:06	118	1	D		60	47.52	146	45.00	7	surface
04/08	07:22	146	1	D		60	10.72	148	02.80	11	surface
02/08	09:45	135	1	F	Naked	60	41.52	147	28.65	9	
02/08	13:00	136	1	F		60	40.15	147	26.77	18	
03/08	08:45	137	1	F	Jackpot Bay	60	20.69	148	12.08	9	
04/08	13:45	151	1	F	Shelter Bay	60	07.70	147	56.67	16	
04/08	15:30	152	1	F		60	03.91	147	50.16	3	
23/07	08:50	38	2	J	C0402; Naked Is	60	37.16	147	22.38	40	20
23/07	10:50	41	1	J	C0410A	60	40.51	147	20.95	67	33
23/07	12:00	42	1	J	C0502A	60	39.29	147	22.26	45	33
30/07	09:37	104	2	J		60	37.66	146	28.93	30	15
05/08	08:30	154	1	T	Montague St	60	09.702	147	33.189	103	70
05/08	09:20	155	1	T	Montague St	60	10.92	147	27.36	100	70
05/08	10:45	156	1	T	Montague St	60	14.25	147	22.25	45	35-40
05/08	11:45	157	1	T	Montague St	60		147		35	10-20
05/08	13:00	158	1	T	Montague St	60	17.67	147	17.67	125	80-90
05/08	14:00	159	1	T	Montague St	60	20.00	147	18.00	135	125
05/08	15:00	160	1	T	S. of Applegate	60	19.69	147	25.11	70	50
06/08	08:21	161	1	T	E. of Knight Is.	60	27.63	147	36.19	100	30
06/08	10:45	163	1	T		60	24.10	147	21.76	120	60-70
06/08	13:10	165	1	T	C03	60	26.28	147	24.39	20	48
20/07	11:30	19	1	U	Ewan Bay	60	20.27	148	7.36	100	33
23/07	12:05	42	2	U	C0502A	60	39.29	147	22.26	45	33
24/07	08:33	49	1	U	Naked Is.	60	40.87	147	27.94	29	33
24/07	14:23	54	1	U	SE Naked Is.	60	38.12	147	23.53	25	34
25/07	08:34	56	1	U	N1901A	60	55.89	146	36.50	28	33
25/07	10:00	58	1	U	N1904A	60	56.70	146	40.45	48	33
25/07	14:45	61	1	U	N1702A	60	53.91	146	44.06	28	35
27/07	14:40	87	1	U	Port Gravina	60	42.77	146	14.78	30	33
29/07	15:45	97	2	U		60	41.92	146	10.68	82	33
CRUISE 97-3											
03/10	00:48	10		T	N10	60	43.81	146	12.24	60	7-20
03/10	03:40	11		T	St. Matthews Bay	60	42.63	146	20.85	38	15-20
03/10	22:44	12		T	N6A	60	40.16	146	24.62	38	30
04/10	01:13	13		T	N2A	60	37.60	146	33.46	40	30
04/10	01:45	13		T	N2A	60	38.38	146	33.23	38	20
04/10	05:25	14		T	Landlocked Bay	60	48.79	146	34.79	44	10-20
08/10	21:06	28		T	S2A	60	60.00	148	09.93	270	10-20

Table 2. Video samples collected to identify acoustic targets on APEX cruise 97-2

DATE	TIME IN	STN	LOCATION	LAT		LONG		BOTTOM DEPTH (M)	GEAR DEPTH (M)
18/07	17:50	4	Prince of Wales P.	60	1.33	148	8.89	35	30
18/07	18:12	5	Prince of Wales P.	60	0.92	148	9.20	21	50
18/07	18:30	6	Prince of Wales P.	60	2.11	148	8.54	67	15
18/07	18:44	7	Prince of Wales P.	60	2.19	148	8.48	67	17
19/07	09:30	9	Prince of Wales P.	60	5.23	148	5.5	13	67
19/07	10:00	10	Prince of Wales P.	60	5.77	148	4.63	130	17
19/07	11:25	11	Gage Is.	60	11.33	148	1.36	40	20
19/07	14:00	13	Bainbridge P.	60	8.94	148	9.46	50	5
20/07	10:30	18	off Delenia Is.	60	20.32	148	8.19	28	8
20/07	15:39	21	Dangerous P.	60	23.93	147	59.65	90	7
20/07	17:30	22	S2003A; N. Squire Is.	60	15.60	147	57.80	33	33
21/07	11:40	24	M0104B; Montague Is.	60	10.17	147	22.38	1	10
21/07	13:40	26	M0110A	60	14.74	147	19.12	25	10
21/07	16:00	29	M0205A	60	16.09	147	14.19	33	20
22/07	08:20	30	near C0101A; Knight Is	60	21.46	147	37.08	62	35
22/07	10:41	32	C0105B	60	23.29	147	40.13	28	5
22/07	11:40	33	C0107A	60	24.01	147	41.49	20	13
22/07	15:40	35	Inget Is.	60	29.74	147	36.87	13	8
22/07	16:10	36	C0302A	60	31.25	147	33.60	73	16
23/07	08:27	38	C0402, Naked Is.	60	37.16	147	22.38	40	20
23/07	10:31	40	C0409B	60	40.96	147	19.49	33	7
23/07	11:00	41	C0410A	60	40.51	147	20.95	67	19
23/07	14:45	44		60	44.1	147	22.7	23	20
23/07	15:15	45	C0601B	60	44.92	147	23.19	100	20
24/07	11:59	52	C0706B	60	38.63	147	30.29	40	40
25/07	09:30	57	N1901B	60	56.01	146	36.81	24	5 to 12
25/07	16:50	62	N1508A; beginning	60	50.06	146	49.53	28	15-20
25/07	17:35	64	N1504B	60	48.11	146	48.53	15	9
25/07	18:00	65	N1504B	60	47.69	146	48.61	36	9-21
25/07	18:15	66	N1503B	60	47.83	146	47.34	25	9-25
25/07	18:35	67	N1503B	60	47.61	146	46.90	36	12-17
26/07	07:55	68	N1301A	60	52.69	146	38.05	52	6-21
26/07	09:10	69	N1305A	60	48.51	146	39.05	41	2-9
26/07	12:15	72	N0910A	60	47.61	146	19.72		
26/07	13:20	73	Irish Cove; Pt Fidalgo	60	46.08	146	26.74	12	3-8
26/07	14:00	74	N0909B; Pt Fidalgo	60	46.46	146	29.27	6-11	3-9
26/07	16:05	76	N0706A	60	44.77	146	38.86	18	2
26/07	16:15	77	N0705B	60	44.52	146	39.51	36	35
26/07	17:05	78	N0702A	60	44.31	146	42.74	36	35
26/07	17:25	79	N0701B	60	44.17	146	43.55	36	32
27/07	08:10	80	N0508A	60	40.853	146	35.096	15	15
27/07	08:40	81	Knowles Bay	60	41.06	146	33.62	12	12
27/07	09:45	83	N0504A	60	40.3	146	30.71	6	2-8
27/07	12:45	84	N0305B	60	43.53	146	19.58	37	5-12
27/07	13:45	86	N0302B	60	42.33	146	17.73	52	45
27/07	16:40	89	N0110B; Pt. Gravina	60	42.262	146	09.75	40	30-40
27/07	17:40	90	N0110B; Pt. Gravina	60	40.36	146	14.27	15-21	12-20
29/07	14:20	95	972N10A (S. end)	60	41.96	146	10.25	91	15
29/07	14:35	96	972N9A (N. end)	60	43.03	146	11.17	45	16
29/07	15:00	97		60	41.84	146	10.69	88	15
29/07	17:00	98	Pt Gravina	60	42.14	146	18.45	58	5-15
29/07	17:40	99	Pt Gravina; 972N8A	60	39.30	146	18.24	115	8
30/07	09:05	104		60	38.50	146	30.67	30	15
30/07	10:21	105		60	40.06	146	28.77	4	3
30/07	11:15	106	3A	60	39.00	146	34.02	36	24
30/07	11:35	107	3A						
30/07	12:15	108	2A	60	37.56	146	36.86	45	30
30/07	13:05	110		60	39.65	146	39.69	43	8-11
30/07	14:05	111		60	42.04	146	42.0	25	5-15
30/07	14:30	112		60	42.08	146	43.14	41	6-15
31/07	08:15	116		60	48.11	146	30.77	182	8-15
31/07	15:30	123		60	54.09	146	46.60	18	6
01/08	11:40	126		60	44.45	147	22.16	45	30
04/08	08:10	147		60	10.30	148	02.92	51	26

Table 3. Plankton samples collected in APEX process studies during 1997. Gear codes: N - NIO/Tucker, G - Bongo

DATE	TIME IN	STN	GEAR	LOCATION	LATITUDE		LONGITUDE		BOTTOM DEPTH (M)	GEAR DEPTH (M)
97/18/05	23:20	3	G	971N5	60	43.82	146	19.52	43	40
97/19/05	0:24	4	G	971N4	60	42.44	146	20.03	45	40
97/19/05	1:18	5	G	971N7	60	40.64	146	18.78	120	60
97/19/05	2:12	6	G	971N8	60	42.02	146	13.39	151	60
97/19/05	22:56	8	G	971N3	60	40.87	146	23.46	38	35
97/19/05	23:39	9	G	971N6	60	38.62	146	22.82	127	60
97/20/05	0:23	10	G	971N2	60	38.87	146	28.03	45	40
97/20/05	1:12	11	G	971N1	60	39.85	146	36.32	25	25
97/22/05	22:55	18	G	971S1	60	19.28	148	10.03	257	60
97/22/05	23:42	19	G	971S2; Icy Bay sill	*		*		160	60
97/23/05	0:29	20	G	971S3; SW Chenega	60	16.45	148	7.97	280	60
97/23/05	1:18	21	G	971S4; Whale Bay	*		*		300	60
97/23/05	2:14	22	G	971S5; SE Chenega	*		*		465	60
97/23/05	3:28	23	G	971S7; SE of Squire	*		*		600	60
97/23/05	4:21	24	G	971S6; Bainbridge	*		*		250	60
97/23/05	5:06	25	G	971S8; Prince of Wales	*		*		58	45
97/18/05	23:38	3	N	971N5	60	43.87	146	19.44	42-43	20
97/19/05	0:41	4	N	971N4	60	42.32	146	20.04	48	35
97/19/05	1:28	5	N	971N7	60	40.4	146	19.51	124	54
97/19/05	2:23	6	N	971N8	60	42.31	146	12.27	157	73
97/19/05	2:55	5	N	971N7	60	40.99	146	18.1		
97/19/05	23:09	8	N	971N3	60	41.08	146	22.9	44	30
97/19/05	23:49	9	N	971N6	60	39.05	146	22.91	130	62
97/20/05	0:30	10	N	971N2	60	38.9	146	27.24	45	44
97/20/05	1:17	11	N	971N1	60	39.83	146	36.82	30	30
97/20/05	1:33	11	N	971N1	60	39.3	146	38.02	44	
97/22/05	23:05	18	N	971S1	60	19.46	148	10.06	134	53
97/22/05	23:52	19	N	971S2; Icy Bay sill	60	16.62	148	11.64	73	42
97/23/05	0:37	20	N	971S3; SW Chenega	60	16.52	148	8.3	294	55
97/23/05	1:25	21	N	971S4; Whale Bay	60	13.47	148	10.24	192	66
97/23/05	2:53	22	N	971S5; SE Chenega	60	15.67	148	3.15	465	41
97/23/05	3:35	23	N	971S7; SE of Squire	60	14.64	148	58.89	600	67
97/23/05	4:26	24	N	971S6; Bainbridge	60	12.1	148	5.09	250	60
97/23/05	5:15	25	N	971S8; Prince of Wales	60	9.25	147	59.67	190	46
97/23/05	5:31	26	N	Near Prince of Wales	60	9.81	147	57.65	247	15
CRUISE 97-2										
29/07	23:28	1	N	972N8	60	41.91	146	14.36	149	44
29/07	23:46	1	N	972N8	60	41.93	146	13.82	149	
30/07	1:35	2	N	972N7	60	40.275	146	18.41	130	61
30/07	2:00	2	N	972N7	60	40.62	146	18.71	119	46
30/07	3:36	3	N	972N4	60	42.32	146	20.05	60	44
30/07	3:44	3	N	972N4	60	42.48	146	20.22	38	
30/07	4:24	4	N	972N5	60	43.72	146	19.94	32	
30/07	4:33	4	N	972N5	60	43.66	146	20.19	26	20
30/07	5:04	4	N	972N5	60	43.97	146	19.38	41	32
30/07	23:33	5	N	972N3	60	40.87	146	23.65	41	32
30/07	23:39	5	N	972N3	60	40.94	146	23.32	43	35
31/07	0:32	6	N	972N6	60	39	146	22.45	127	55
31/07	0:52	6	N	972N6	60	38.96	146	23.11	115	20
31/07	2:23	7	N	972N2	60	38.77	146	28.1	49	37
31/07	2:38	7	N	972N2	60	38.89	146	28.53	42	24
31/07	3:29	8	N	972N1	60	40.01	146	35.57	30	24
31/07	3:40	8	N	972N1	60	40.11	146	35.97	27	24
31/07	23:36	9	N	972C8	60	38	147	16.89	115	66
31/07	23:49	9	N	972C8	60	37.72	147	16.77	153	30
01/08	1:10	10	N	972C7	60	39.71	147	14.45	154	67
01/08	1:24	10	N	972C7	60	39.79	147	13.91	160	30
01/08	2:23	11	N	972C6	60	41.21	147	14.47	166	41
01/08	2:40	11	N	972C6	60	41.42	147	14.8	173	30
01/08	3:45	12	N	972C5	60	43.22	147	16.16	128	56
01/08	3:58	12	N	972C5	60	43.33	147	15.84	175	55
01/08	22:53	13	N	972C1	60	44.23	147	35.86	600	67
01/08	23:14	13	N	972C1	60	44.1	147	35.59	590	23
02/08	1:30	14	N	972C2	60	40.81	147	33.22	308	67
02/08	1:43	14	N	972C2	60	40.86	147	32.79	226	23
02/08	2:46	15	N	972C3	60	38.82	147	38.2	652	
02/08	3:01	15	N	972C3	60	38.67	147	38.72	657	61
02/08	3:40	16	N	972C4	60	36.64	147	38.2	740	46
02/08	3:56	16	N	972C4	60	36.38	147	37.62	547	44
02/08	22:39	17	N	972S1	60	19.75	148	10.27	98	58
02/08	22:53	17	N	972S1	60	19.72	148	10.48	104	48
03/08	0:19	18	N	972S2	60	17.59	148	11.13	272	67
03/08	0:35	18	N	972S2	60	17.42	148	10.95	283	23
03/08	1:40	19	N	972S3	60	16.5	148	8.2	320	44
03/08	1:57	19	N	972S3	60	16.46	148	8.97	346	59
03/08	3:32	20	N	972S4	60	13.85	148	10.5	330	33.5
03/08	3:48	20	N	972S4	60	13.52	148	10.2	155	44
03/08	22:40	21	N	972S6	60	12.57	148	4.52	246	73
03/08	22:53	21	N	972S6	60	12.48	148	4.78	252	44
04/08	0:04	22	N	972S5	60	50.62	148	2.75	217	64
04/08	0:13	22	N	972S5	60	15.87	148	2.72	262	23
04/08	1:03	23	N	972S7	60	14.8	147	59.01	481	24
04/08	1:18	23	N	972S7	60	14.37	147	58.71	360	46

Table 3. Continued

DATE	TIME	STN	GEAR	LOCATION	LATITUDE		LONGITUDE		BOTTOM DEPTH (M)	GEAR DEPTH (M)
04/08	2:28	24	N	972S8	60	9.93	147	59.15	102	
04/08	2:41	24	N	972S8	60	9.72	147	59.5	243	73
04/08	22:47	25	N	972N8	60	42.12	146	12.5	161	53
05/08	0:38	26	N	972N8	60	40.72	146	17.91	135	
29/07	20:49	1	G	972N8	60	40	146	13.39	153	60
30/07	1:22	2	G	972N7	60	40.79	146	18.23	132	60
30/07	3:23	3	G	972N4	60	42.27	146	20.2	62	60
30/07	4:15	4	G	972N5	60	43.7	146	20.16	27	
30/07	23:22	5	G	972N3	60	40.81	146	23.58	45	40
31/07	0:21	6	G	972N6	60	38.94	146	22.1	132	60
31/07	2:15	7	G	972N2	60	38.58	146	27.93	57	50
31/07	3:22	8	G	972N1	60	39.9	146	35.34	35	30
31/07	23:24	9	G	972C8	60	38.22	147	16.62	113	60
01/08	1:01	10	G	972C7	60	39.57	147	14.46	152	60
01/08	2:09	11	G	972C6	60	40.88	147	14.31	168	60
01/08	3:32	12	G	972C5	60	43.16	147	16.46	145	60
01/08	22:38	13	G	972C1	60	44.24	147	36.03	597	60
02/08	0:16	14	G	972C2	60	40.9	147	33.06	300	60
02/08	2:33	15	G	972C3	60	38.94	147	38.08	657	60
02/08	3:32	16	G	972C4	60	36.77	147	38.37	740	60
02/08	22:27	17	G	972S1	60	19.52	148	10.13	227	60
03/08	0:11	18	G	972S2	60	17.5	148	11.25	148	60
03/08	1:30	19	G	972S3	60	16.56	148	8.33	295	60
03/08	3:22	20	G	972S4	60	13.85	148	10.5	273	60
03/08	22:29	21	G	972S6	60	12.22	148	4.37	220	60
03/08	23:55	22	G	972S5	60	15.4	148	2.53	459	60
04/08	0:56	23	G	972S7	60	14.92	147	59.06	490	60
04/08	2:20	24	G	972S8	60	10.03	147	59.14	220	60
CRUISE 97-3										
01/10	17:10	1	G	N6	60	38.52	146	22.93	125	60
01/10	20:44	2	G	N4	60	42.40	146	19.96	40	30
01/10	21:30	3	G	N3	60	40.84	146	23.60	36	25
01/10	22:14	4	G	N2	60	38.85	146	28.05	42	30
01/10	23:14	5	G	N1	60	39.82	146	36.14	32	20
02/10	00:20	6	G	N6	60	38.53	146	23.03	126	60
02/10	01:54	7	G	N7	60	40.61	146	18.80	123	60
02/10	20:35	8	G	N5	60	43.77	146	19.56	30	25
02/10	21:34	9	G	N8	60	42.01	146	13.29	148	60
04/10	20:07	15	G	C8	60	37.82	146	16.24	177	60
04/10	21:22	16	G	C7	60	39.86	146	13.58	140	60
04/10	22:10	17	G	C6	60	41.37	146	13.51	173	60
04/10	23:23	18	G	C5	60	43.40	146	16.28	168	60
05/10	01:01	19	G	C1	60	43.98	147	34.53	578	60
06/10	20:05	20	G	S1	60	19.18	148	10.15	232	60
06/10	21:25	21	G	S2	60	16.79	148	12.16	158	60
06/10	23:02	22	G	S3	60	16.45	148	08.18	256	60
06/10	23:58	23	G	S5	60	15.77	148	02.62	478	60
07/10	01:22	24	G	S6	60	12.17	148	04.96	248	60
07/10	02:50	25	G	S4	60	13.65	148	10.82	278	60
07/10	20:15	26	G	S7	60	14.26	147	59.26	591	60
07/10	21:43	27	G	S8	60	09.53	147	59.17	207	60
01/10	17:24	1	N	N6	60	38.52	146	22.74	100	40
01/10	20:58	2	N	N4	60	42.16	146	19.50	55	38
01/10	21:37	3	N	N3	60	40.66	146	23.68	38	35
01/10	22:20	4	N	N2	60	38.79	146	28.68	40	35
01/10	23:21	5	N	N1	60	39.65	146	35.53	36	22
02/10	00:27	6	N	N6	60	38.43	146	23.13	126	53
02/10	00:50	6	N	N6	60	38.31	146	23.65	126	25-14
02/10	02:00	7	N	N7	60	40.50	146	19.02	123	53
02/10	02:23	7	N	N7	60	40.46	146	19.42	124	63
02/10	20:41	8	N	N5	60	43.72	146	19.81	25-40	24
02/10	21:41	9	N	N8	60	41.92	146	13.67	148	53
02/10	22:01	9	N	N8	60	42.30	146	12.37	148	20-8
04/10	20:14	15	N	C8	60	37.74	146	15.69	180	63
04/10	20:34	15	N	C8	60	37.68	146	17.28	180	25, 12
04/10	21:30	16	N	C7	60	39.74	146	12.73	162	
04/10	22:18	17	N	C6	60	41.18	146	12.69		76
04/10	22:38	17	N	C6	60	41.13	146	12.65	175	29, 13
04/10	23:30	18	N	C5	60	43.38	146	15.49	168	53
05/10	01:07	19	N	C1	60	43.87	147	34.13	578	74
06/10	20:12	20	N	S1	60	18.92	148	10.14	232	72
06/10	20:29	20	N	S1	60	19.04	148	10.13	232	29, 12
06/10	21:34	21	N	S2	60	16.96	148	11.93	158	68
06/10	21:57	21	N	S2	60	17.01	148	11.84	158	23,11
06/10	22:14	21	N	S2	60	16.94	148	11.76	158	60
06/10	23:13	22	N	S3	60	16.24	148	07.51	256	
07/10	00:01	23	N	S5	60	15.55	148	02.26	478	60
07/10	00:22	23	N	S5	60	15.49	148	02.43		30, 13
07/10	01:37	24	N	S6	60	11.92	148	05.28	241	60
07/10	01:58	24	N	S6	60	11.99	148	05.08		20, 12
07/10	03:04	25	N	S4	60	13.65	148	10.38	278	60
07/10	03:25	25	N	S4	60	13.70	148	10.60	278	18, 11
07/10	20:22	26	N	S7	60	13.94	147	59.34	591	60
07/10	20:38	26	N	S7	60	14.00	147	59.45	591	60, 40
07/10	21:49	27	N	S8	60	09.30	147	59.40	207	82
07/10	22:11	27	N	S8	60	09.25	147	59.45	207	48, 30

Table 4. CTD stations sampled on APEX research cruises in 1997

DATE	TIME	STN	LOCATION	LATITUDE		LONGITUDE		BOTTOM DEPTH (M)	GEAR DEPTH (M)
CRUISE 97-1									
97/18/05	22:27	3	971N5	60	43.77	146	19.56	38	25
97/19/05	0:16	4	971N4	60	42.45	146	19.98	44	35
97/19/05	1:09	5	971N7	60	40.67	146	18.83	120	115
97/19/05	2:04	6	971N8	60	42.01	146	13.33	151	145
97/19/05	15:00	7	St. Matt's Bay	60	44.72	146	19.22	40	30
97/19/05	22:50	8	971N3	60	40.88	146	23.57	38	30
97/19/05	23:31	9	971N6	60	38.64	146	22.91	126	120
97/20/05	0:19	10	971N2	60	38.87	146	28.04	45	40
97/20/05	1:07	11	971N1	60	39.86	146	36.27	30	25
97/20/05	14:00	12	Whale Bay	60	12.94	146	11.89	33	25
97/20/05	14:50	12	Whale Bay	60	12.94	147	11.89	33	25
97/22/05	22:47	18	971S1	60	19.33	148	10.25	245	200
97/22/05	23:33	19	971S2	60	16.83	148	12.14	160	155
97/23/05	0:19	20	971S3	60	16.43	148	8.02	287	200
97/23/05	1:09	21	971S4	60	13.68	148	10.85	310	200
97/23/05	2:08	22	971S5	60	15.87	148	2.79	465	200
97/23/05	3:17	23	971S7	60	14.47	148	59.06	600	200
97/23/05	4:12	24	971S6	60	12.25	148	4.91	250	200
97/23/05	4:59	25	971S8	60	9.91	147	59.04	57	40
CRUISE 97-2									
97/18/07	0940	1	S0205	60	3.97	147	54.58	120	120
97/18/07	10:00	1	S0205	60	3.97	147	54.58	110	100
97/18/07	11:30	2	S0405	60	5.21	147	53.17	320	125
97/19/07	08:00	8	S0605	60	3.45	148	6.8	50	45
97/19/07	12:25	12	S0805	60	12.6	148	3.95	310	155
97/19/07	16:02	15	S1005	60	14.5	148	9.9	366	155
97/20/07	08:20	17	S1405	60	19.79	148	9.77	120	110
97/20/07	15:10	20	S1605	60	22.96	148	1.73	100	95
97/20/07	18:14	23	S2005	60	13.84	147	58.95	600	155
97/21/07	11:55	25	M0104	60	10.70	147	21.58	33	25
97/22/07	09:30	31	C0104	60	23.79	147	33.78	100	95
97/22/07	13:10	34	C0205	60	28.13	147	36.22	160	145
97/22/07	17:20	37	C0305	60	33.09	147	31.32	310	155
97/23/07	09:40	39	C0405	60	38.19	147	18.21	80	75
97/23/07	14:00	43	C0505	60	41.11	147	20.69	80	70
97/23/07	17:05	47	C0605	60	44.62	147	28.04	120	132
97/24/07	10:20	50	C0705A	60	39.95	147	30.3	55	50
97/24/07	13:19	53	C0805A	60	37.95	147	23.60	54	50
97/25/07	07:50	55	N1905A	60	56.5	146	41.05	109	110
97/25/07	13:27	60	N1705B	60	55.0	146	45.8	114	110
97/25/07	17:24	63	N1505A	60	47.9	146	49.5	45	40
97/26/07	08:57	69	N1305A	60	48.51	146	39.05	33	30
97/26/07	10:00	70	N1302B	60	49.84	146	36.47	61	1-2
97/26/07	11:21	71	N0905A	60	47.52	146	26.18	212	135
97/26/07	15:45	75	N0705A	60	45.05	146	39.5	45	40
97/27/07	09:21	82	N0505A	60	40.3	146	32.4	21	20
97/27/07	13:10	85	N0305	60	44.01	146	19.46	41	40
97/27/07	18:10	91	N0105A	60	40.05	146	15.5	45	40
97/29/07	12:20	92	972N6	60	38.88	146	19.70	140	120
97/29/07	12:58	93	972N7	60	39.76	146	15.90	133	120
97/29/07	13:29	94	972N8	60	40.83	146	12.41	144	130
97/29/07	18:30	100	972N3	60	39.40	146	21.85	48	40
97/29/07	19:01	101	972N4	60	41.07	146	18.00	60	60
97/29/07	19:22	102	972N5	60	42.67	146	18.73	30	25
97/30/07	08:40	103	972N2	60	37.92	146	24.67	54	50
97/30/07	12:55	109	972N1	60	38.63	146	35.65	40	30
97/30/07	15:21	113	N13	60	41.42	146	48.46	364	150
97/30/07	16:03	114	N12	60	43.48	146	53.49	424	150

Table 4. Continued

DATE	TIME	STN	LOCATION	LATITUDE		LONGITUDE		BOTTOM	GEAR
97/30/07	17:50	115	N01A2	60	45.47	146	38.62	113	115
97/31/07	10:04	117	N02A2	60	47.45	146	38.51	78	70
97/31/07	12:37	119	N01A	60	45.39	146	59.03	424	150
97/31/07	13:45	121	N03A	60	49.69	146	58.77	364	150
97/31/07	14:40	122	N05A	60	52.73	146	55.54	348	150
97/31/07	18:10	124	N07A	60	58.10	146	46.45	364	150
97/01/08	12:35	127	972C5	60	43.72	147	17.84	154	140
97/01/08	13:09	128	972C6	60	41.70	147	15.05	173	150
97/01/08	13:39	129	972C7	60	40.30	147	15.11	118	125
97/01/08	14:09	130	972C8	60	38.30	147	15.00	170	140
97/01/08	16:00	131	972C4	60	37.04	147	36.20	606	150
97/01/08	16:34	132	972C3	60	39.12	147	36.37	545	150
97/01/08	17:10	133	972C2	60	41.02	147	33.34	398	150
97/01/08	17:52	134	972C1	60	43.71	147	33.44	364	150
97/03/08	9:35	138	972S1	60	19.5	148	9.95	240	150
97/03/08	10:46	139	972S2	60	16.88	148	12.8	160	140
97/03/08	11:05	140	972S2	60	17.14	148	11.18	250	150
97/03/08	11:31	141	972S3	60	16.48	148	8.09	265	150
97/03/08	15:48	144	972S4	60	13.86	148	10.37	340	150
97/03/08	16:49	145	972S6	60	12.18	148	4.69	245	150
97/04/08	09:53	148	972S8	60	10.19	147	58.69	237	150
97/04/08	10:43	149	972S7	60	14.03	147	59.60	545	150
97/04/08	11:17	150	972S5	60	15.24	148	02.89	540	150
97/04/08	16:50	153		60	06.99	147	48.75	980	150
97/06/08	09:20	162	C01	60	22.26	147	30.10	152	140
97/06/08	12:20	164	C03	60	26.30	147	30.00	155	140
97/06/08	14:35	166	C05	60	30.30	147	29.96	194	150
CRUISE 97-3									
01/10	17:02	1	N6	60	38.58	146	23.00	125	115
01/10	20:38	2	N4	60	42.43	146	19.99	40	30
01/10	21:26	3	N3	60	40.84	146	23.53	36	25
01/10	22:09	4	N2	60	38.89	146	28.08	41	30
01/10	22:57	5	N1	60	39.86	146	36.24	29	20
02/10	00:11	6	N6	60	38.58	146	22.91	126	115
02/10	01:45	7	N7	60	40.65	146	18.76	123	110
02/10	20:31	8	N5	60	43.80	146	19.55	38	25
02/10	21:25	9	N8	60	42.02	146	13.35	148	135
04/10	20:00	15	C8	60	37.93	146	16.27	152	140
04/10	21:13	16	C7	60	39.94	146	13.59	140	130
04/10	22:02	17	C6	60	41.41	146	13.61	173	150
04/10	23:13	18	C5	60	43.43	146	16.40	168	150
05/10	00:53	19	C1	60	44.00	147	34.71	578	150
06/10	19:57	20	S1	60	19.23	148	10.25	232	150
06/10	21:15	21	S2	60	16.85	148	12.11	158	145
06/10	22:52	22	S3	60	16.45	148	08.10	256	150
06/10	23:49	23	S5	60	15.84	148	02.72	478	150
07/10	01:19	24	S6	60	12.26	148	04.90	248	150
07/10	02:47	25	S4	60	13.64	148	10.83	278	150
07/10	20:05	26	S7	60	14.33	147	59.15	591	150
07/10	21:32	27	S8	60	09.72	147	59.18	207	150

Table 5. Mean biomass density estimates for 1996 and 1997 nearshore acoustic surveys in North, Central and South study areas of PWS

		TRANSECT LENGTH (km)			**BIOMASS DENSITY (G/M2)**	
	N	**Mean**	**Std. Err.**		**Mean**	**Std. Err.**
1996						
NORTH	181	1.200	0.020		1.560	0.340
CENTRAL	111	1.230	0.020		0.780	0.310
SOUTH	137	1.240	0.016		1.060	0.320
1997						
NORTH	181	1.060	0.020		0.238	0.056
CENTRAL	154	1.090	0.025		1.675	0.792
SOUTH	170	1.100	0.030		1.300	0.600

Table 6. Positive identifications of acoustic targets in the 1997 nearshore acoustic survey of PWS.

GEAR CODES: A - Cast net, B - Beach seine, D - Dip net, F - Fry seine, J - Herring jig, T - Midwater trawl, U - Purse seine, V - Video

DATE	TIME	STN	GEAR	LOCATION		LAT.		LONG	BOTTOM DEPTH (M)	GEAR DEPTH (M)	SPECIES
18/07	17:50	4	V	Prince of Wales P.	60	1.33	148	8.89	35	30	ROCKFISH
18/07	18:12	5	V	"	60	0.92	148	9.20	21	50	HERRING
18/07	18:30	6	V	"	60	2.11	148	8.54	67	15	HERRING
19/07	14:15	14	B	"	60	8.94	148	9.46	50	3	SANDLANCE
19/07	14:00	13	V	Bainbridge P.	60	8.94	148	9.46	50	5	SANDLANCE
20/07	11:30	19	U	Ewan Bay	60	20.27	148	7.36	100	33	HERRING
21/07	15:00	27	B	Green Is.	60	15.86	147	21.48	18	5	HERRING
21/07	13:40	26	V	M0110A	60	14.74	147	19.12	25	10	HERRING
22/07	11:00	32	A	C0105B	60	23.29	147	40.13	28	3	SANDLANCE
22/07	08:20	30	V	near C0101A; Knight Is	60	21.46	147	37.08	62	35	ROCKFISH
22/07	10:41	32	V	C0105B	60	23.29	147	40.13	28	5	HERRING
22/07	11:40	33	V	C0107A	60	24.01	147	41.49	20	13	HERRING, ROCKFISH
22/07	15:40	35	V	Inget Is.	60	29.74	147	36.87	13	8	HERRING
23/07	08:50	38	J	C0402; Naked Is	60	37.16	147	22.38	40	20	HERRING
23/07	08:27	38	V	C0402, Naked Is.	60	37.16	147	22.38	40	20	HERRING
24/07	11:00	51	B	b/t Cabin and Outside Bay	60	38.75	147	29.71	5	5	SANDLANCE
24/07	08:33	49	U	small cove N. of Cabin Bay	60	40.87	147	27.94	29	33	SOCKEYE
24/07	11:59	52	V	C0706B	60	38.63	147	30.29	40	40	ROCKFISH
25/07	10:00	58	U	N1904A	60	56.70	146	40.45	48		HERRING
25/07	14:45	61	U	N1702A	60	53.91	146	44.06	28		HERRING
25/07	17:35	64	V	N1504B	60	48.11	146	48.53	15	9	ROCKFISH
25/07	18:15	66	V	N1503B	60	47.83	146	47.34	25	9-25	HERRING
26/07	07:55	68	V	N1301A	60	52.69	146	38.05	52	6-21	HERRING
26/07	12:15	72	V	N0910A	60	47.61	146	19.72			SHARKS
26/07	13:20	73	V	Irish Cove; Pt Fidalgo	60	46.08	146	26.74	12	3-8	HERRING
26/07	17:25	79	V	N0701B	60	44.17	146	43.55	36	32	HERRING
27/07	15:57	88	D	Olsen Bay	60	43.39	146	12.78	48	surface	HERRING
27/07	14:40	87	U	b/t St Matthew's and Olson	60	42.77	146	14.78	30		HERRING
27/07	13:45	86	V	N0302B	60	42.33	146	17.73	52	45	HERRING
27/07	16:40	89	V	N0110B; Pt. Gravina	60	42.262	146	09.75	40	30-40	ROCKFISH, SHARK
27/07	17:40	90	V	"	60	40.36	146	14.27	15-21	12-20	ROCKFISH,
29/07	15:45	97	U		60	41.92	146	10.68	82		HERRING
29/07	15:00	97	V		60	41.84	146	10.69	88	15	HERRING
29/07	17:00	98	V	Pt Gravina	60	42.14	146	18.45	58	5-15	HERRING
29/07	17:40	99	V	Pt Gravina; 972N8A	60	39.30	146	18.24	115	8	HERRING
30/07	09:37	104	J		60	37.66	146	28.93	30	15	HERRING
30/07	09:05	104	V		60	38.50	146	30.67	30	15	HERRING
30/07	11:15	106	V	3A	60	39.00	146	34.02	36	24	HERRING
30/07	13:05	110	V		60	39.65	146	39.69	43	8-11	HERRING
31/07	11:06	118	D		60	47.52	146	45.00	7	surface	HERRING
31/07	15:30	123	V		60	54.09	146	46.60	18	6	HERRING
01/08	10:20	125	B	N. end of Storey Is.	60	43.4	147	23.65	2-3		HERRING, SANDLANCE
02/08	09:45	135	F	Naked	60	41.52	147	28.65	9		HERRING
02/08	13:00	136	F		60	40.15	147	26.77	18		HERRING
03/08	08:45	137	F	Jackpot Bay	60	20.69	148	12.08	9		HERRING
03/08	14:00	142	F		60	10.36	148	10.25	12		HERRING
04/08	07:22	146	D		60	10.72	148	02.80	11	surface	HERRING
04/08	15:30	152	F		60	03.91	147	50.16	3		HERRING
04/08	13:45	151	F	Shelter Bay	60	07.70	147	56.67	16		HERRING,SANDLANCE
04/08	08:10	147	V		60	10.30	148	02.92	51	26	HERRING
05/08	08:30	154	T	Montague St	60	09.702	147	33.189	103	70	POLLOCK
05/08	09:20	155	T	"	60	10.92	147	27.36	100	70	POLLOCK,HERRING
05/08	10:45	156	T	"	60	14.25	147	22.25	45	35-40	HERRING, CAPELIN
05/08	11:45	157	T	"	60		147		35	10-20	CAPELIN
05/08	13:00	158	T	"	60	17.67	147	17.67	125	80-90	POLLOCK

Table 7. Biomass density estimates from nearshore acoustic surveys of North, Central and South study areas in 1996 and 1997.

SPECIES	96 NORTH	97 NORTH	96 CENTRAL	97 CENTRAL	96 SOUTH	97 SOUTH
YOY HERRING	0.013	0.128		0.008	0.001	0.016
1+ HERRING	0.754	0.002			0.432	
ADULT HERRING	0.001	0.011	0.442	1.444	0.353	1.092
SAND LANCE	0.19		0.002	0.023	0.001	0.017
YOY POLLOCK	0.021					0.001
ROCKFISH	0.087		0.257	0.155	0.19	0.11
PLANKTON/OTHER	0.492	0.098	0.08	0.061	0.081	0.066
TOTAL	1.557	0.238	0.781	1.69	1.058	1.302

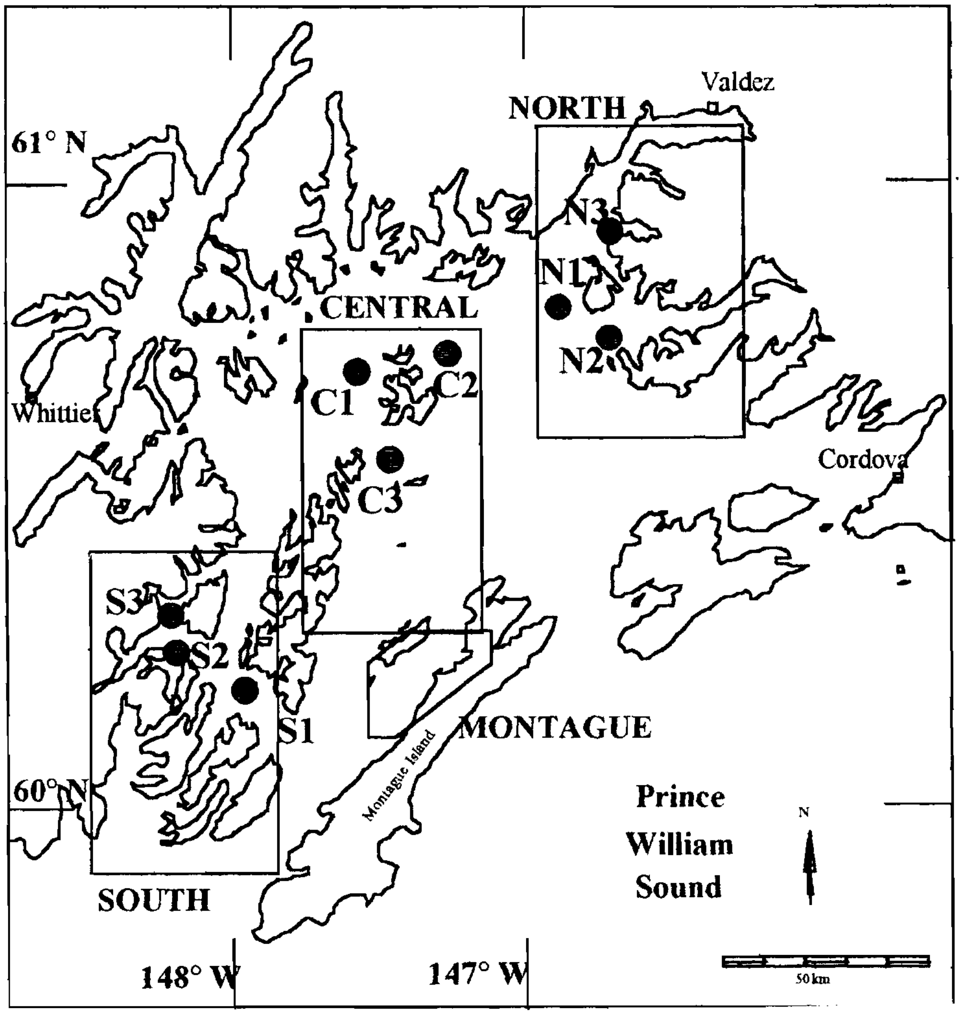

Figure 1. Locations of acoustic survey study areas for the APEX project, with locations of temperature projles comparing 1995, 96 and 97.

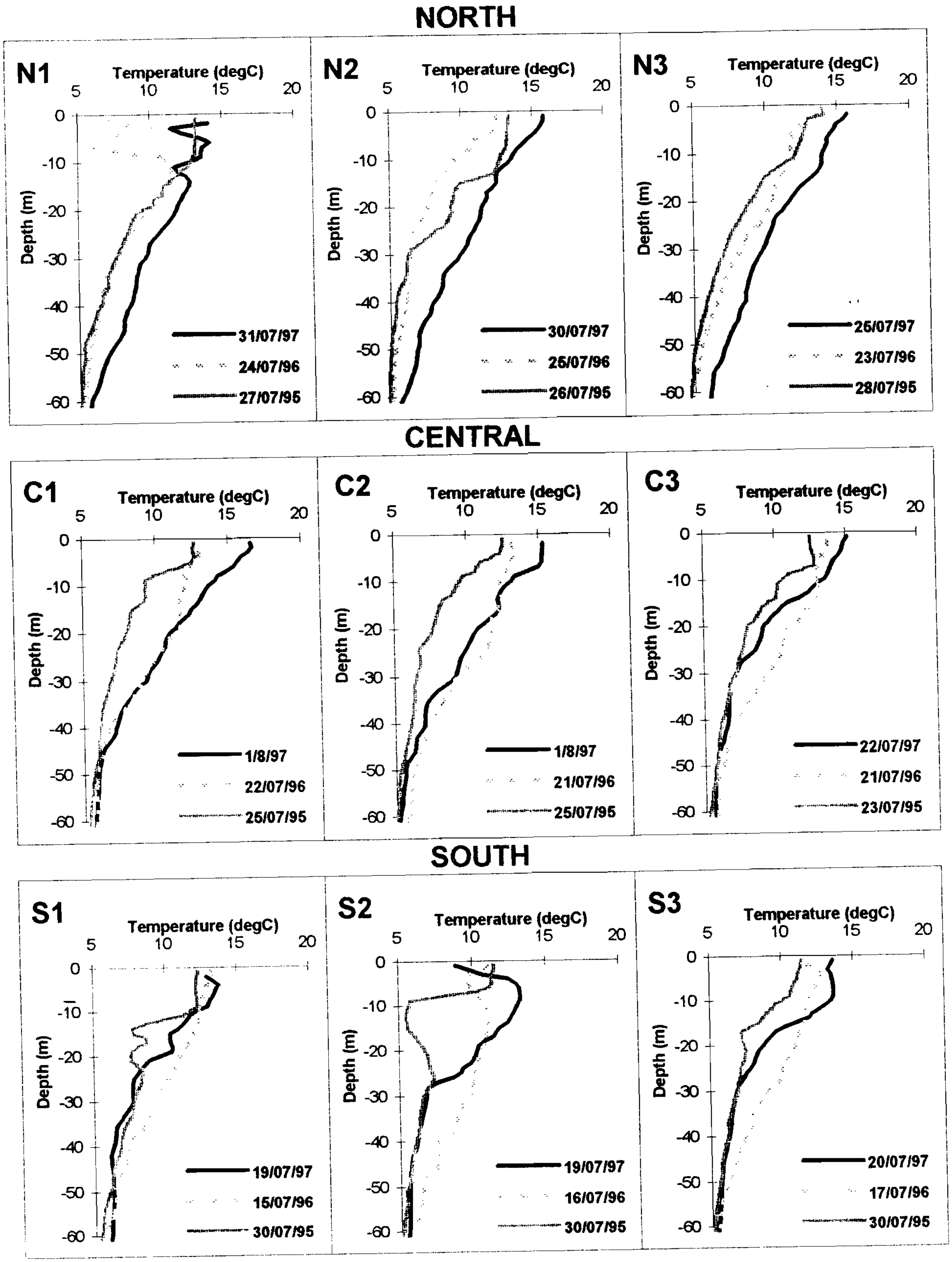

Figure 2. Temperature profiles for selected stations in the North, Central and South study areas in 1995, 1996 and 1997.

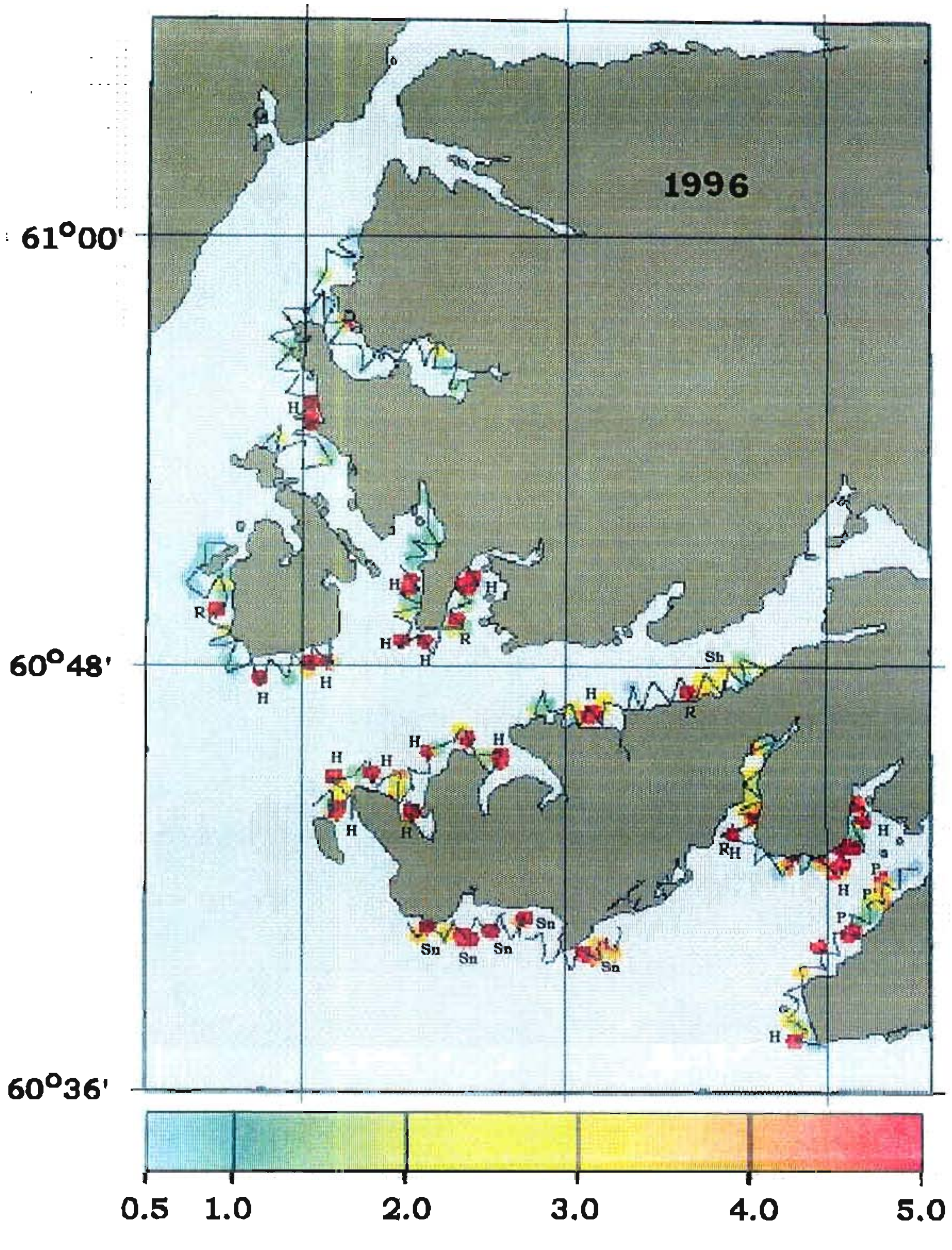

Figure 3. Geographic distibution of acoustic biomass in the North study area in 1996. Color scale units are grams/m^2. Codes for species are H - herring, Sn - sandlance, R - rockfish.

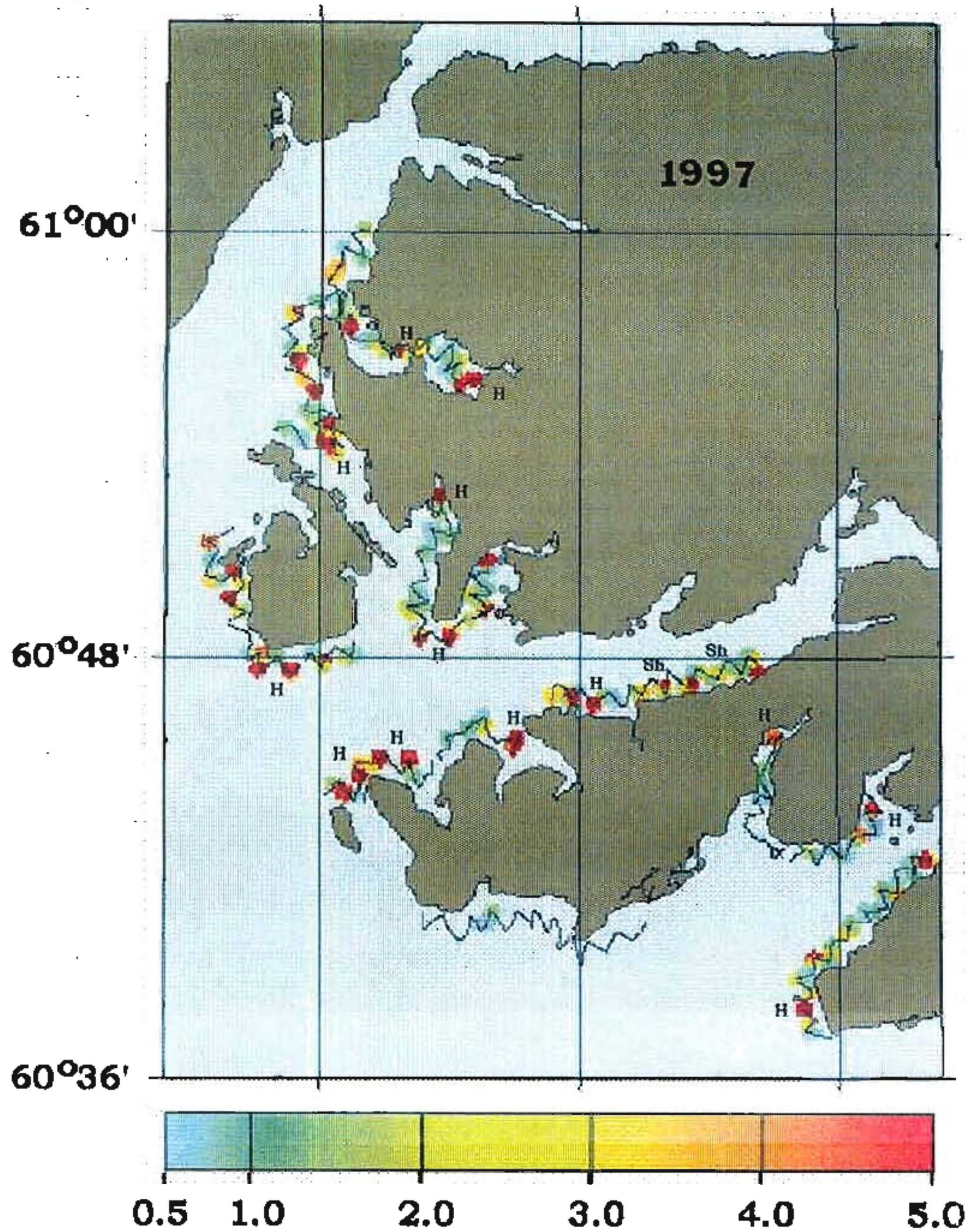

Figure 4. Geographic distibution of acoustic biomass in the North study area in 1997. Color scale units are grams/m^2. Codes for species are H - herring, Sn - sandlance, R - rockfish.

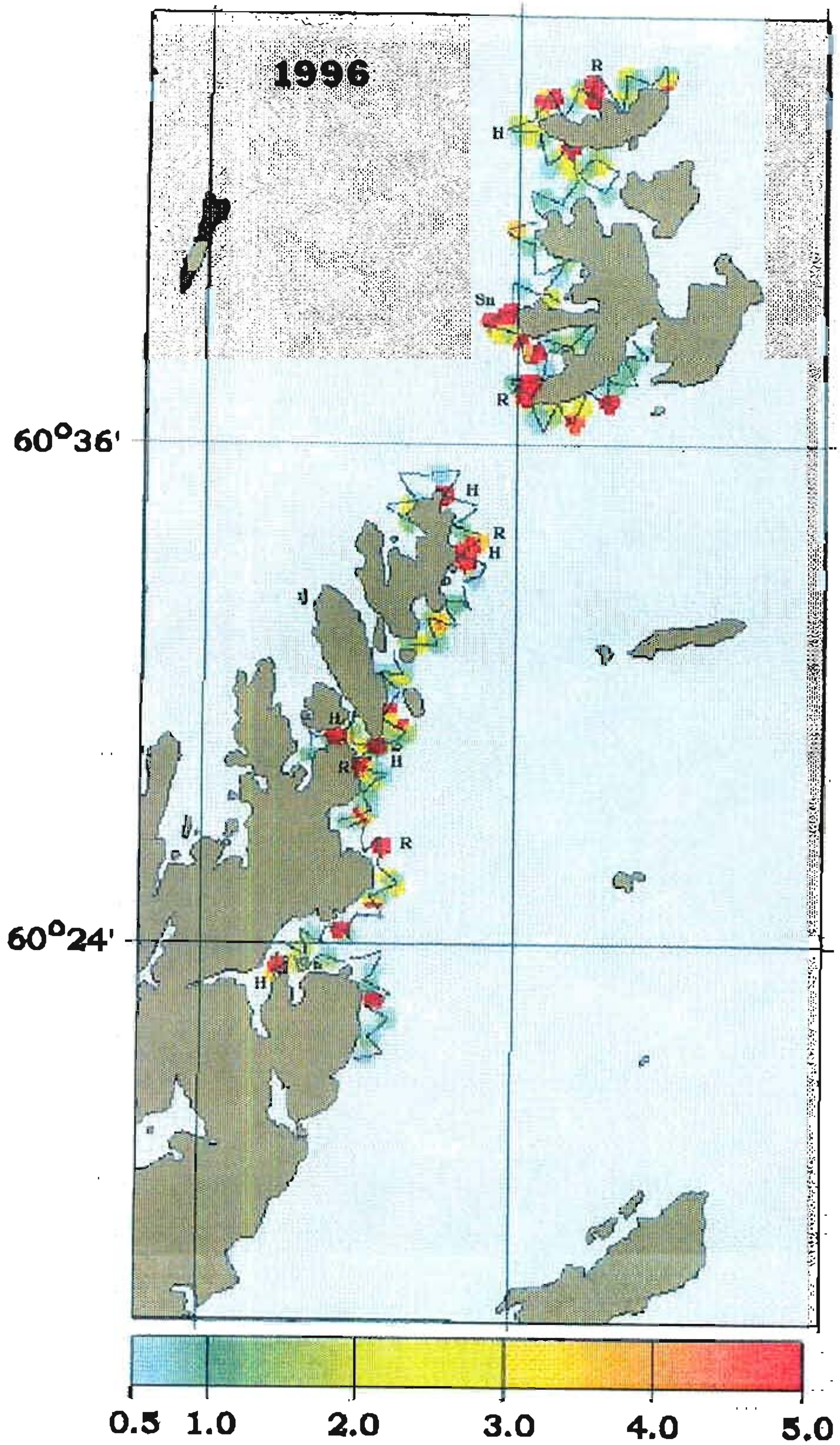

Figure 5. Geographic distibution of acoustic biomass in the Central study area in 1996. Color scale units are grams/m^2. Codes for species are H - herring, Sn - sandlance, R - rockfish.

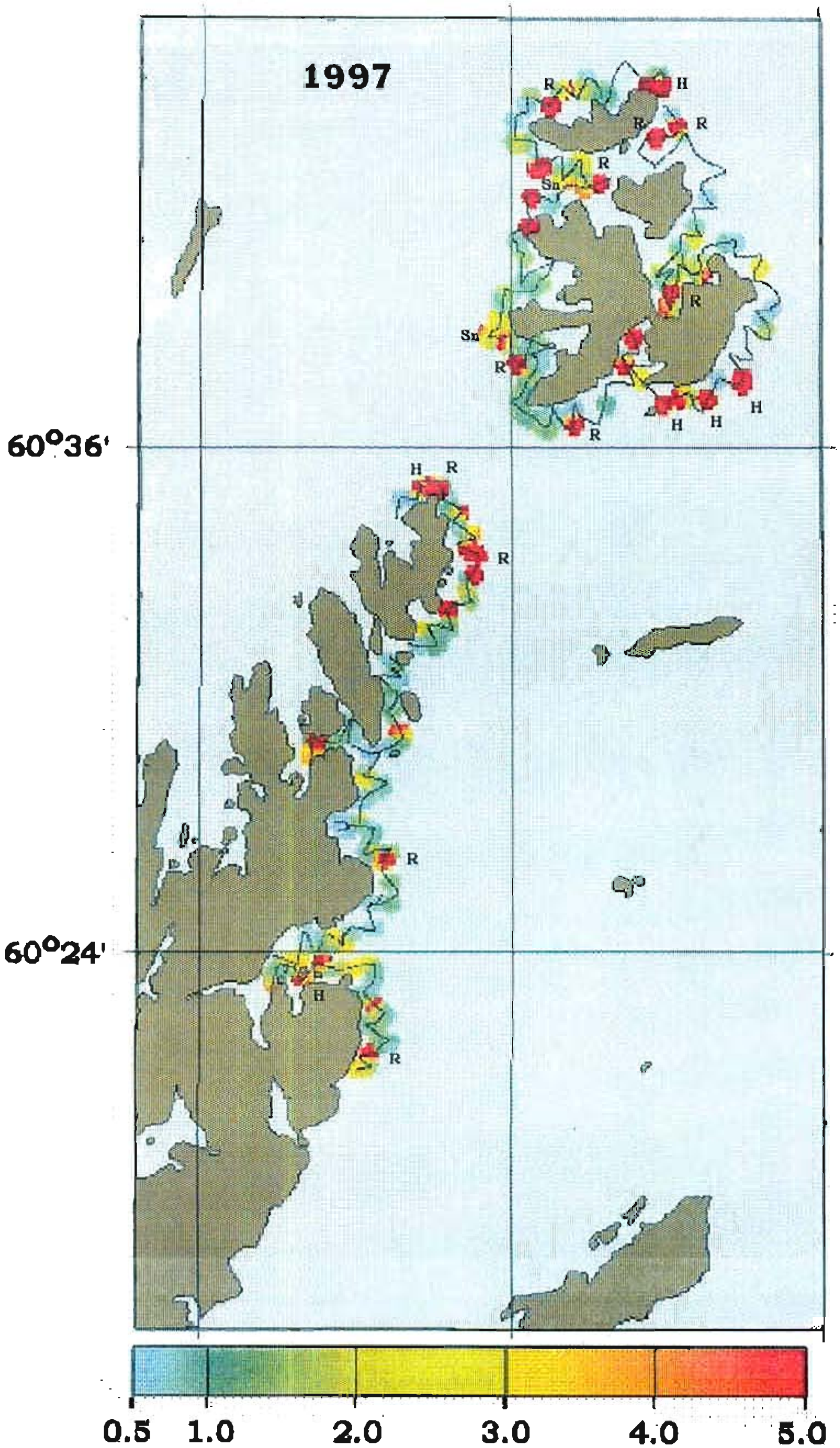

Figure 6. Geographic distibution of acoustic biomass in the Central study area in 1997. Color scale units are grams/m^2. Codes for species are H - herring, Sn - sandlance, R - rockfish.

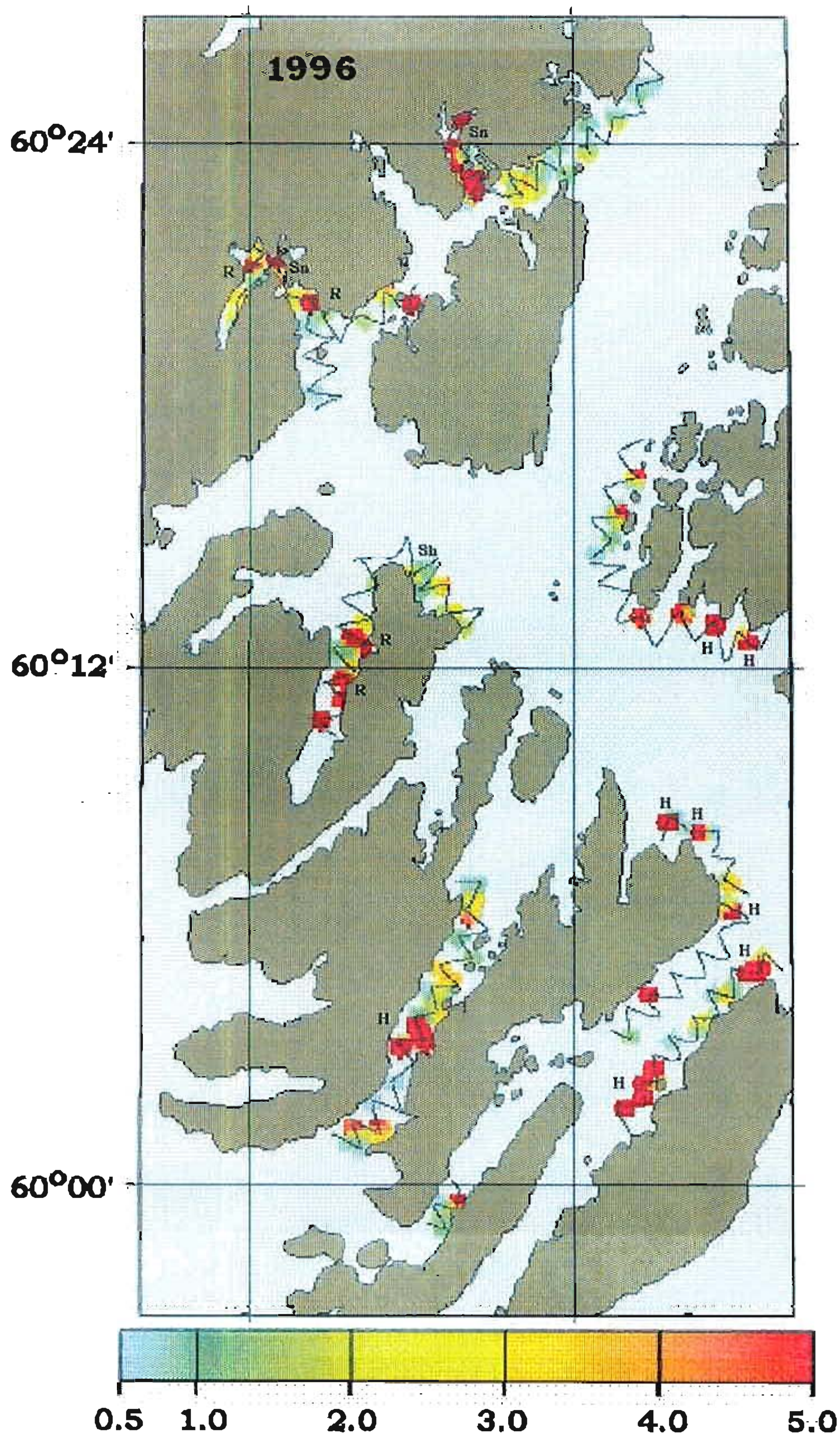

Figure 7. Geographic distibution of acoustic biomass in the South study area in 1996. Color scale units are grams/m^2. Codes for species are H - herring, Sn - sandlance, R - rockfish.

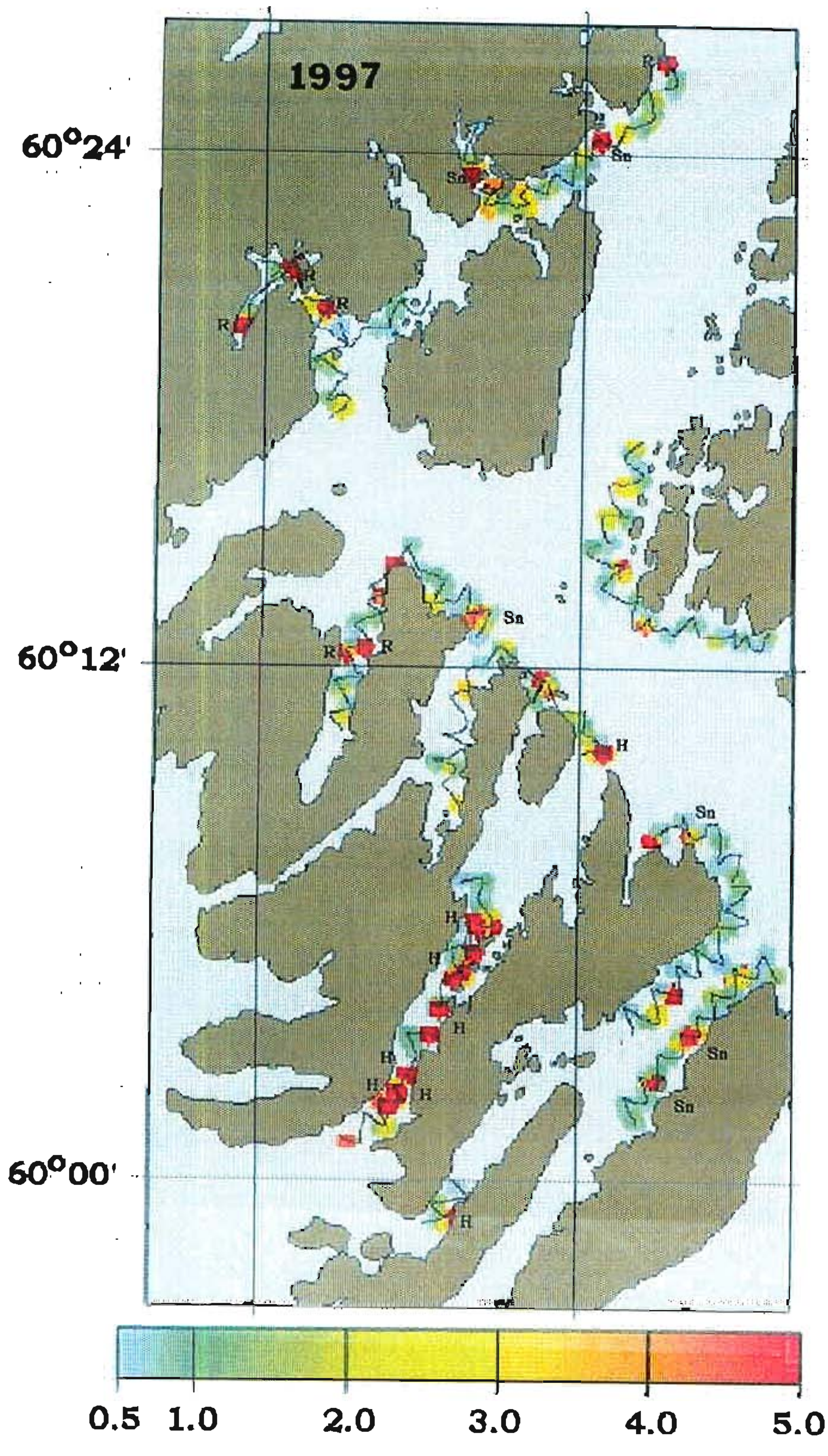

Figure 8. Geographic distibution of acoustic biomass in the South study area in 1997. Color scale units are grams/m^2. Codes for species are H - herring, *Sn* - sandlance, R - rockfish.

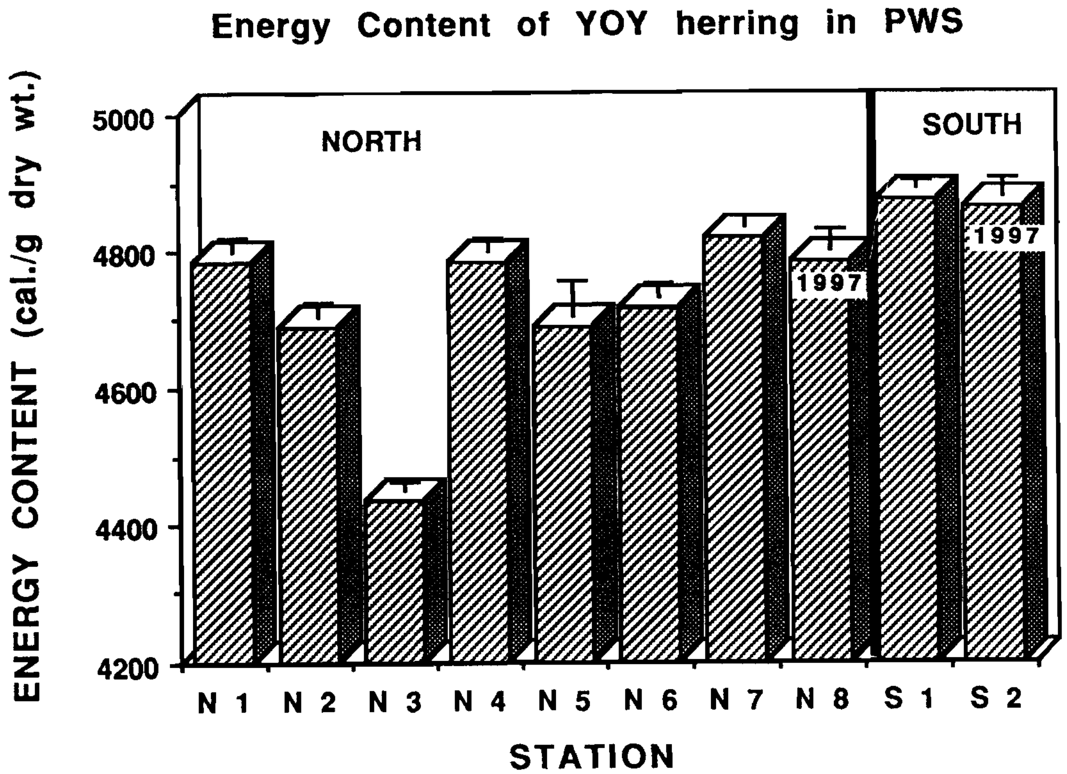

Figure 9. Energy content of YOY herring collected in Prince William Sound in 1996 and 1997. Sample locations are: N1 - Tatitlek Narrows, N2 - Landlocked Bay, N3 - Bligh Island, N4 - Port Gravina, N5 - Red Head, N6 - St. Mathews Bay, N7 - Gravina Point, N8 - 1997 Tatitlek Narrows, S1- 1996 Jackpot Bay, S2 - 1997 Shelter Bay.

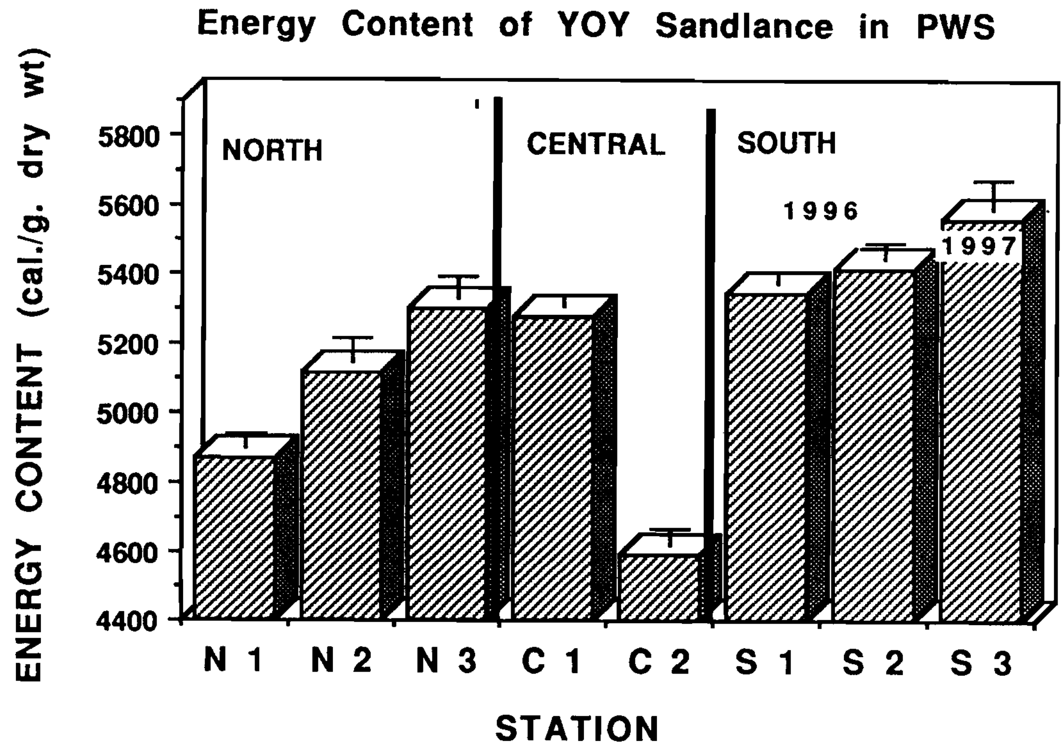

Figure 10. Energy content of YOY sandlance collected in Prince William Sound in 1996 and 1997. Sample locations are: N1 - Knowles Bay, N2 - Bligh Island, N3 - Port Fidalgo, C1 - Bay of Isles, C2 - Cabin Bay, S1 - Swanson Bay, S2 - Bainbridge Passage, S3 - 1997 Shelter Bay.