AMNWR 04/01

SEABIRD, FISH, MARINE MAMMAL, AND OCEANOGRAPHY COORDINATED INVESTIGATIONS (SMMOCI) IN SITKA SOUND, ALASKA, JULY 2000

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Key Words: Alaska, CTD, fishes, hydroacoustics, marine mammals, oceanography, pelagic surveys, prey, salinity, seabirds, St. Lazaria Island, Sitka Sound, southeast Alaska, temperature, thermosalinograph

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August 2005

Cite as: Piatt, J. F., and D. E. Dragoo. 2005. Seabird, fish, marine mammal, and oceanography coordinated investigations (SMMOCI) in Sitka Sound, Alaska, July 2000. U. S. Fish and Wildl. Serv. Report AMNWR 04/01.

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EXECUTIVE SUMMARY

Surveys for seabirds, marine mammals and forage fish were conducted in Sitka Sound from the *M/V Tiĝlax̂* during 12-16 July 2000. The objective was to characterize the marine environment in the vicinity of St. Lazaria Island, one of ten seabird colonies monitored annually by the Alaska Maritime National Wildlife Refuge. In addition to censusing seabirds and mammals encountered on line transects, we characterized local oceanography. Zooplankton were sampled at the surface and with vertical tows. The relative abundance of zooplankton and fish biomass was measured using a dual-frequency echosounder. Significant acoustic targets were sampled with a mid-water trawl net. Long-lines were set to catch large demersal fish species and stomach samples from some of these fishes were analyzed to further characterize the marine food web.

The Sitka Sound study area was interesting because transects of only 28-56 km in length extended from shallow coastal waters to a deep oceanic basin. Coastal habitat included shallow waters of less than100 m, numerous islands and island passes, and numerous shoals, reefs and rocks; and was mostly in Sitka Sound. Shelf habitat included waters between 100 and 200 m in depth with relatively smooth bottom, which comprised a broad band running north to south outside Sitka Sound. Shelf-edge (slope) habitat (200-1500 m) extended offshore and ran the length of this shelf, and deep oceanic waters were found beyond about the 1500 m contour. For comparison, it would require a 556-649 km transect to cover such a range of habitats in the southeastern Bering Sea, and a 222-259 km transect in the northern Gulf of Alaska.

A total of 3225 birds was counted on 19 transects that covered 597 linear km. This equals about 18 birds/km^2 over an area of approximately 179 km^2, a bird density comparable to Glacier Bay, another southeast Alaska site. Coastal species included pelagic cormorants and marbled murrelets. Coastal/shelf species included common murres, *Larus* gulls and tufted puffins. Shearwaters were common in both shelf and slope habitat. Commonly distributed across both slope and oceanic habitats were northern fulmars, fork-tailed storm-petrels, and black-footed albatrosses. Rhinoceros auklets and Cassin's auklets were unusual in that they spanned all habitats from coastal to oceanic.

Harbor seals, sea otters, harbor porpoises, and sea lions were observed entirely in coastal/shelf waters. Humpback whales were observed in coastal, shelf and slope waters, sei whales and Dall's porpoises in slope waters, and Pacific white-sided dolphins in oceanic waters.

In general, acoustic biomass was greatest in slope habitat, where deep layers of myctophids observed during the day moved up at night; in shelf habitat where extended aggregations of juvenile walleye pollock were observed between mid-water and the bottom; and in coastal habitat where rocks and shoals provided bathymetric relief to otherwise soft bottoms. Schools of rockfish were evident on the echosounder in association with bottom topographic features in many areas. A total of 23,016 mostly juvenile fish were caught during 12 trawls and catches were dominated by jellyfish and walleye pollock. Fifty-six groundfish were caught during 2 long-line sets, including Pacific halibut, quillback rockfish, and yelloweye rockfish. Stomachs from quillback rockfish contained a variety of prey, Pacific sand lance being the most prevalent.

Examination of water column temperature and salinity profiles showed that all waters were stratified. Analysis of sea-surface temperature and salinity measurements suggested marked gradients in surface properties throughout the study area.

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INTRODUCTION

Surveys for seabirds and marine mammals were conducted in and near Sitka Sound, Alaska (Fig. 1) from the *M/V Tiĝlax̂* during 12-16 July 2000 (Table 1, Fig. 1). The objective was to characterize the marine environment in the vicinity of St. Lazaria Island, one of ten seabird colonies monitored annually by the Alaska Maritime National Wildlife Refuge (See Dragoo et al. 2003). In addition to censusing seabirds and mammals encountered on line transects, local oceanography was characterized by measuring water temperature and salinity continuously at the sea surface, and by taking profiles of the water column on a series of CTD transects. The relative abundance of zooplankton and fish biomass was measured using a dual-frequency echosounder. Significant acoustic targets were sampled with a mid-water trawl net. Long-lines were set twice to catch and characterize diets of large demersal fish species.

Rosenthal et al. (1981 and 1982) studied the bottomfish component of the nearshore habitats in southeastern Alaska including the Sitka Sound area during the summers of 1980 and 1981, allowing comparisons of our findings to those from the earlier works. There are no previous surveys for seabirds or marine mammals in this area with which we can compare our surveys.

Personnel

The following scientific personnel participated in the cruise:
U.S. Fish and Wildlife Service: Vernon Byrd, Don Dragoo, Jeff Williams, Susan Woodward, Leslie Slater, Doug Palmer, John Tobin, Claire Caldes
U.S. Geological Survey: John Piatt
Volunteers: Barry Sampson (Minnesota DNR), Rebecca Joyce (Sitka)

METHODS

Bird and Marine Mammal Observations

Birds were censused using line transect methods described by Gould and Forsell (1989), and employed on previous SMMOCI cruises. Surveys were conducted on 19 different transects, most of which ran northeast to southwest and encompassed most of inner Sitka Sound and offshore waters beyond the continental shelf (Fig. 2). All birds observed on the water within 150 m on either side of the vessel were recorded continuously; flying birds were counted on 'scans' every three minutes. Other behaviors (feeding, carrying fish, etc.) also were noted. Marine mammals and jumping salmon were counted on the same transects as birds. Data were recorded on logging computers and all records were assigned GPS positions in real time. Bird and marine mammal distributions were mapped and densities were estimated from these data.

Hydroacoustic Surveys

Acoustic data were collected along the same transects used for marine bird and mammal observations (Fig. 2). Relative prey abundance was determined on all transects using a dual frequency (38 and 120 kHz split beam transducers) Simrad EK500 echosounder. In addition, acoustic data were collected during mid-water trawls on significant fish sign. The threshold for data collection was set at -80 dB. Acoustic data were echo integrated using SonarData Echoview® software to a maximum depth of 200 m, excluding the top 10 m of the water column. Nineteen depth strata were defined for analysis, beginning at 10 m below the hull-mounted transducers to a depth of 200 m, in 10 m increments. Data were summarized as: 1) estimated water column biomass (relative density) by transect, and 2) estimated relative biomass of prey by 10 m depth stratum. Only data from the 120 kHz transducer were integrated and summarized for this report because this frequency tends to highlight the size range of typical seabird prey species.

Fishing

Trawls.--Mid-water trawls were conducted to describe prey recorded with the hydroacoustics equipment. Significant fish aggregations were sampled with a 6 m modified herring trawl towed for 10 or 15 minutes at 2-3 kts. A depth sounder (Netmind, Northstar Technical, St. John's, NF, Canada) was attached to the foot rope of the trawl to determine fishing depth. Samples collected were identified, counted, and measured for fork length (a subsample only).

Long-line Sets.-- Single skates with about 100 hooks baited with herring were deployed at subjectively selected sites at or near slack tide and soaked for about 2 hours. Fish caught were identified, measured (fork length), and some of their stomachs were removed for later analysis.

Oceanographic Data

Water Column Temperature and Salinity Profile.-- A portable CTD (Sea-Bird Seacat SBE-19 Profiler, with pump) was deployed every three nmi. along three transect lines (6, 11 and 16), approximately every 6 nautical mile along transect 12 and at the end of each fishing event (tow or long-line set). In this way temperature and salinity data were obtained for the entire water column, to the maximum cable length of the deployment crane (about 100 m). Water column temperature and salinity profiles were produced using Ocean Data View® (Schlitzer 2004).

Sea Surface Temperature and Salinity.--Sea surface temperature and salinity were recorded continuously using a Sea-Bird Seacat SBE21 thermosalinograph during transects. Data were used to generate temperature and salinity contour maps as a way of illustrating the occurrence of surface structures such as fronts.

RESULTS AND DISCUSSION

Habitats may be characterized with respect to bathymetry and distance from land. These characterizations reflect what we observed in Sitka Sound, but are based on work conducted elsewhere as well. This study area was interesting because transects of only 28-56 km (15-30 nm) in length included depths from shallow coastal waters to a deep oceanic basin (>1500 m, Fig. 2). Coastal habitat included shallow waters of ca. <100 m, numerous islands and island passes, and numerous shoals, reefs and rocks. Shelf habitat included waters between 100 and 200 m in depth with relatively smooth bottom, which comprised a broad band running north to south outside Sitka Sound. Shelf-edge (slope) habitat (200-1500 m) extended offshore the length of this shelf , and deep oceanic waters were found beyond about the 1500 m contour. For comparison, it would require a 556-649 km (300-350 nm) transect to cover such a range of habitats in the SE Bering Sea, and a 222-259 km (120-140 nm) transect in the northern Gulf of Alaska.

Bird and Marine Mammal Observations

A total of 3225 birds was counted on 19 transects that covered 597 linear km of surveys (Table 2, Appendix A). This translates into about 18 birds/km^2 over an area of approximately 179 km^2. These densities are typical for southeast Alaska, much lower than observed around most other seabird colonies in the Gulf of Alaska and Bering and Chukchi Seas, but similar to Norton Sound (see table below).

Estimates of seabird density from other SMMOCI-like cruises are:

Colony Area	**# birds/km^2**	**Reference**
Cape Thompson / Chukchi Sea	54	Piatt et al. 1990
Diomede Islands / Bering Strait	73	Piatt et al. 1990
Norton Sound	13	D. Dragoo Unpubl. Data
Pribilof Islands / Southeast Bering Sea	51	Dragoo and Byrd 1998
Buldir Island/ Western Aleutians	145	Dragoo and Byrd 1999
Kasatochi Island / Central Aleutians (1996)	110	Drew et al. 2003
Aiktak Island / Unimak Pass, Eastern Aleutians	38	Byrd et al. 1997
Barrens / Lower Cook Inlet (1992)	174	Piatt 1994
Barrens / Lower Cook Inlet (1996)	126	Piatt 2003
Glacier Bay/ Southeast Alaska	21	Robards et al. 2003
St. Lazaria/ Sitka Sound, Southeast Alaska	18	This study

In contrast to some of these other regions, the bird community off Sitka was not dominated numerically by a few species; rather, diversity was relatively high and no species comprised more than 20% of the total (Table 2). Most abundant were common murres (17.7%), rhinoceros auklets (12.2%), marbled murrelets (12.1%), glaucous-winged gulls (10.0%) and northern fulmars (7.1%). No other species comprised more than 5% of the total. Overall, the community was dominated by Alcids (54%), Procellarids (20%) and *Larus* gulls (18%).

Seabirds can be characterized according to their distributions, which reflect their foraging behavior and feeding ecology. Coastal species included pelagic cormorants (PECO) and marbled murrelets (MAMU) which were found most frequently in waters less than 100 m in depth, and therefore close to shore (Figs. 3-4). Coastal/Shelf species were commonly found in both coastal and shelf (100-200 m) habitats (Figs. 5-7), and included common murres (COMU), *Larus* gulls (glaucous-winged, herring, mew), and tufted puffins (TUPU). Shearwaters (both short-tailed and sooty) were common in both shelf and slope (200-1500 m) habitat (Fig. 8). Commonly distributed across both slope and oceanic (>1500 m) habitats (Figs. 9-11) were northern fulmars (NOFU), fork-tailed storm-petrels (FTSP), and black-footed albatrosses (BFAL). Leach's storm-petrels (not mapped) were found only in deep oceanic waters. Rhinoceros auklets (RHAU) and Cassin's auklets (CAAU) were unusual in that they spanned all habitats from coastal to oceanic (Figs. 12-13).

Relatively few marine mammals were observed (Table 3, Appendix B). Harbor seals, sea otters, harbor porpoises, and sea lions were observed entirely in coastal/shelf waters (Fig. 14). Humpback whales were observed in coastal, shelf and slope waters, sei whales and Dall's porpoises in slope waters, and Pacific white-sided dolphins in oceanic waters.

A total of 83 adult salmon jumping out of the water were recorded on bird and mammal surveys (Fig. 15, Appendix C). Most salmon were found in shelf habitat between the 100 and 200 m contour. Many also were observed inside Sitka Sound, generally in waters less than 100 m in depth (coastal).

Prey

Acoustic Surveys.--In general, acoustic biomass was greatest in slope habitat (200-1500 m), where deep layers of myctophids observed during the day moved up at night (Figs. 16 and 17); in shelf habitat (100-200 m) where extended aggregations of juvenile walleye pollock (with jellyfish, cod, etc.) were observed between mid-water and the bottom, especially along the basin in the middle of Sitka Sound (Figs. 16 and 17); and in coastal habitat where rocks and shoals provided bathymetric relief to otherwise soft bottoms. Schools of rockfish were evident on the echosounder in association with bottom topographic features (rocks, pinnacles, etc.) in many areas (Fig. 16).

The highest estimated water column prey biomass (relative density) occurred on transect 5 near the northern end of the study area (Fig. 18). The lowest prey biomass was on transect 21, a coastal transect east of St. Lazaria Island. The estimated relative density of prey (excluding the surface stratum) was highest in stratum 17 (170-180 m below the hull-mounted transducer, Fig. 19). Relative prey density was lowest in stratum 5 (50-60 m below the hull-mounted transducer).

Mid-water Trawls.--A total of 23,016 fish were caught during 12 trawls (Table 4, Fig. 20) and catches were dominated by jellyfish and walleye pollock (Table 5). One collected species, the slender snipe eels caught in trawls just south of Kruzof Island,

constituted only the second record for this species in Alaska (Mecklenburg et al. 2002). Most fishes caught were juveniles and measured less than 100 mm in fork length (Table 6). Average fork lengths of some of the more common taxa were: walleye pollock (45.2 mm), northern lampfish (39.1 mm), Pacific herring (30.7 mm). See Appendix D for a sample of photographs of species captured.

According to Rosenthal et al. (1981 and 1982) the nearshore fish fauna in the Sitka Sound area is dominated by rockfish. We caught rockfish in longlines but our midwater trawls were dominated by jellyfish and walleye pollock, with very few rockfishes represented. This is probably due to the fact that rockfish schools tend to be closely associated with bottom topographic features (Fig. 16), which we avoided with our trawl nets. Our midwater trawl catch reflects the species composition in the water column rather than the demersal areas.

Long-line Sets.--A total of 56 groundfish were caught during 2 long-line sets (Table 4, Fig. 20), including Pacific halibut, quillback rockfish, and yelloweye rockfish (Table 7). See Appendix D for a sample of photographs of species captured. Pacific halibut was the most numerous species caught during our long-lining. Using comparable techniques and fishing in similar locations, Rosenthal et al. (1982) reported that halibut dominated their long-line catch in summer 1981 as well. In 1981, yelloweye rockfish were the second most abundant fish caught, followed by quillback rockfish (Rosenthal et al. 1982). In 2000, we caught more quillback rockfish than yelloweye rockfish overall (Table 7). In fact, yelloweye rockfish were caught only during our second long-line set, which occurred in somewhat deeper water than our first set (Table 7). Rosenthal et al. (1981 and 1982) found that the rockfish community in the Sitka Sound area was strongly influenced by depth, with yelloweye rockfish generally being found in deeper water than quillback rockfish. It is not surprising, then, that we caught more quillback rockfish in our shallower set and that yelloweye rockfish occurred only in the deeper set.

Pacific halibut averaged 653.2 mm in fork length (Table 8). The average fork length of captured quillback and yelloweye rockfishes was 375.1 mm and 604.4 mm, respectively. Rosenthal et al. (1981 and 1982) found that, within a species, larger rockfish tended to occupy deeper water. The only such comparison we could make was between the lengths of quillback rockfish in our two long-line sets, the second of which was deeper than the first (Table 4). We found that quillback rockfish from the deeper set were slightly longer than those from the shallower set. Quillback rock fish that we caught were similar in length to those sampled by Rosenthal et al. (1981 and 1982). In contrast, the black and yelloweye rockfish captured in 2000 tended to be slightly larger on average than those from the earlier survey.

Stomachs from quillback rockfish contained a variety of prey, Pacific sand lance being the most prevalent (Table 9, Fig. 21). Rosenthal et al. (1982) also found sand lance to be the main food item in summer rockfish diets. Pacific sand lance also is a potentially important prey species for at least some of the seabirds that breed in the Sitka Sound area (Dragoo et al. 2004). Of 27 halibut caught, only two had food in their stomach when brought on board; capelin and fishery discards were the only contents.

Oceanography

Water Column Profile.-- A total of 34 CTD profiles were taken, 7 stations on transect number 6 north of Cape Edgecumbe, 11 stations on transect number 11 that ran through the center of Sitka Sound, 5 stations on transect number 12, also through the approximate center of Sitka Sound, and 6 stations on transect number 16 south of Sitka Sound (Table 10, Fig. 22). The remaining CTD casts were taken in association with prey sampling. Casts from transects 11 and 12 were combined for profile generation. Examination of water column temperature and salinity profiles showed that all waters were stratified (Figs. 23-25), with weakest stratification in the outer Sound; suggesting that some mixing occurs in this transitional zone between oceanic and coastal waters. Coastal waters appeared to have a thin surface layer of low salinity, warm water. Shelf, slope and oceanic waters appeared to have a thicker layer of very warm, moderately saline water overlaying cold, high salinity water.

Sea Surface Temperature and Salinity.--Analysis of sea-surface temperature (Fig 26) and salinity (Fig 27) measurements suggested marked gradients in surface properties throughout the study area. Surface salinity in inner Sitka Sound was quite low, presumably reflecting river input of freshwater from Baranof Island. A sharply increasing gradient of sea-surface salinity was observed at the 200 m bathymetric contour, and sea-surface salinities of greater than 31.5 ‰ were observed in slope and oceanic habitats (200-1500 m depths). In general, sea-surface temperatures showed a similar pattern, except that surface temperatures also were warm in inner Sitka Sound. North of Cape Edgecumbe, we speculate that eddies formed north of the cape may pull warmer, saline oceanic water nearshore. Alternatively, or in combination, little freshwater may enter the nearshore from Kruzof Island, resulting in a much narrower band of low sea-surface salinity water nearshore. The average sea surface salinity and temperature we recorded were similar to those found in summer 1981 by Rosenthal et al. (1982).

ACKNOWLEDGEMENTS

We would like to thank all of the people who helped gather data during the 2000 Sitka Sound SMMOCI survey. Their perseverance, professionalism and good cheer were much appreciated. Martin Robards and Catherine W. Mecklenburg aided with fish identifications. Mei-Sun Yang of the National Marine Fisheries Service, Alaska Fisheries Science Center in Seattle, WA kindly provided the identifications of the contents of fish stomach samples. We appreciate their assistance. We would also like to thank the staff of Alaska Maritime National Wildlife Refuge, Homer for their help and support. Finally, we would like to express our sincere thanks to the captain and crew of *M/V Tiĝlax̂* without whose enthusiasm, professionalism and patience this work would not have been possible. The cover photo and other fish photos are by Jeffery C. Williams, U. S. Fish and Wildlife Service.

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Table 1. Locations (in decimal degrees) and times[a] of surveys used for bird and marine mammal observations, and hydroacoustics surveys near St. Lazaria Island, Alaska, in 2000.

Transect	Date	Start Latitude (°N)	Start Longitude (°W)	Stop Latitude (°N)	Stop Longitude (°W)	Start Time	Stop Time	Transect Length (km)
04	7/15	56.9405°	136.3097°	57.1771°	135.8496°	1707	1916	38.4
05	7/15	57.1323°	135.8300°	56.8940°	136.3057°	1429	1647	43.4
06	7/15	56.8548°	136.2715°	57.0688°	135.8757°	1019	1207	34.2
07	7/15	57.0130°	135.8810°	56.8247°	136.2486°	0823	1004	30.8
08	7/13	56.7906°	136.2055°	56.9881°	135.8413°	1512	1702	31.4
09	7/13	56.9933°	135.7293°	56.7606°	136.1728°	1256	1457	37.6
10	7/13	56.9853°	135.7335°	56.7353°	136.1275°	1759	2136	49.7
11	7/14	57.0476°	135.4414°	56.7105°	136.0794°	0751	1048	54.2
12	7/14	56.6980°	136.0144°	57.0238°	135.3963°	1204	1908	56.0
13	7/16	56.7043°	135.9358°	56.9476°	135.4618°	0806	1022	43.2
14	7/12	56.9065°	135.4458°	56.6561°	135.8758°	0948	1204	42.3
15	7/12	56.6538°	135.8198°	56.8799°	135.4012°	1228	1426	36.1
16	7/12	56.8381°	135.4035°	56.6450°	135.7382°	1510	1748	30.4
19	7/13	57.0001°	135.5800°	57.0757°	135.4841°	0856	0924	10.9
20	7/13	57.0774°	135.5538°	57.1461°	135.4305°	0943	1018	11.9
21[b]	7/16	57.0131°	135.5705°	56.9924°	135.6794°	1107	1139	11.3
22[c]	7/16	56.9926°	135.6818°	56.9940°	135.6850°	1143	1207	7.7
23[b]	7/16	56.9953°	135.6842°	57.0205°	135.8693°	1221	1305	14.8
24[b]	7/16	57.0214°	135.8788°	56.9851°	135.7350°	1308	1349	12.4

[a]All times are Alaska Daylight.
[b]Coastal transect.
[c]Circumnavigation of St. Lazaria Island.

Table 2. Species composition and numbers of seabirds observed on 19 transects near St Lazaria Island, Alaska during July 2000.

Species	Scientific Name	No. Observed	Density[a]	% Total
All bird species total		3,225	18.01	100.0
Common Loon	*Gavia immer*	1	0.01	<0.1
Yellow-billed Loon	*Gavia adamsii*	3	0.02	0.1
Black-footed Albatross	*Phoebastria nigripes*	80	0.45	2.5
Unidentified Albatross	*Diomedeidae* sp.	3	0.02	0.1
Northern Fulmar	*Fulmarus glacialis*	228	1.27	7.1
Sooty Shearwater	*Puffinus griseus*	57	0.32	1.8
Short-tailed Shearwater	*Puffinus tenuirostris*	61	0.34	1.9
Unidentified Shearwater	*Puffinus* sp.	65	0.36	2.0
Fork-tailed Storm-petrel	*Oceanodroma furcata*	124	0.69	3.8
Leach's Storm-petrel	*Oceanodroma leucorhoa*	8	0.04	0.3
Unidentified Storm-petrel	*Oceanodroma* sp.	14	0.08	0.4
Double-crested Cormorant	*Phalacrocorax auritus*	1	0.01	<0.1
Pelagic Cormorant	*Phalacrocorax pelagicus*	145	0.81	4.5
Unidentified Cormorant	*Phalacrocorax* sp.	2	0.01	0.1
White-winged Scoter	*Melanitta fusca*	19	0.11	0.6
Unidentified Scoter	*Melanitta* sp.	9	0.05	0.3
Bald Eagle	*Haliaeetus leucocephalus*	2	0.01	0.1
Black Turnstone	*Arenaria melanocephala*	5	0.03	0.2
Red-necked Phalarope	*Phalaropus lobatus*	58	0.32	1.8
Unidentified Phalarope	*Phalaropus* sp.	9	0.05	0.3
Parasitic Jaeger	*Stercorarius parasiticus*	1	0.01	<0.1
Mew Gull	*Larus canus*	14	0.08	0.4
Herring Gull	*Larus argentatus*	30	0.17	0.9
Glaucous-winged Gull	*Larus glaucescens*	321	1.79	10.0
Unidentified Gull	*Larinae* sp.	230	1.28	7.1
Common Murre	*Uria aalge*	570	3.18	17.7
Thick-billed Murre	*Uria lomvia*	4	0.02	0.1
Unidentified Murre	*Uria* sp.	41	0.23	1.3
Pigeon Guillemot	*Cepphus columba*	6	0.03	0.2

Table 2. Species composition and numbers of seabirds observed on 19 transects near St Lazaria Island, Alaska during July 2000 (continued).

Species	Scientific Name	No. Observed	Density[a]	% Total
Marbled Murrelet	*Brachyramphus marmoratus*	389	2.17	12.1
Unidentified *Brachyramphus* Murrelet	*Brachyramphus* sp.	5	0.03	0.2
Ancient Murrelet	*Synthliboramphus antiquus*	31	0.17	1.0
Cassin's Auklet	*Ptychoramphus aleuticus*	138	0.77	4.3
Parakeet Auklet	*Aethia psittacula*	8	0.04	0.3
Unidentified small dark Alcid	*Aethia* sp.	4	0.02	0.1
Rhinoceros Auklet	*Cerorhinca monocerata*	394	2.20	12.2
Horned Puffin	*Fratercula corniculata*	23	0.13	0.7
Tufted Puffin	*Fratercula cirrhata*	122	0.68	3.8

[a]Individuals/km^2. A total of 179.1 km^2 was surveyed.

Table 3. Species composition and numbers of marine mammals observed on 19 transects near St. Lazaria Island, Alaska during July 2000.

Species	Scientific Name	No. Observed	Density[a]	% Total
Pacific White-sided Dolphin	*Lagenorhynchus obliquidens*	4	0.02	8.2
Harbor Porpoise	*Phocoena phocoena*	1	0.01	2.0
Dall's Porpoise	*Phocoenoides dalli*	19	0.11	38.8
Sei Whale	*Balaenoptera borealis*	2	0.01	4.1
Humpback Whale	*Megaptera novaeangliae*	9	0.05	18.4
Sea Otter	*Enhydra lutris*	11	0.06	22.5
Steller's Sea Lion	*Eumetopias jubatus*	2	0.01	4.1
Harbor Seal	*Phoca vitulina*	1	0.01	2.0

[a]Individuals/km^2. A total of 179.1 km^2 was surveyed.

Table 4. Locations (in decimal degrees), times[a] and depths of fishing effort near St. Lazaria Island, Alaska, in 2000.

Tow[b]	Date	Start Latitude (N)	Start Longitude (W)	Start Time	Depth (m) Range
MW01	7/12	56.7420°	135.6940°	1915	0-72
MW02	7/12	56.8323°	135.6810°	2125	0-60
MW03	7/13	56.9030°	135.8079°	1855	0-75
MW04	7/13	56.7462°	136.0453°	2311	0-125
MW05	7/14	56.8550°	135.7250°	1503	0-75
MW06	7/14	56.9555°	135.5323°	1739	0-48
MW07	7/15	57.1660°	135.8740°	1940	0-35
MW08	7/16	56.8573°	136.2583°	0020	0-148
MW09	7/16	56.9928°	135.7168°	1406	0-25
MW10	7/16	57.0438°	135.5450°	1529	0-20
MW11	7/17	56.9918°	135.6235°	0814	0-35
MW12	7/17	56.9953°	135.7073°	0902	0-22
LL01	7/13	56.9912°	135.6927°	0822	38-50
LL02	7/15	56.9767°	135.8733°	0815	65-78

[a] All times are Alaska Daylight.
[b] MW = Mid-water trawl, LL = Long-line set.

Table 5. Species captured with mid-water trawls during SMMOCI sampling in 2000 near St. Lazaria Island, Alaska.

	Tow Number											
Species	1	2	3	4	5	6	7	8	9	10	11	12
Jellyfish	(5500)[a]	X[b]	X	(1000)	(8500)	(27,500)	(33,500)	(24,000)	(37,000)	(17,000)	(9000)	(17,500)
Pteropod		1										
Squid				8	1			7				1
Shrimp	2			1		1		43				
Amphipod		1		3		5	1		1			1
Euphausiid		27		804				(340)				
Crab	5			2			1			2		
Salps		X	X	(3000)	8	X		(5500)				
Pacific Lamprey (*Lampetra tridentata*)				1								
Slender Snipe Eel (*Nemichthys scolopaceus*)									2		1	
Pacific Herring (*Clupea pallasii*)							1		18	8		16
Chinook Salmon (*Oncorhynchus tshawytscha*)										1		
Longfin Dragonfish (*Tactostoma macropus*)								1				
Pacific Viperfish (*Chauliodus macouni*)								2				

Table 5. Species captured with mid-water trawls during SMMOCI sampling in 2000 near St. Lazaria Island, Alaska (continued).

	Tow Number											
Species	1	2	3	4	5	6	7	8	9	10	11	12
Northern Lampfish (*Stenobrachius leucopsarus*)				233				505				
Pacific Cod (*Gadus macrocephalus*)						6						
Pacific Tomcod (*Microgadus proximus*)	1											
Walleye Pollock (*Theragra chalcogramma*)	454 (250)	367 (182)	9480	4	9100	1515	71	3	17	3	108	28
Ronquil Sp. (*Bathymaster* sp.)	3				1	1						
Prowfish (*Zaprora silenus*)			1			2	1				1	
Pacific Sand Lance (*Ammodytes hexapterus*)										1		3
Rockfish Sp.	1						5	4				
Sablefish (*Anoplopoma fimbria*)				2								
Lingcod (*Ophiodon elongatus*)							1					
Flatfish Sp.	8	6		1		21	3	3		3	1	1

[a]Numbers in parentheses represent the total weight, in grams, of the sample for each group during a particular tow.
[b]Species present but not enumerated or weighed.

Table 6. Fork lengths (mm) of species captured with mid-water trawls during SMMOCI sampling in 2000 near St. Lazaria Island, Alaska.

Species	Mean	SD[a]	Range	n[a]
Pacific Lamprey	357.0	--	--	1
Slender Snipe Eel	625.0	18.0	610-645	3
Pacific Herring	30.7	2.6	21-35	42
Chinook Salmon	195.0	--	--	1
Longfin Dragonfish	254.0	--	--	1
Pacific Viperfish	70.0	7.1	65-75	2
Northern Lampfish	39.1	15.8	26-90	60
Pacific Cod	57.3	0.8	56-58	6
Pacific Tomcod	49.0	--	--	1
Walleye Pollock	45.2	7.7	17-63	239
Ronquil Sp.	36.8	1.7	35-39	4
Prowfish	59.6	29.3	16-91	5
Pacific Sand Lance	67.0	19.4	40-86	4
Rockfish Sp.	19.8	2.5	16-24	8
Sablefish	58.0	7.1	53-63	2
Lingcod	17.0	--	--	1
Flatfish Sp.	28.5	4.2	18-42	41

[a] SD=Standard Deviation, n=Sample Size.

Table 7. Species captured with long-line gear during SMMOCI sampling in 2000 near St. Lazaria Island, Alaska.

	Set Number	
Species	1 (38-50 m)[a]	2 (65-78 m)
Quillback Rockfish (*Sebastes maliger*)	11	7
Black Rockfish (*Sebastes melanops*)		2
Canary Rockfish (*Sebastes pinniger*)		1
Yelloweye Rockfish (*Sebastes ruberrimus*)		5
Lingcod (*Ophiodon elongatus*)		2
Pacific Halibut (*Hippoglossus stenolepis*)	18	9

[a]Numbers in parentheses represent gear depth in meters

Table 8. Fork lengths (mm) of species captured with long-line gear during SMMOCI sampling in 2000 near St. Lazaria Island, Alaska.

Species	Mean	SD[a]	Range	n[a]
Quillback Rockfish	375.1	24.7	320-407	15
Black Rockfish	530.0	42.4	500-560	2
Canary Rockfish	440.0	--	--	1
Yelloweye Rockfish	604.4	118.6	400-695	5
Pacific Halibut	653.2	85.6	496-825	27

[a] SD=Standard Deviation, n=Sample Size.

Table 9. Prey composition of stomach samples from quillback rockfish caught during long-line sets near St. Lazaria Island, Alaska in 2000 (*n* = 8 non-empty stomachs).

Prey Name[a]	% Frequency	% Count	% Weight
Gammaridea (amphipod)	12.50	1.37	0.38
Hippolytidae (shrimp)	50.00	5.48	3.84
Crangonidae (shrimp)	37.50	4.11	1.32
Urochordata (tunicate)	12.50	2.74	1.67
Thaliacea (Pelagic salp)	25.00	2.74	1.43
Non-gadoid Fish Remains	12.50	1.37	7.25
Ammodytes hexapterus (Pacific sand lance)	62.50	79.45	55.31
Fishery discards	12.50	1.37	21.25
Overboard material (non-fishery)	12.50	1.37	7.55

[a] Identifications by Mei-Sun Yang- National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA

Table 10. Locations, times and dates of CTD casts made near St. Lazaria Island, Alaska, in 2000.

Station	Latitude (N)	Longitude (W)	Date	Time[a]	Depth[b] (m)	Notes[c]
1	56° 54.445′	135° 26.944′	11 July	21:24	48 (62)	
2	56° 50.320′	135° 24.220′	12 July	14:58	48 (55)	North end of Tx 16, Sta. 1
3	56° 48.141′	135° 27.720′	12 July	15:33	20 (27)	Tx 16, Sta. 2
4	56° 45.770′	135° 31.400′	12 July	16:04	96 (106)	Tx 16, Sta. 3
5	56° 43.829′	135° 35.838′	12 July	16:38	103 (134)	Tx 16, Sta. 4
6	56° 41.500′	135° 39.514′	12 July	17:11	97 (158)	Tx 16, Sta. 5
7	56° 38.656′	135° 44.356′	12 July	17:48	97 (193)	Tx 16, Sta. 6
8	56° 43.156′	135° 40.469′	12 July	20:16	95 (158)	MWTR 01
9	56° 49.994′	135° 40.060′	12 July	22:14	96 (131)	MWTR 02
10	56° 54.927′	135° 46.598′	13 July	19:49	98 (143)	MWTR 03
11	56° 42.839′	136° 04.501′	13 July	21:54	97 (900)	South end of Tx 11, Sta. 10
12	56° 44.290′	136° 01.960′	13 July	22:44	97 (1060)	Tx 11, Sta. 9
13	56° 46.270′	135° 57.910′	14 July	00:53	97 (450)	Tx 11, Sta. 8
14	56° 48.340′	135° 54.060′	14 July	01:24	98 (197)	Tx 11, Sta. 7
15	56° 50.420′	135° 50.030′	14 July	01:55	98 (172)	Tx 11, Sta. 6
16	56° 52.480′	135° 46.140′	14 July	02:27	96 (130)	Tx 11, Sta. 5
17	56° 54.590′	135° 42.170′	14 July	03:00	95 (137)	Tx 11, Sta. 4
18	56° 56.750′	135° 37.960′	14 July	03:30	78 (93)	Tx 11, Sta. 3
19	56° 58.790′	135° 34.220′	14 July	04:00	48 (53)	Tx 11, Sta. 2
20	57° 00.850′	135° 30.170′	14 July	04:28	98 (138)	Tx 11, Sta. 1
21	57° 02.940′	135° 26.240′	14 July	04:57	33 (41)	Tx 11, Sta. 0
22	56° 42.722′	136° 00.921′	14 July	11:09	97 (800)	South end of Tx 12, Sta. 5
23	56° 47.130′	135° 51.230′	14 July	12:51	98 (188)	Tx 12, Sta. 4
24	56° 51.920′	135° 42.180′	14 July	14:09	98 (128)	Tx 12, Sta. 3
25	56° 56.780′	135° 32.950′	14 July	16:55	96 (130)	Tx 12, Sta. 2
26	57° 01.500′	135° 23.580′	14 July	19:11	78 (86)	Tx 12, Sta. 1
27	57° 09.960′	135° 52.500′	15 July	19:32	58 (64)	MWTR 07
28	57° 04.410′	135° 52.110′	15 July	21:00	28 (30)	North end of Tx 6, Sta. 1
29	57° 01.920′	135° 56.740′	15 July	21:28	68 (72)	Tx 6, Sta. 2
30	56° 59.700′	136° 00.630′	15 July	21:56	98 (106)	Tx 6, Sta. 3
31	56° 57.750′	136° 04.920′	15 July	22:28	97 (242)	Tx 6, Sta. 4
32	56° 55.730′	136° 08.800′	15 July	22:55	97 (~1200)	Tx 6, Sta. 5
33	56° 53.600′	136° 12.750′	15 July	23:25	98 (>1200)	Tx 6, Sta. 6
34	56° 51.530′	136° 16.670′	15 July	23:54	97 (>1200)	Tx 6, Sta. 7

[a]All times are Alaska Daylight.
[b]Depth of cast in meters. Values in parentheses are bottom depths at cast location.
[c]Tx = Transect, Sta. = Station MWTR = Mid-water Trawl

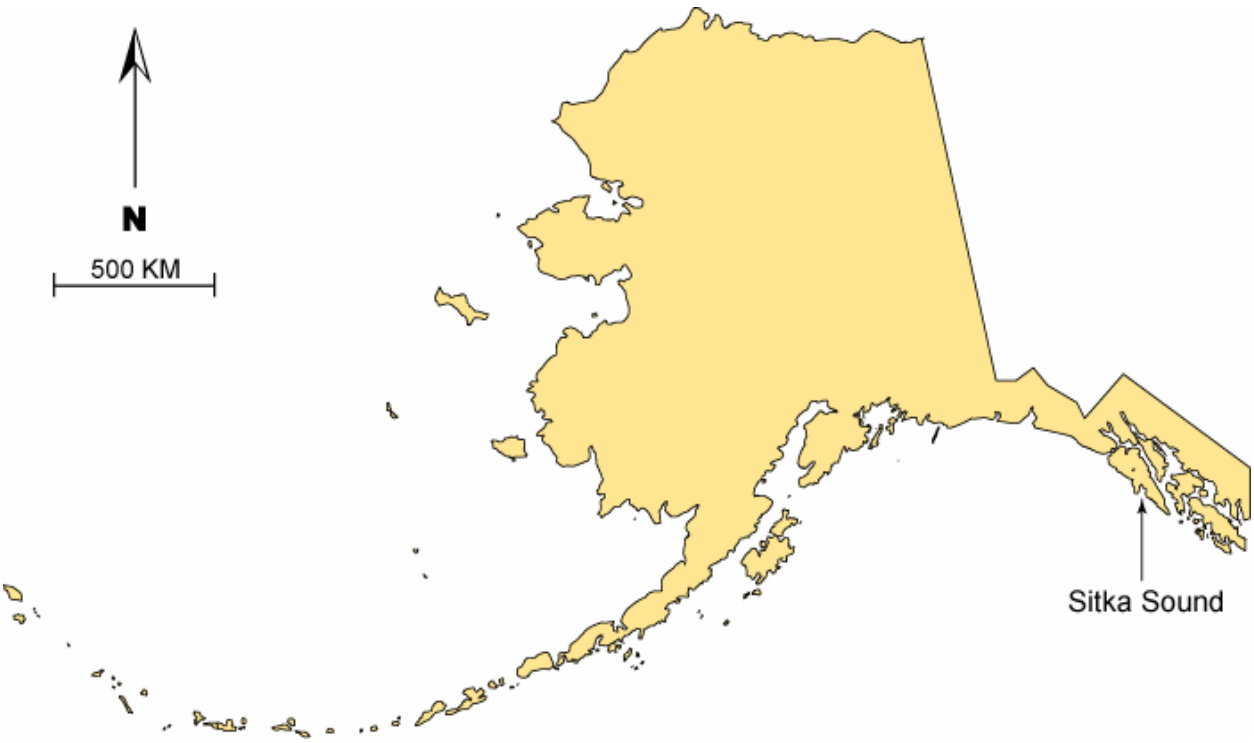


Figure 1. Map of Alaska showing the location of Sitka Sound.

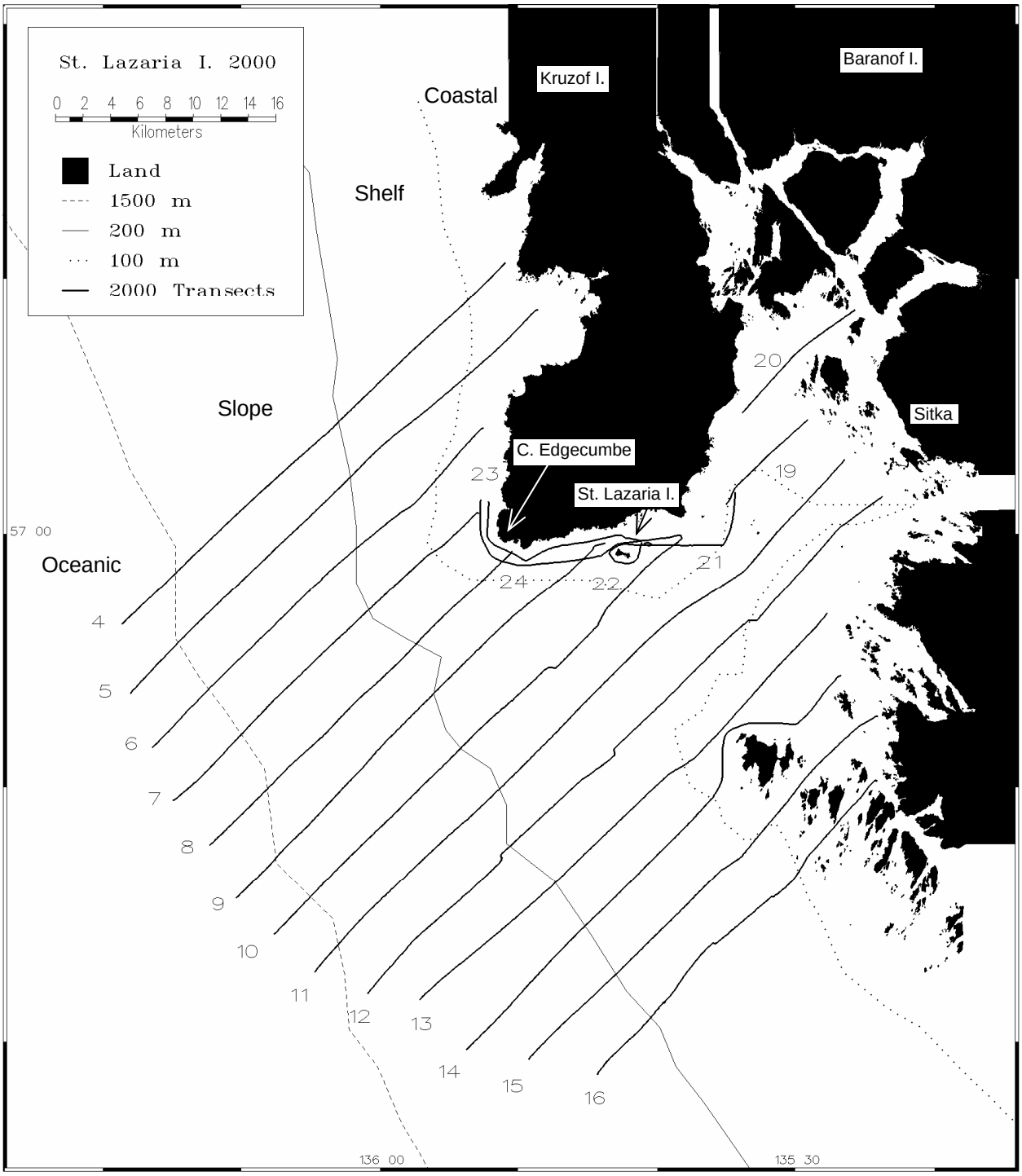


Figure 2. Map of transects surveyed in and near Sitka Sound, Alaska in 2000.

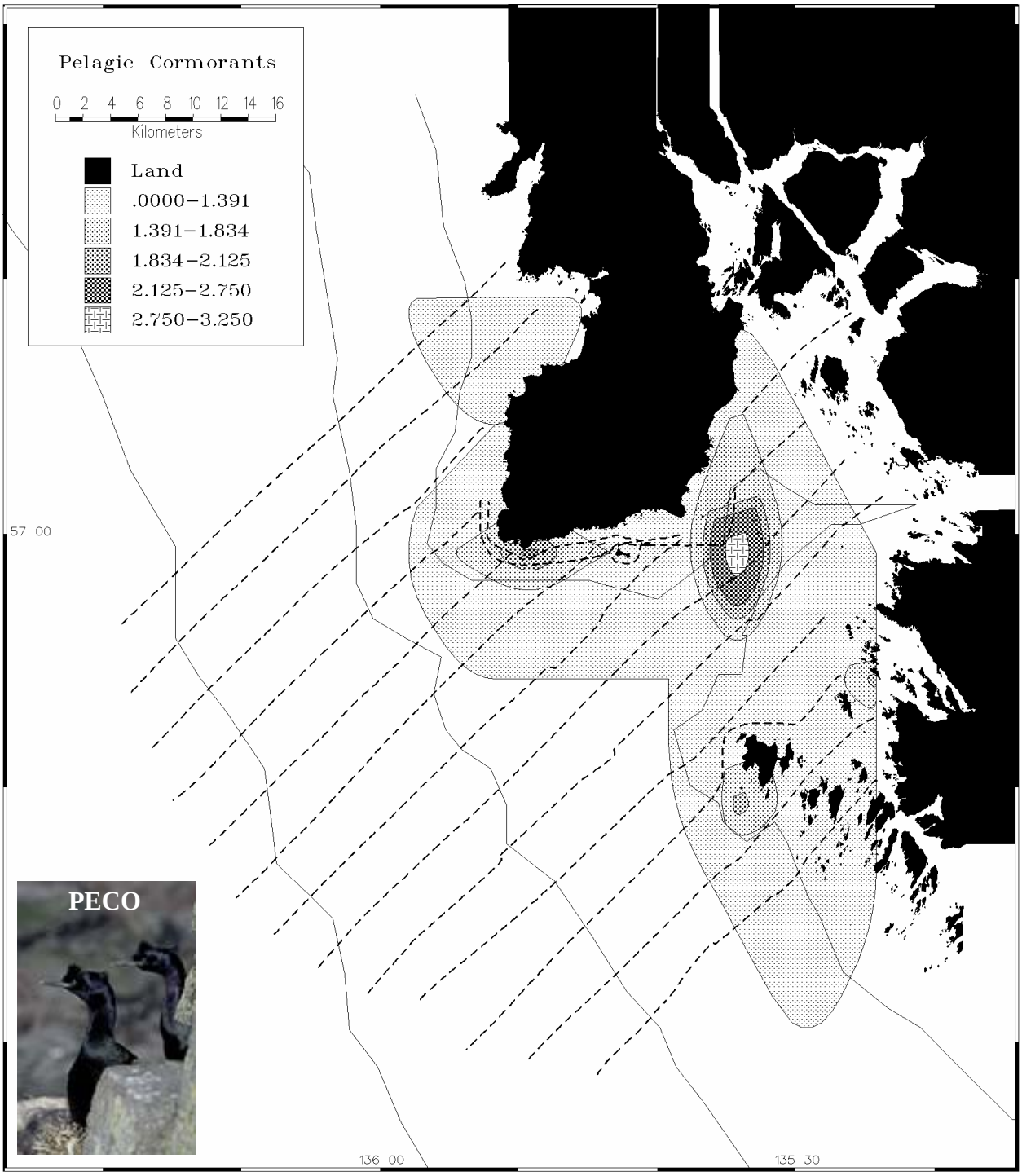


Figure 3. Coastal species: Distribution of pelagic cormorants on transects surveyed in and near Sitka Sound, Alaska in 2000. Includes all birds on water and flying.

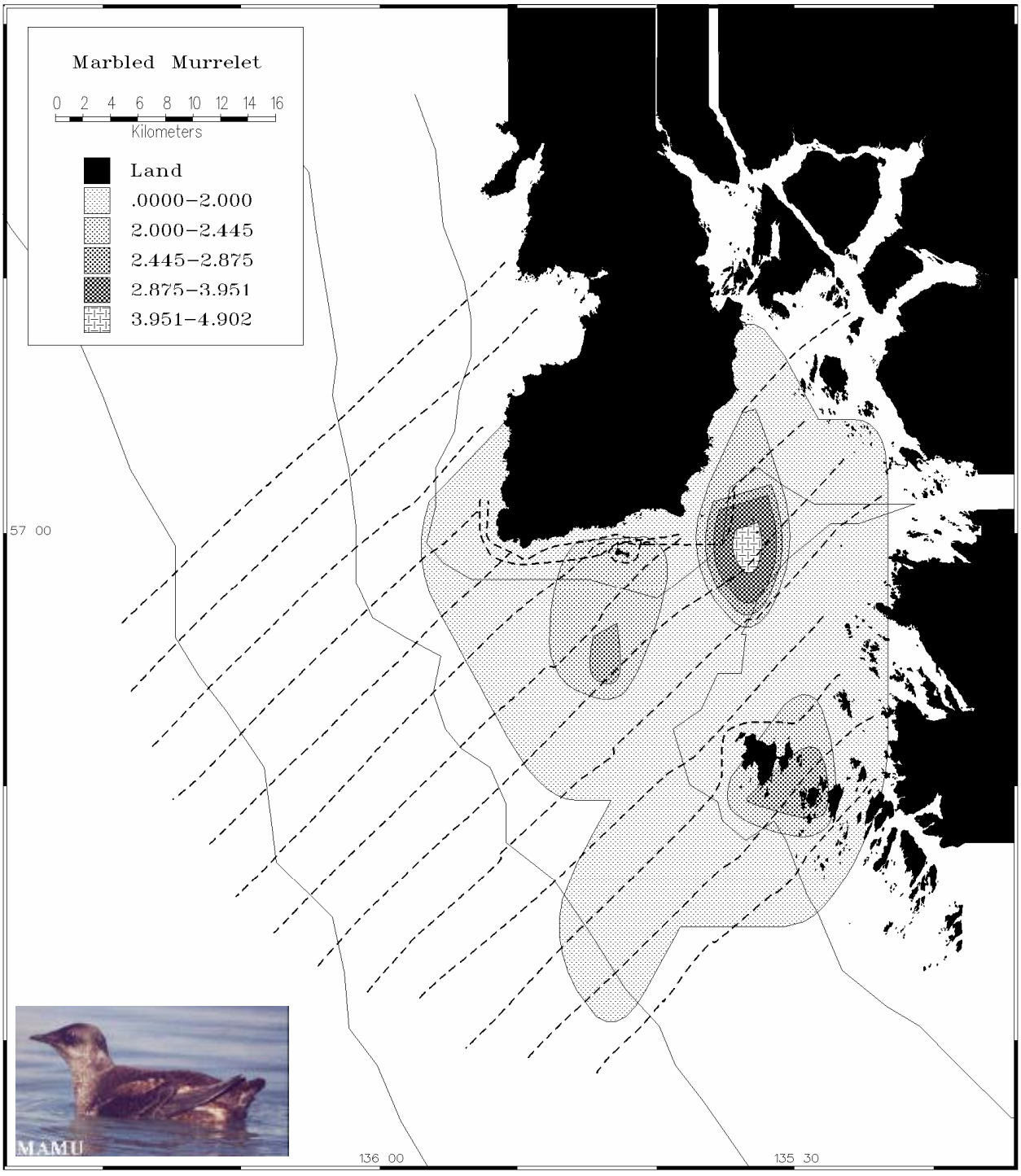


Figure 4. Coastal species: Distribution of marbled murrelets on transects surveyed in and near Sitka Sound, Alaska in 2000. Includes all birds on water and flying.

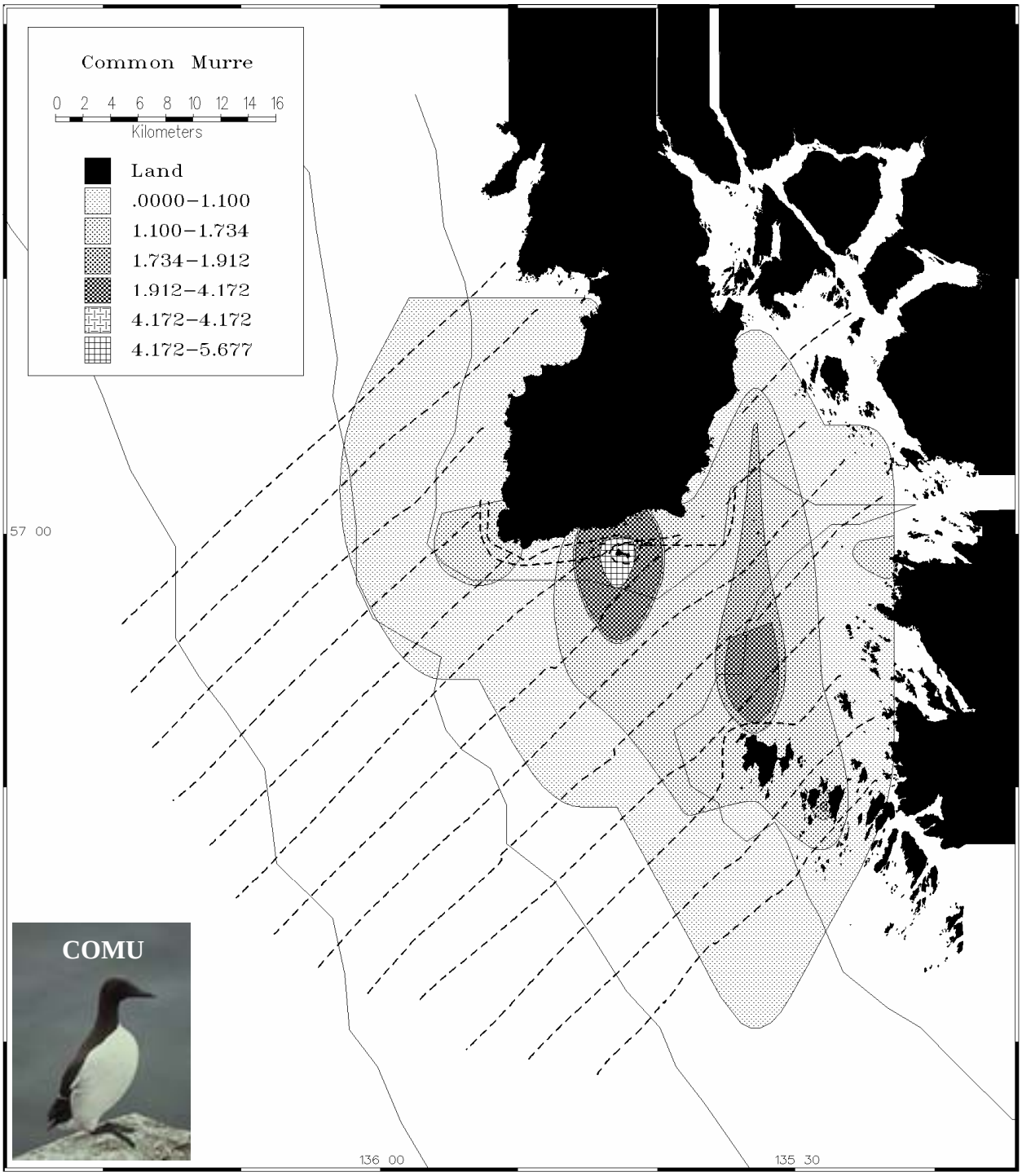


Figure 5. Coastal/Shelf species: Distribution of common murres on transects surveyed in and near Sitka Sound, Alaska in 2000. Includes all birds on water and flying.

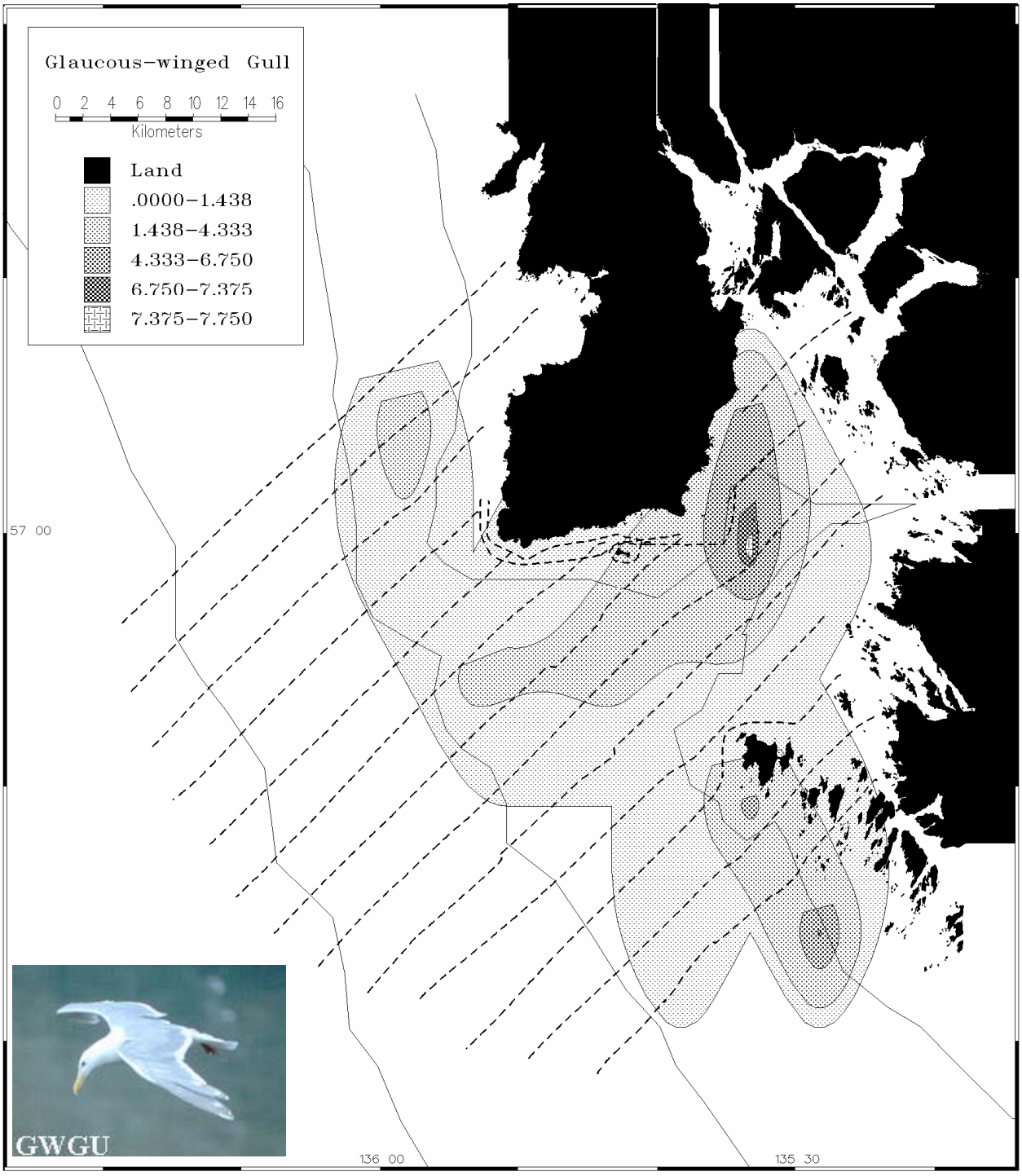


Figure 6. Coastal/Shelf species: Distribution of glaucous-winged gulls on transects surveyed in and near Sitka Sound, Alaska in 2000. Includes all birds on water and flying.

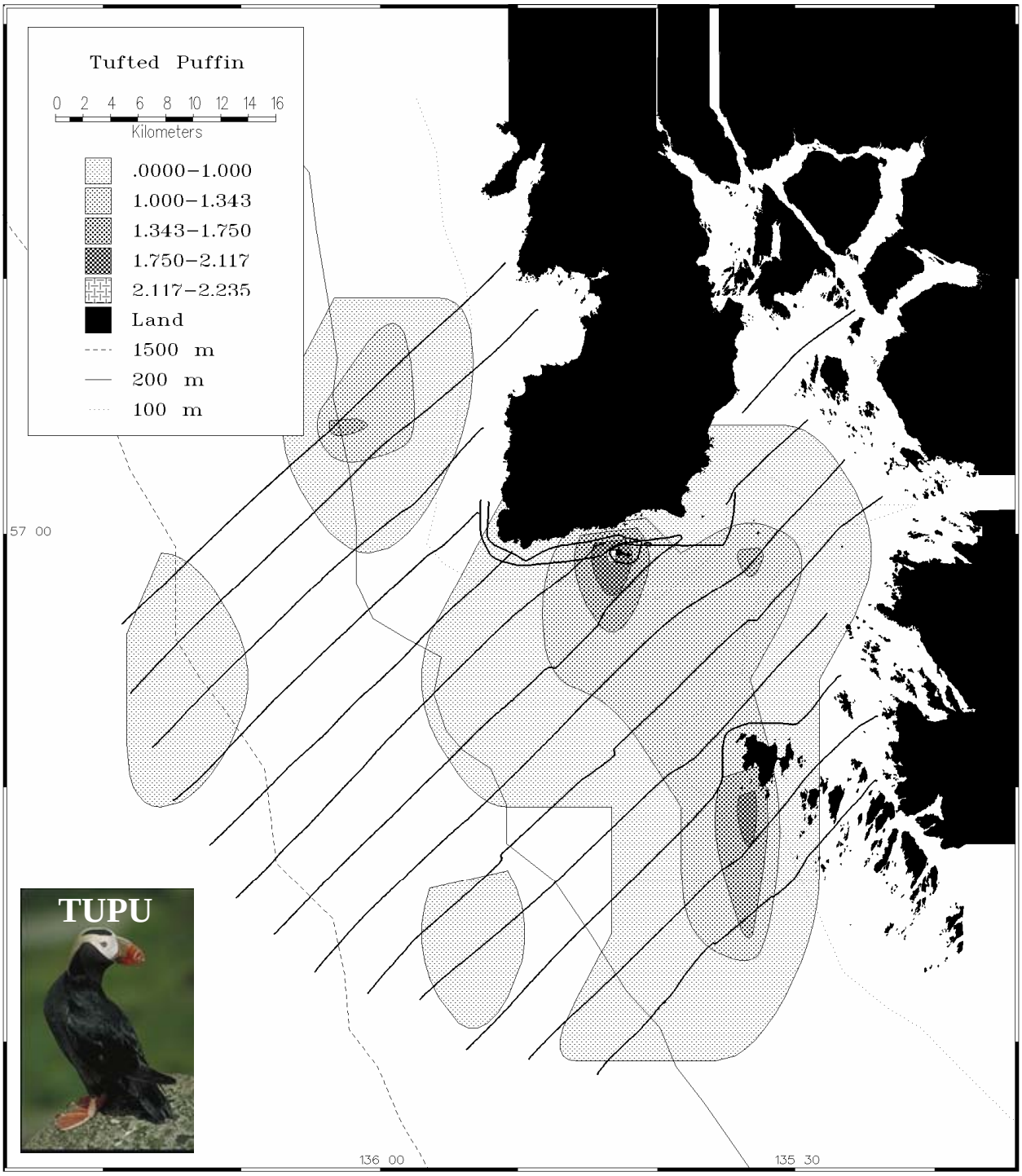


Figure 7. Coastal/Shelf species: Distribution of tufted puffins on transects surveyed in and near Sitka Sound, Alaska in 2000. Includes all birds on water and flying.

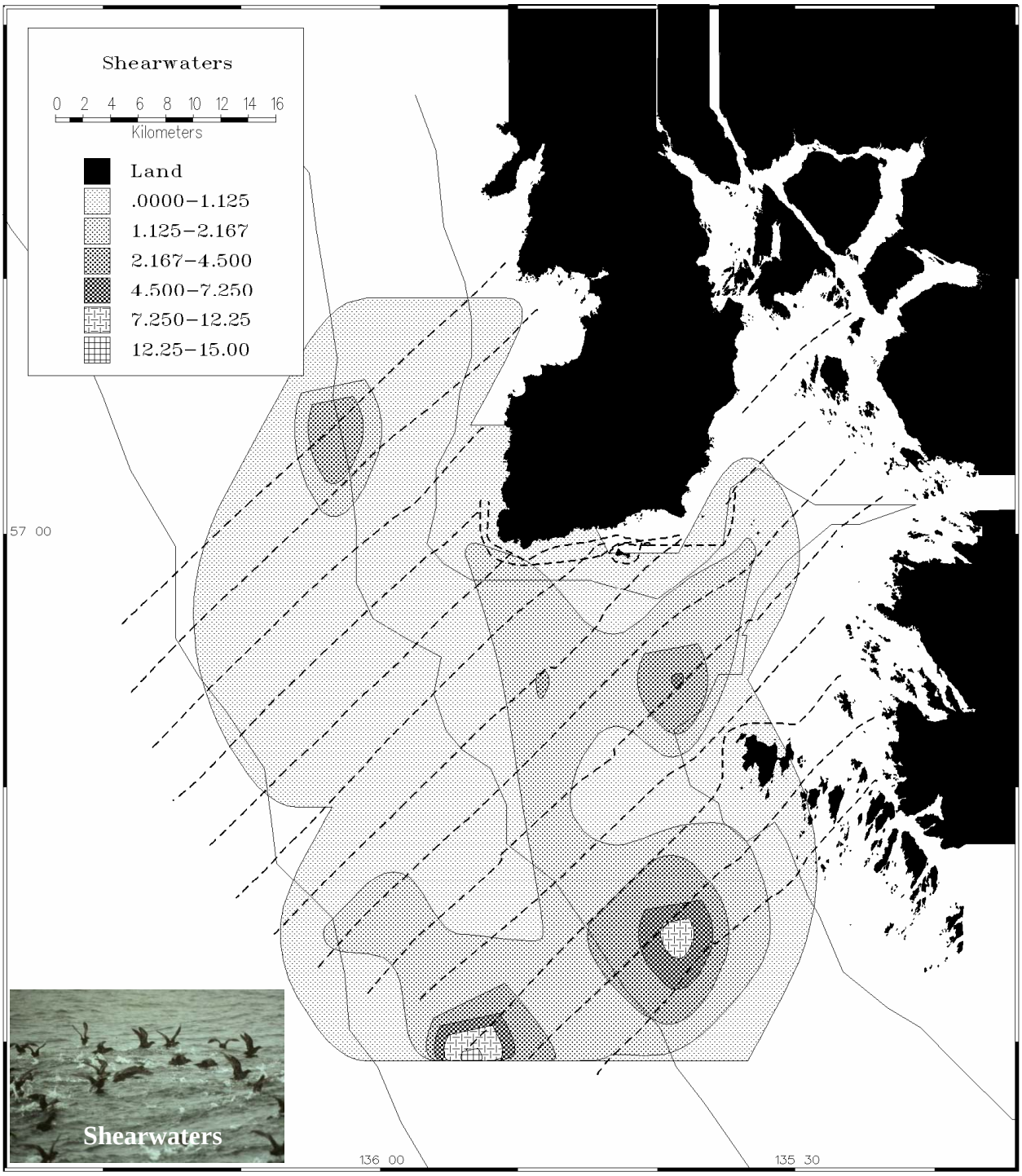


Figure 8. Shelf/Slope species: Distribution of shearwaters on transects surveyed in and near Sitka Sound, Alaska in 2000. Includes all birds on water and flying.

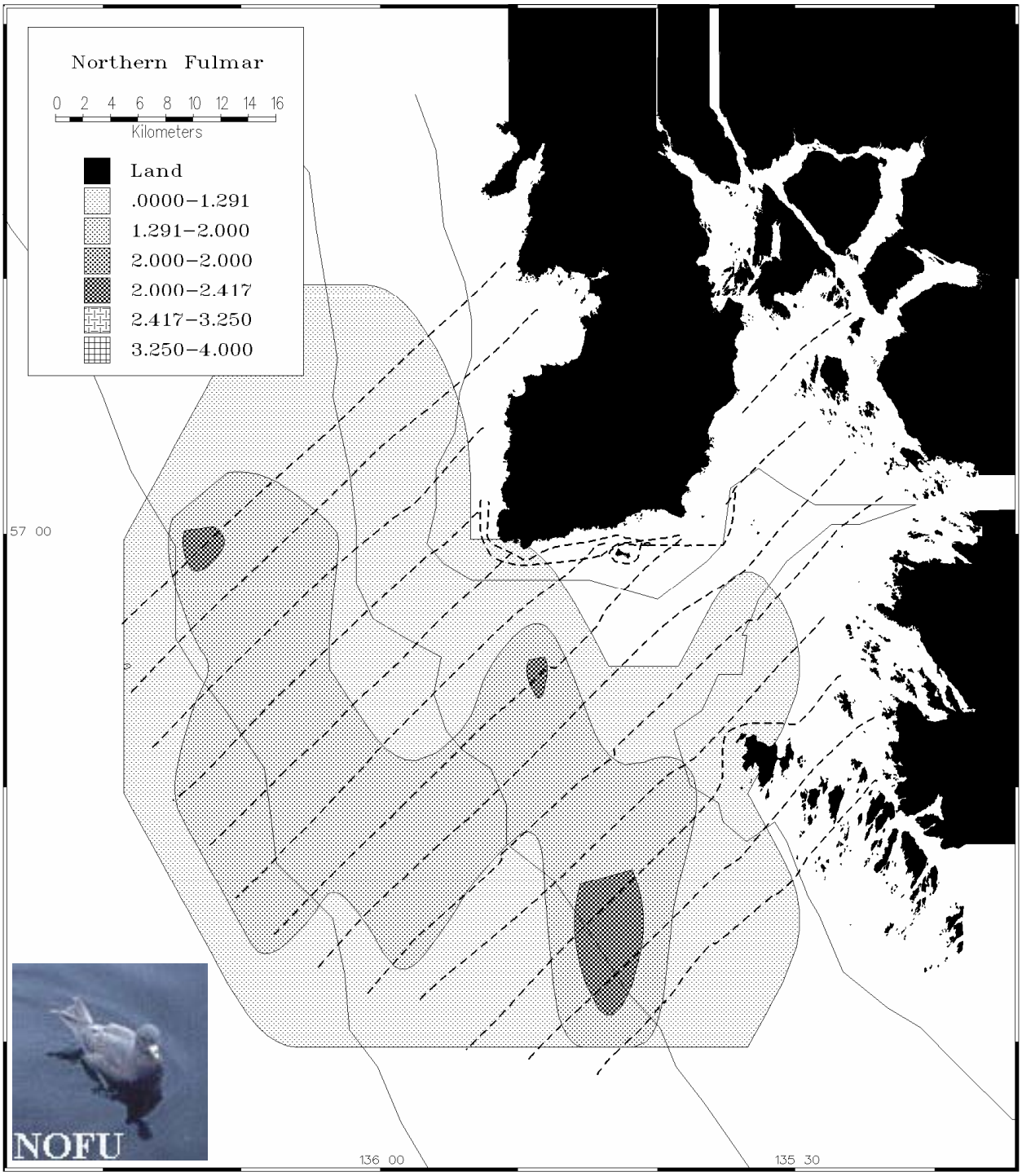


Figure 9. Slope/Oceanic species: Distribution of northern fulmars on transects surveyed in and near Sitka Sound, Alaska in 2000. Includes all birds on water and flying.

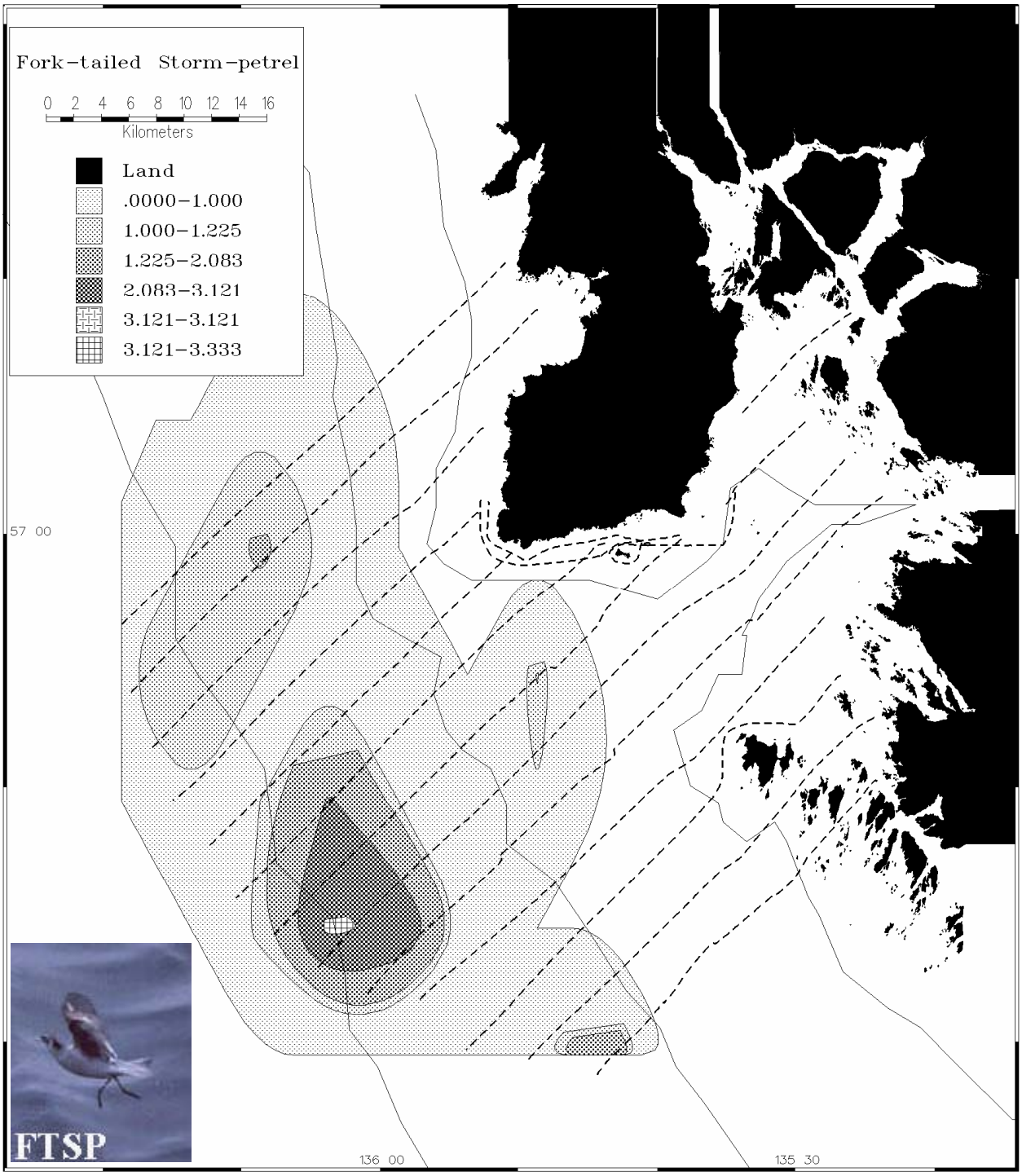


Figure 10. Slope/Oceanic species: Distribution of fork-tailed storm-petrels on transects surveyed in and near Sitka Sound, Alaska in 2000. Includes all birds on water and flying.

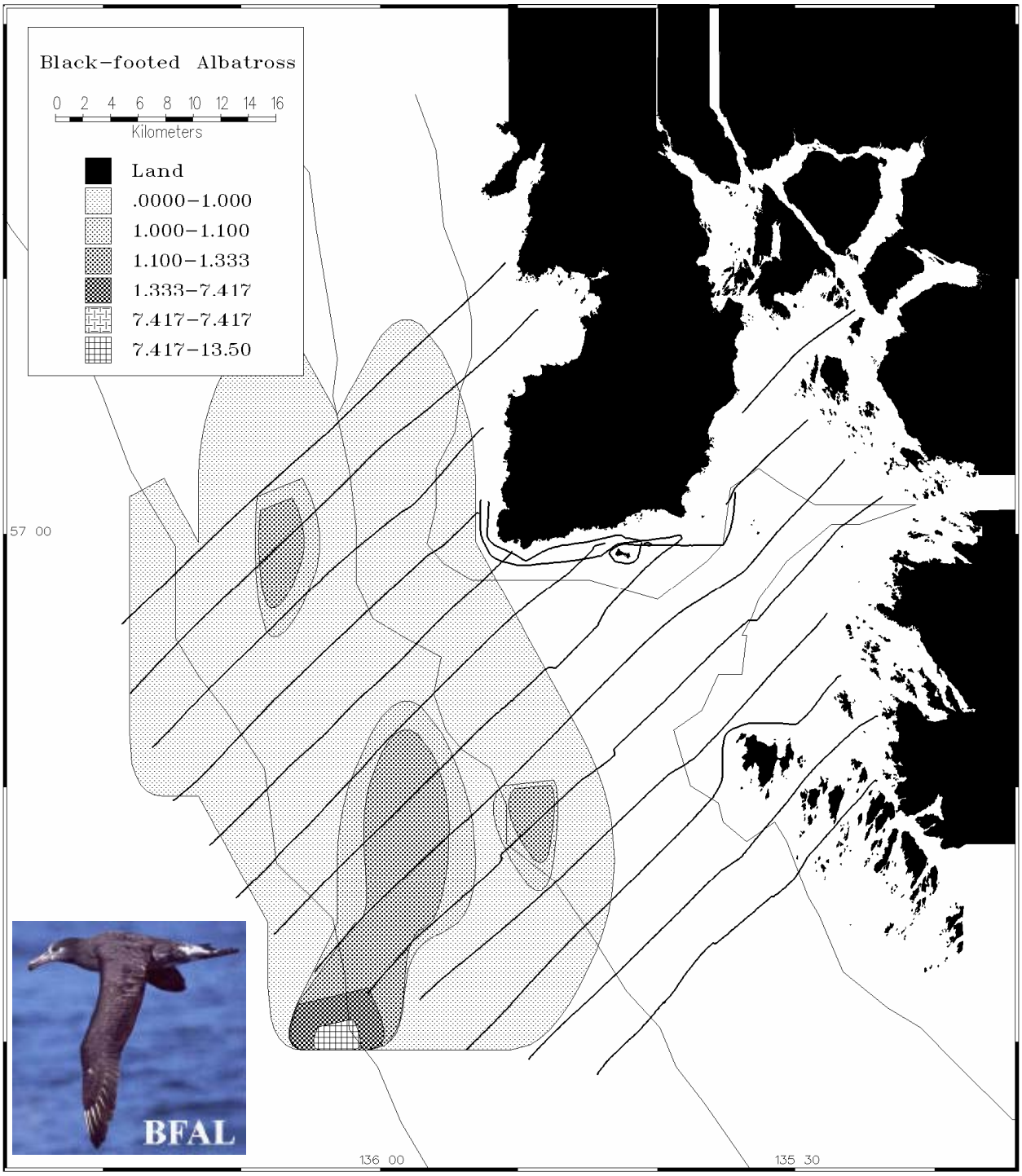


Figure 11. Slope/Oceanic species: Distribution of black-footed albatrosses on transects surveyed in and near Sitka Sound, Alaska in 2000. Includes all birds on water and flying.

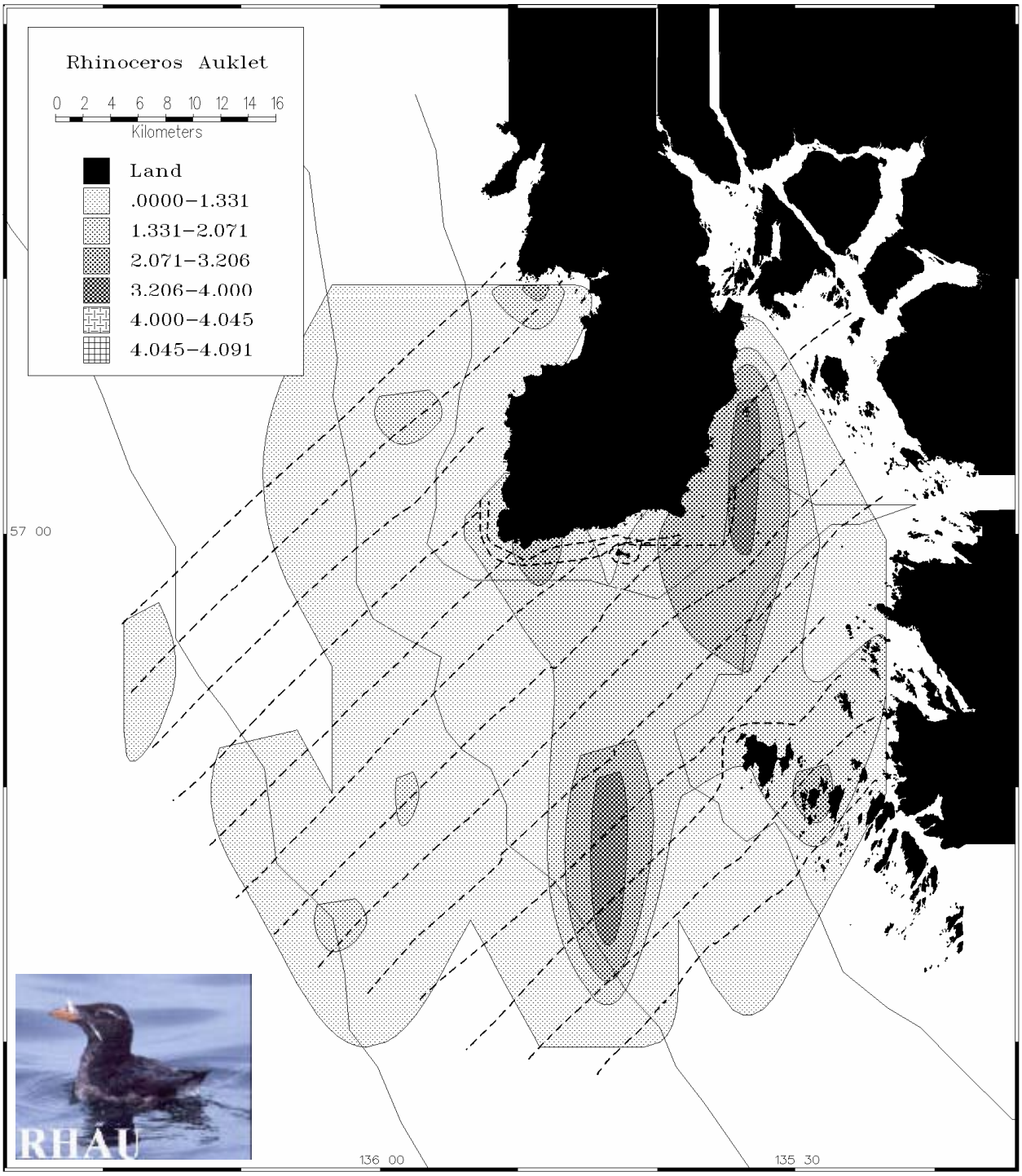


Figure 12. Coastal/Shelf/Slope species: Distribution of rhinoceros auklets on transects surveyed in and near Sitka Sound, Alaska in 2000. Includes all birds on water and flying.

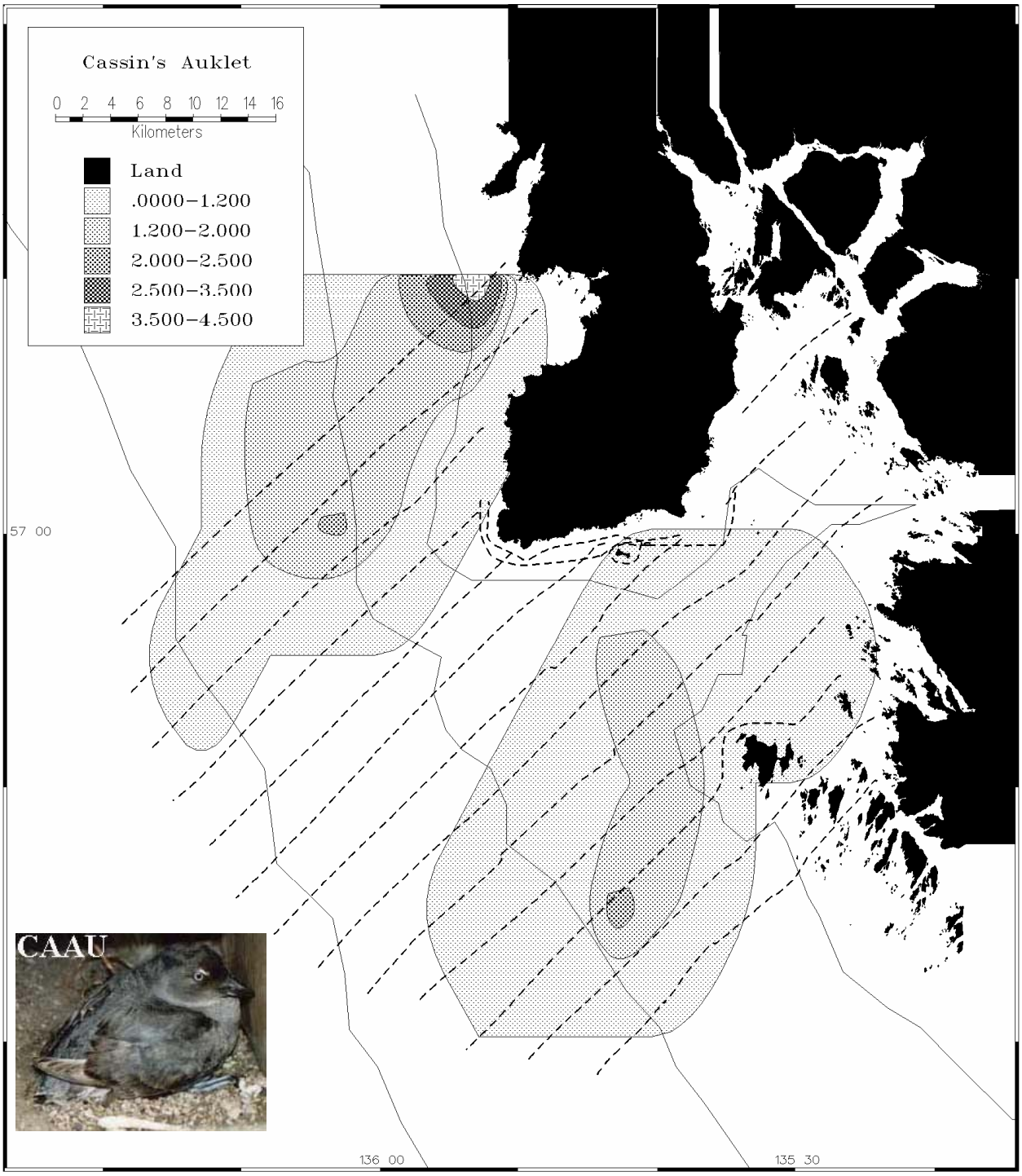


Figure 13. Coastal/Shelf/Slope species: Distribution of Cassin's auklets on transects surveyed in and near Sitka Sound, Alaska in 2000. Includes all birds on water and flying.

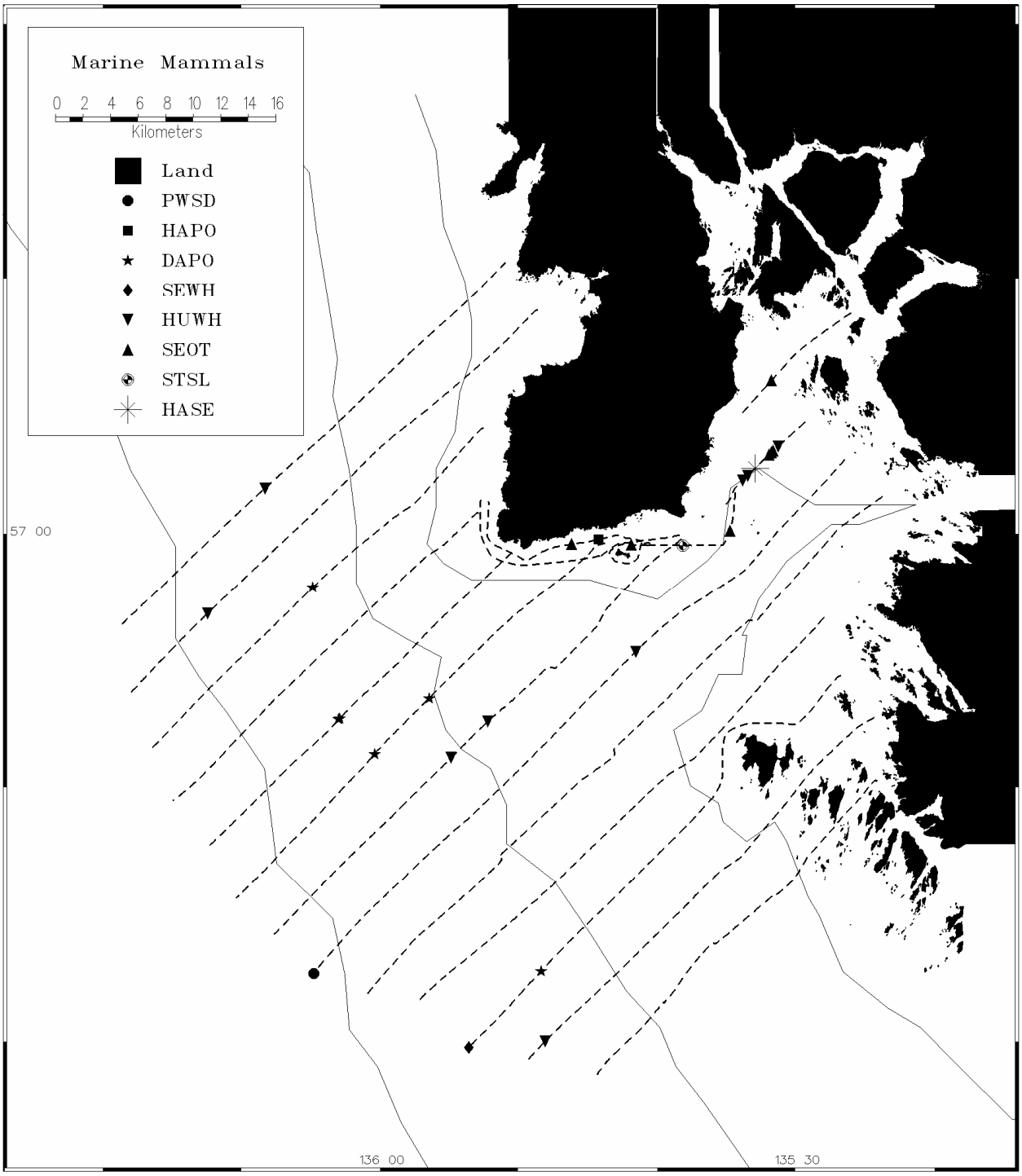


Figure 14. Locations of marine mammals on transects surveyed in and near Sitka Sound, Alaska in 2000. *PWSD*=Pacific white-sided dolphin, *HAPO*=harbor porpoise, *DAPO*=Dall's porpoise, *SEWH*=sei whale, *HUWH*=humpback whale, *SEOT*=sea otter, *STSL*=Steller's sea lion, *HASE*=harbor seal.

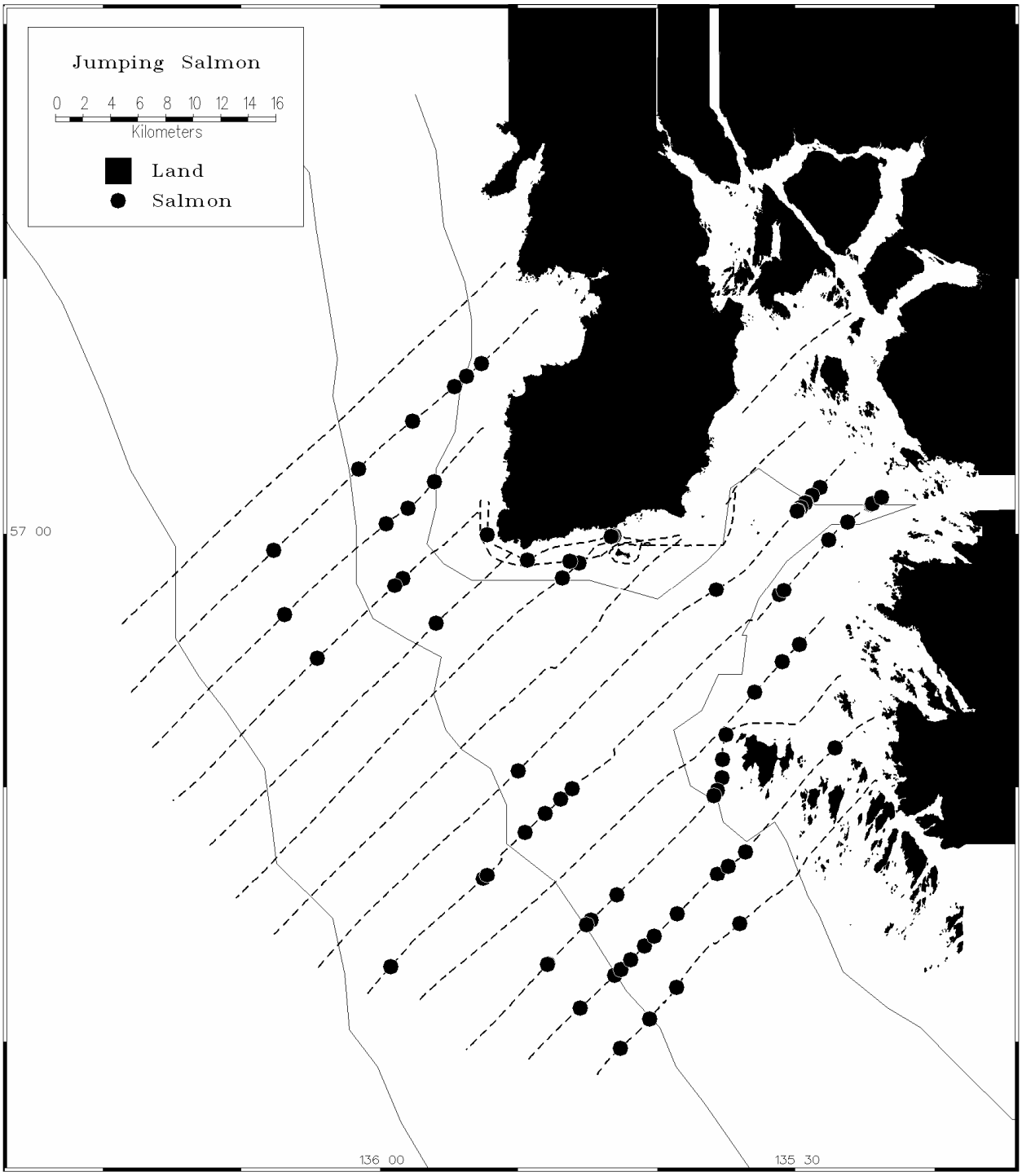


Figure 15. Locations of adult salmon observed jumping out of the water on transects surveyed in and near Sitka Sound, Alaska in 2000.

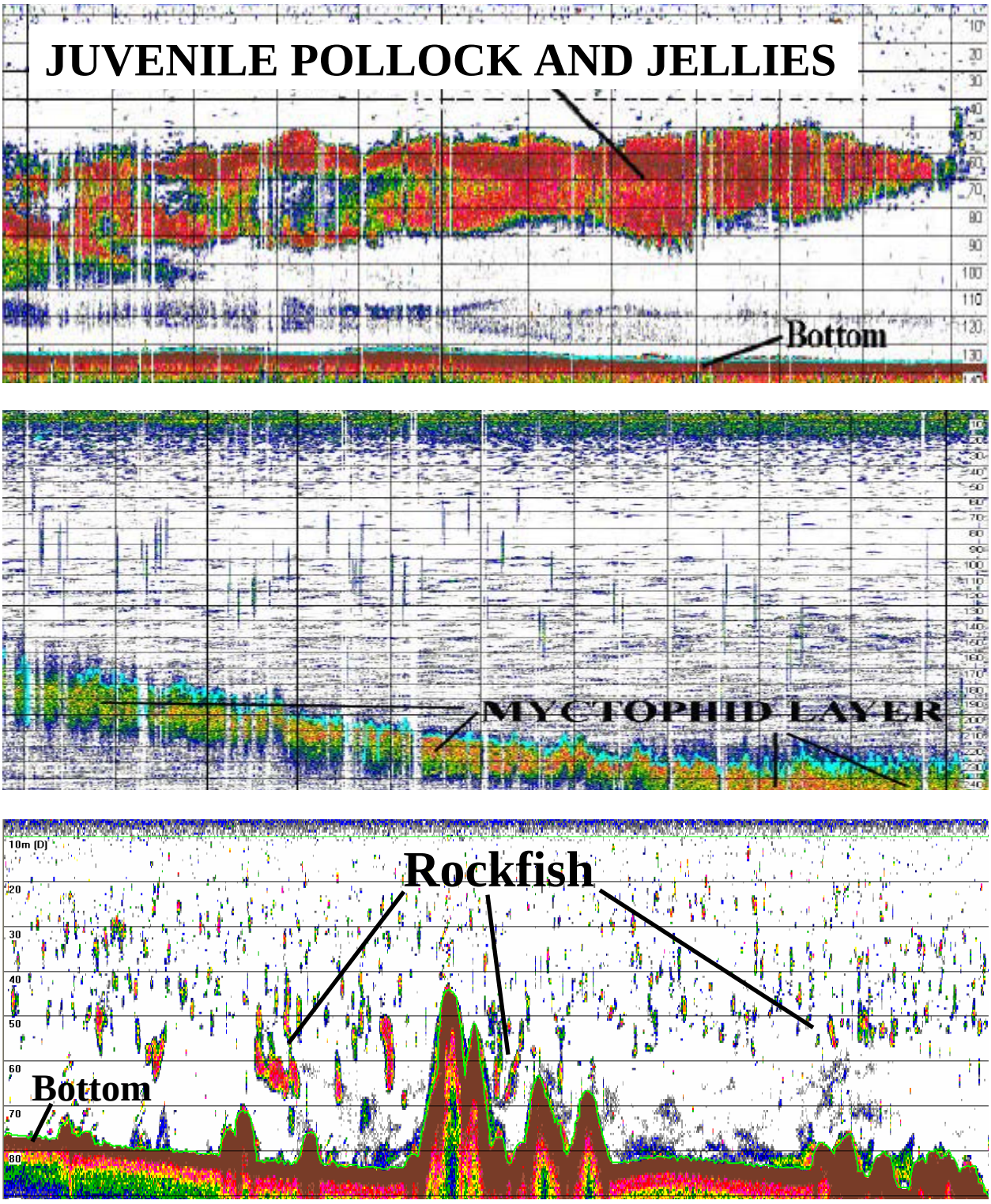


Figure 16. Examples of echograms obtained from the Simrad EK500 (120 kHz), showing mixed jellyfish and juvenile pollock (top), myctophid (middle) and rockfish (bottom) concentrations near St. Lazaria Island, Alaska in 2000. Depth scale (in meters) varies.

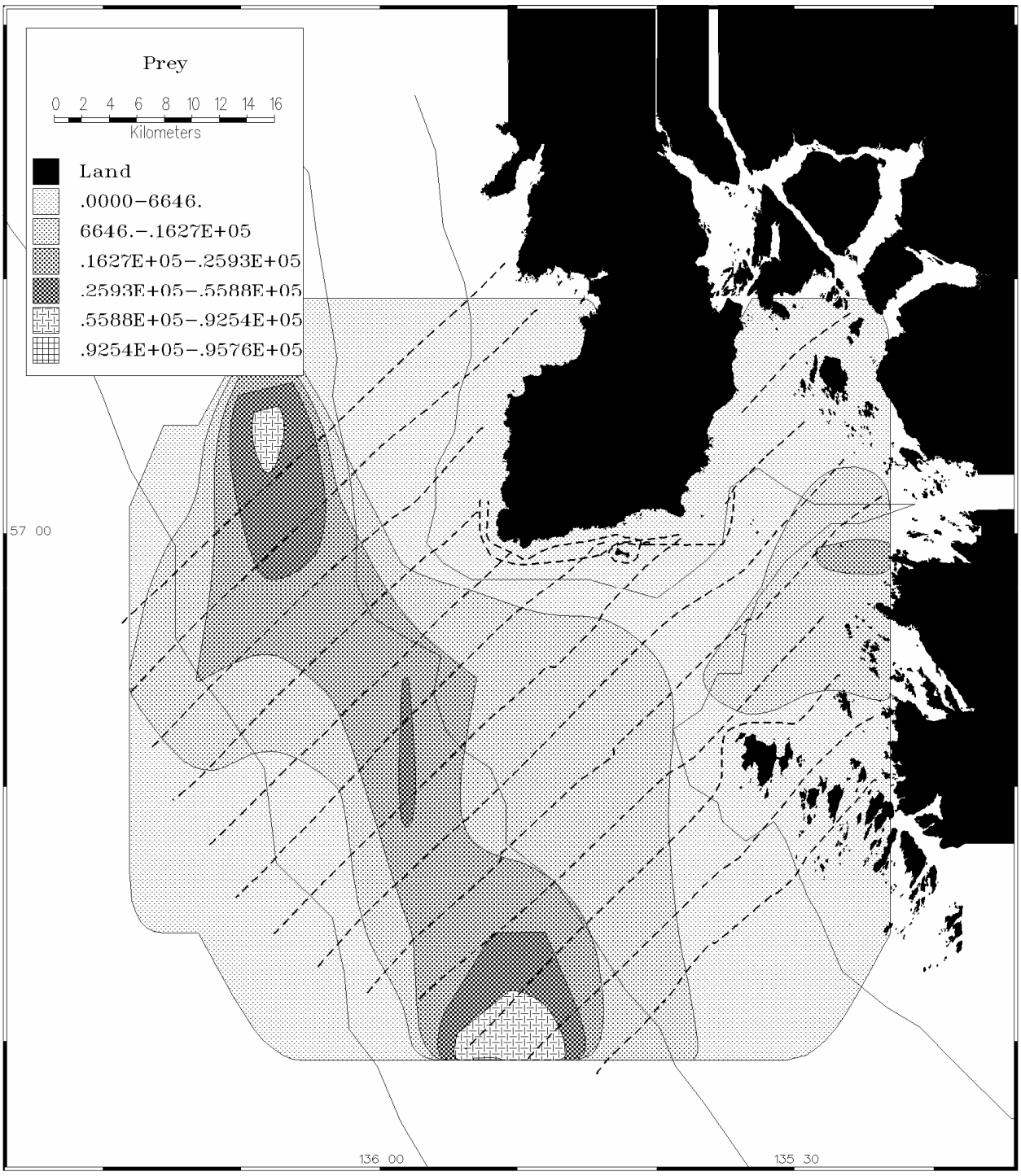


Figure 17. Distribution of prey in the water column (10-200m), based on acoustic surveys (120 kHz) on transects in and near Sitka Sound, Alaska in 2000.

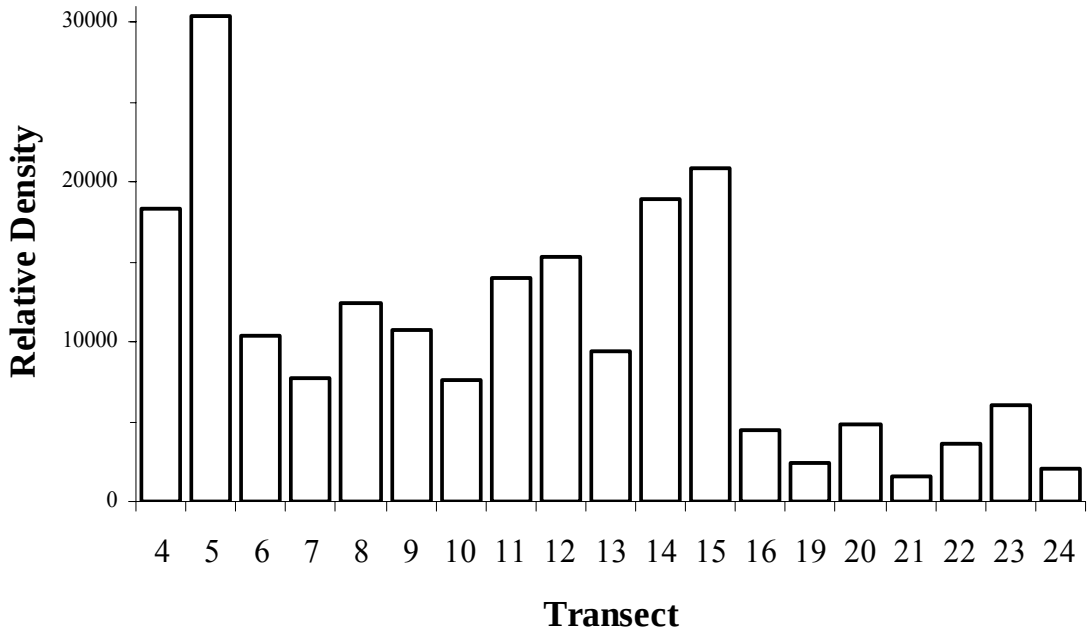


Figure 18. Water column relative prey densities detected during acoustic surveys (120 kHz) on transects in and near Sitka Sound, Alaska in 2000.

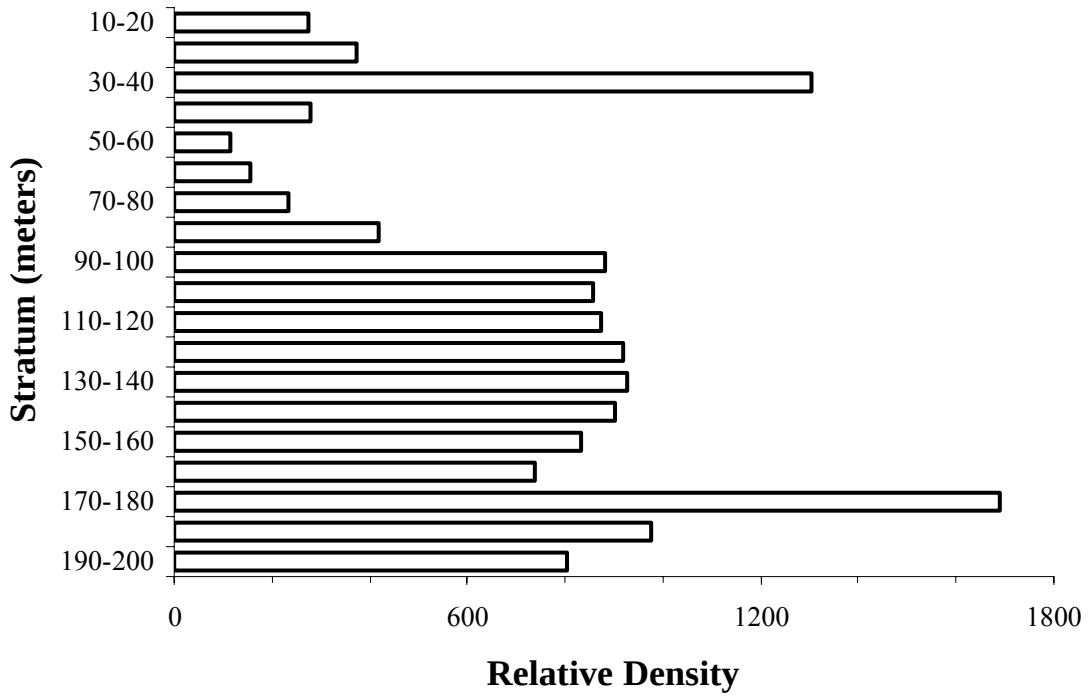


Figure 19. Relative density of prey by depth stratum detected during acoustic surveys (120 kHz) on transects in and near Sitka Sound, Alaska in 2000 (excluding surface stratum: 0-10 m). Depth in meters.

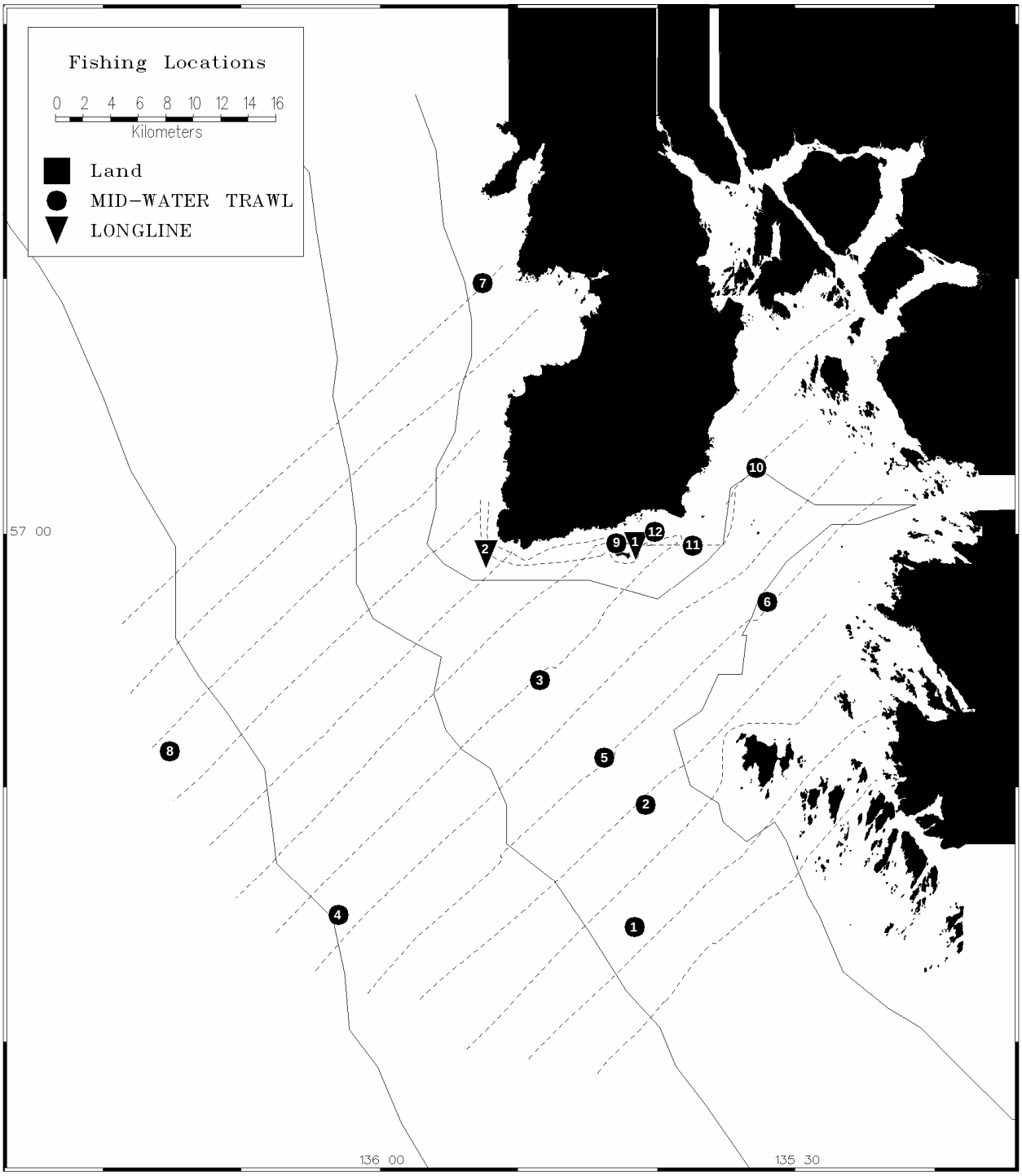


Figure 20. Locations of fishing efforts in or near Sitka Sound, Alaska in 2000.

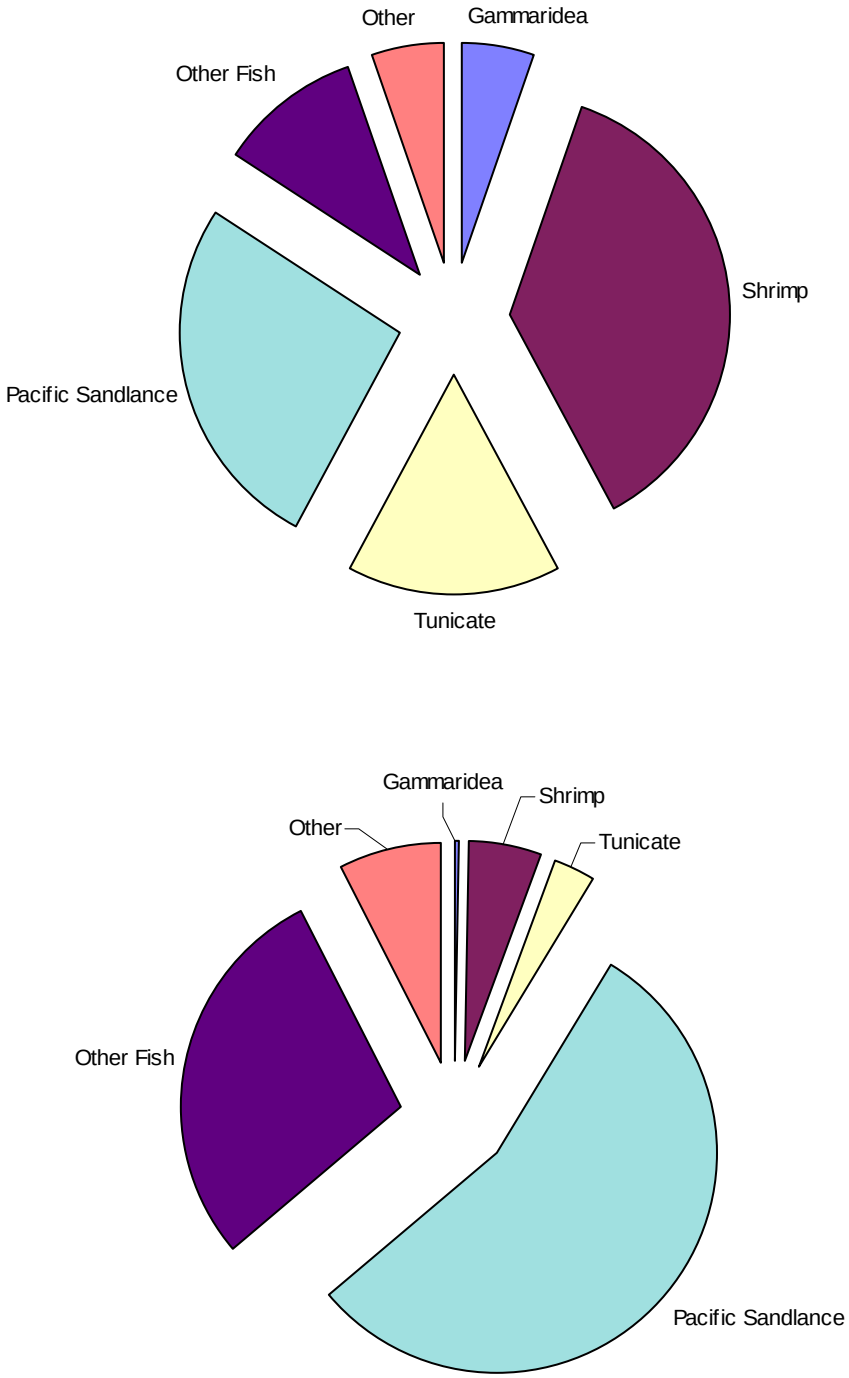


Figure 21. Percent frequency of occurrence (top) and percent total weight (bottom) of prey taken from stomach contents of quillback rockfish (*Sebastes maliger*) caught on long-line gear in Sitka Sound, Alaska in 2000 (n = 8 non-empty stomachs).

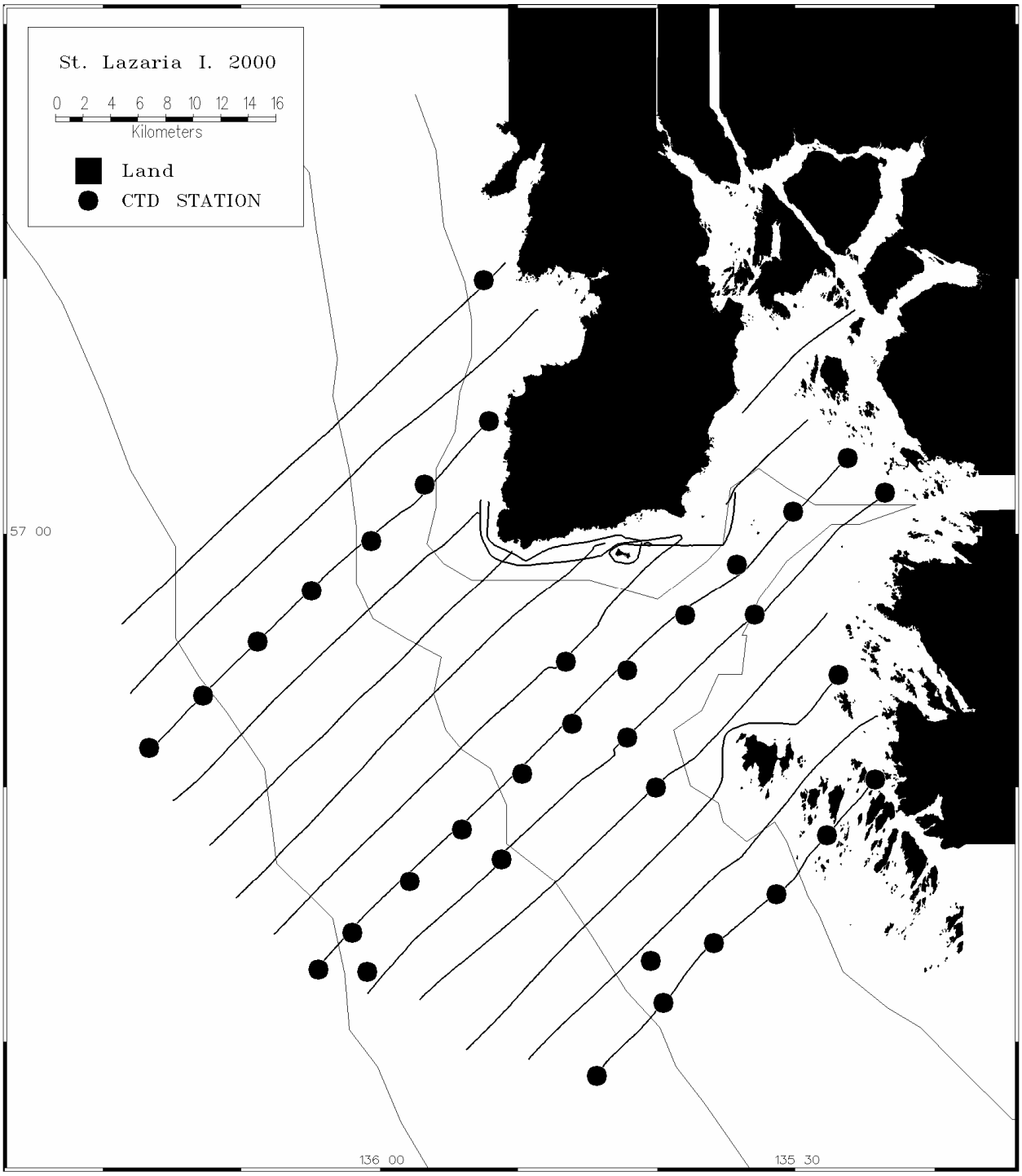


Figure 22. Locations of CTD stations sampled in and near Sitka Sound, Alaska in 2000.

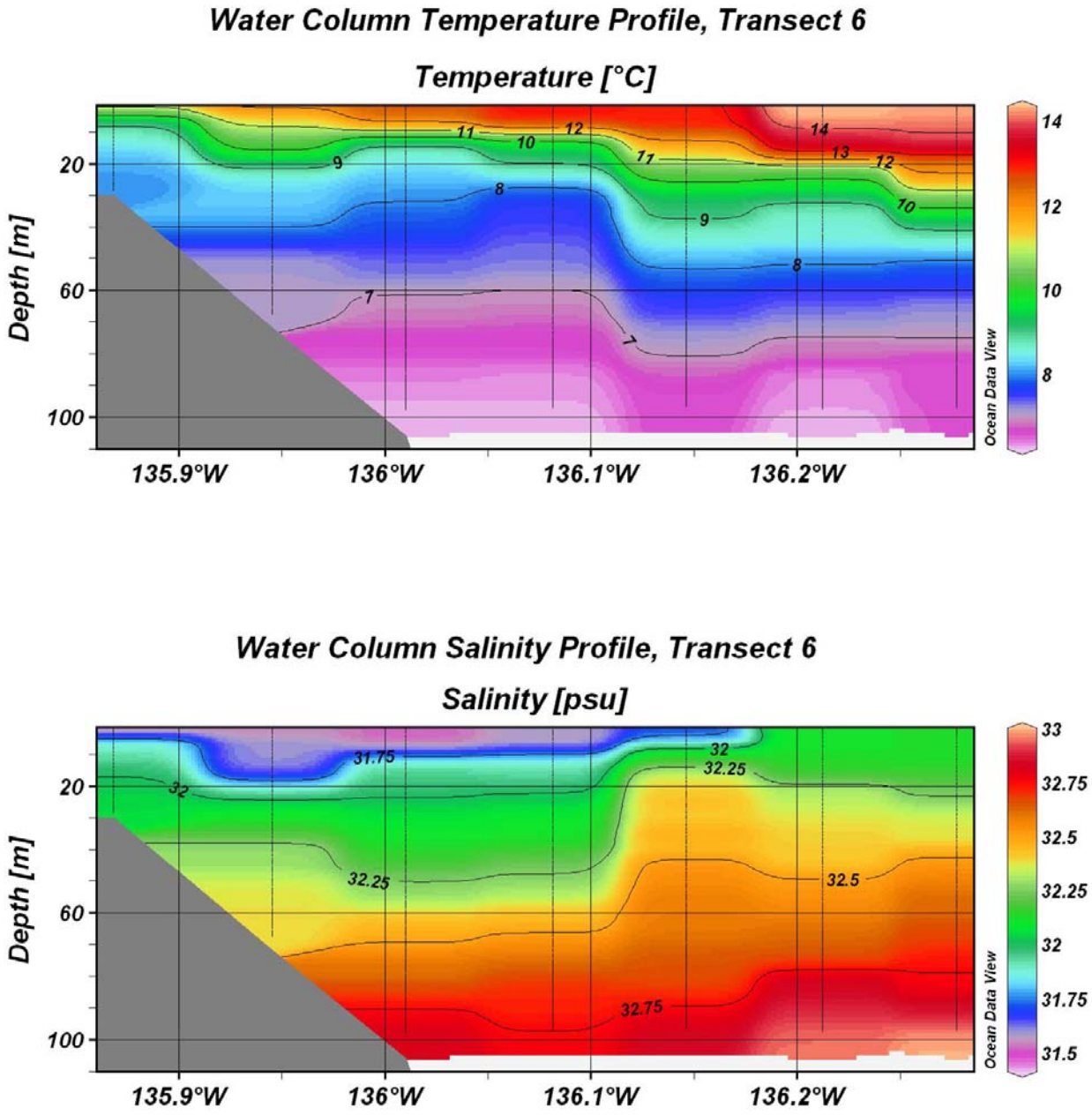


Figure 23. CTD profiles obtained from Sitka Sound, Alaska transect number 6 in 2000.

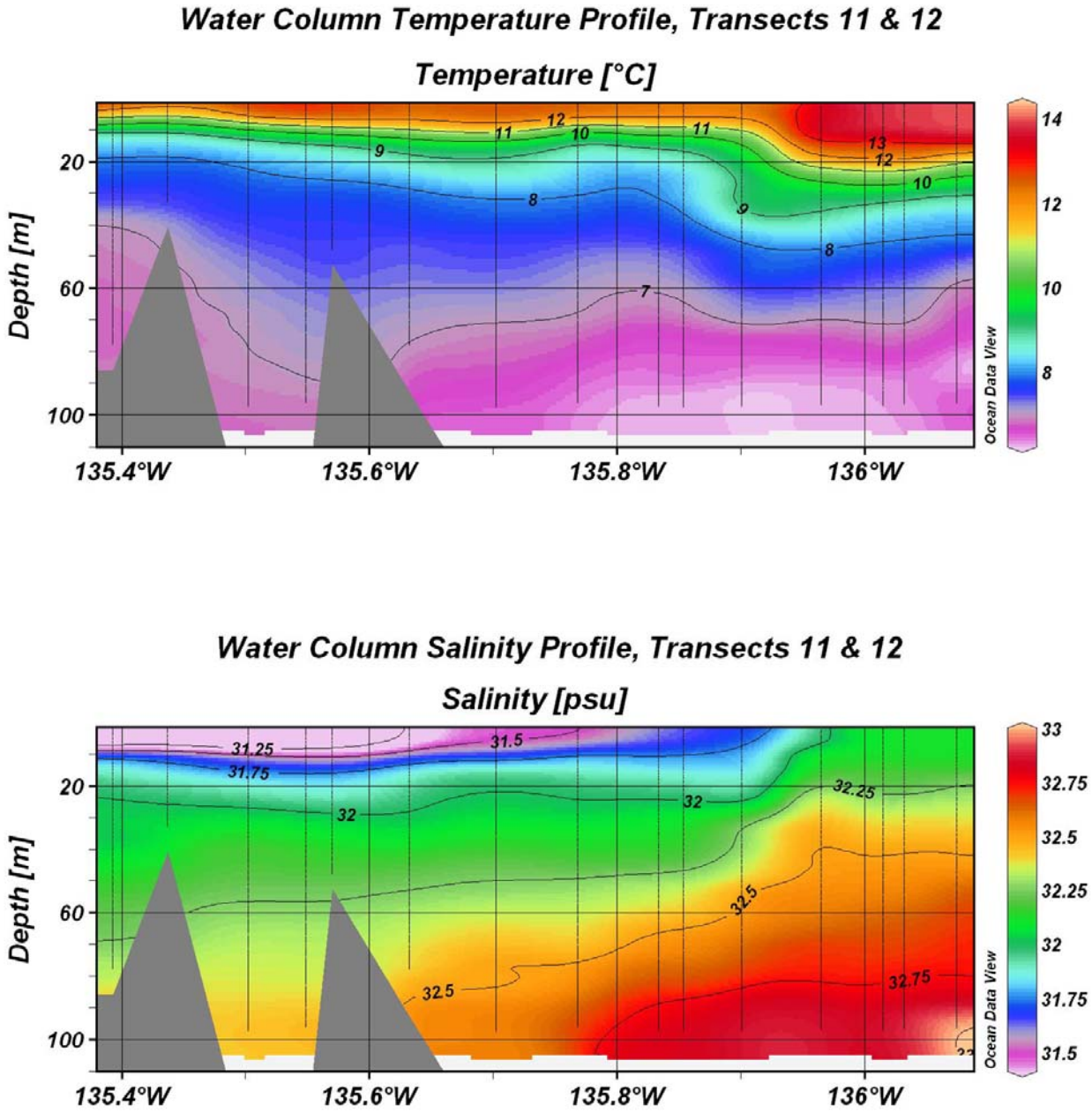


Figure 24. CTD profiles obtained from Sitka Sound, Alaska transects 11 and 12 (combined) in 2000.

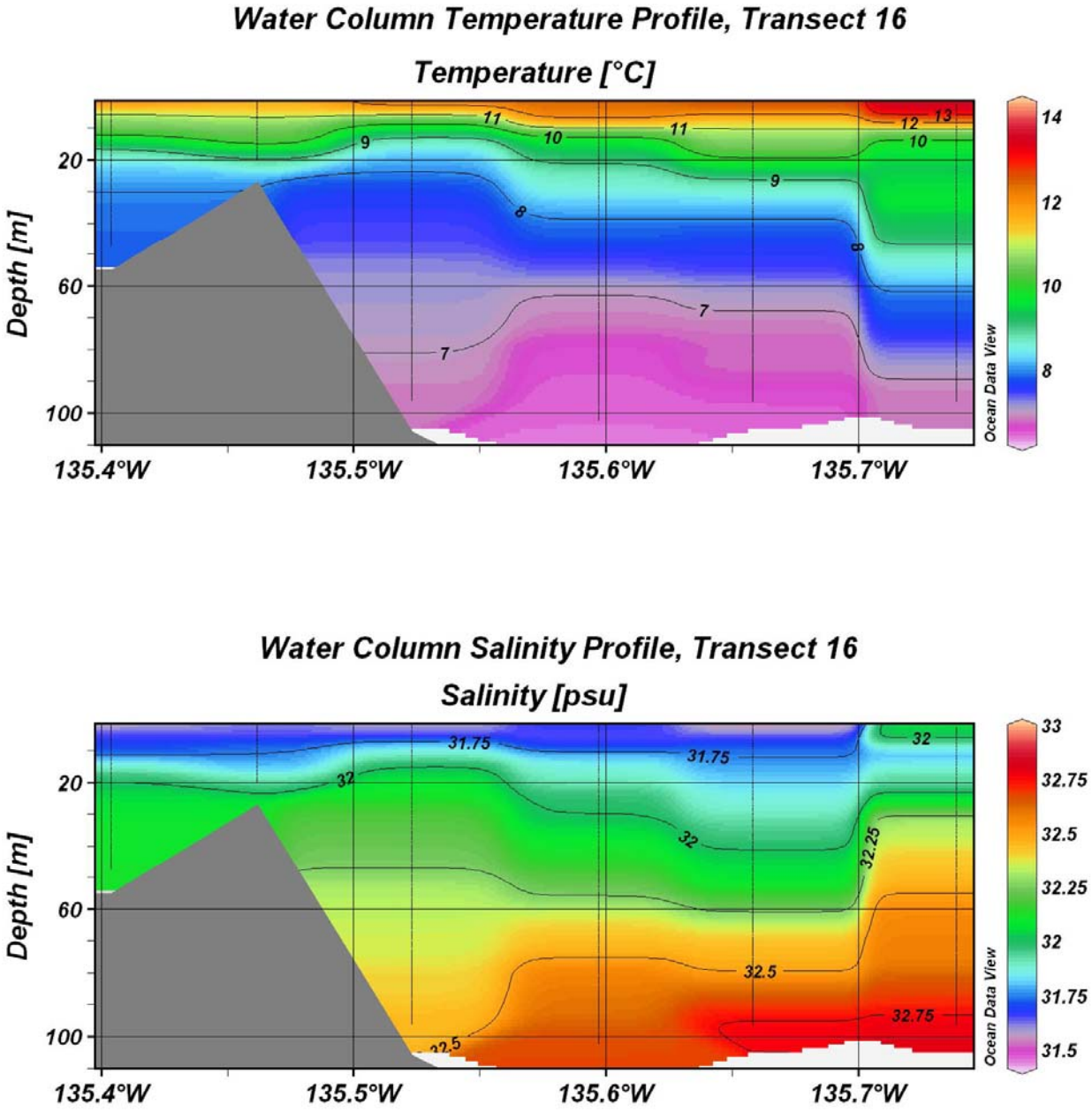


Figure 25. CTD profiles obtained from Sitka Sound, Alaska transect number 16 in 2000.

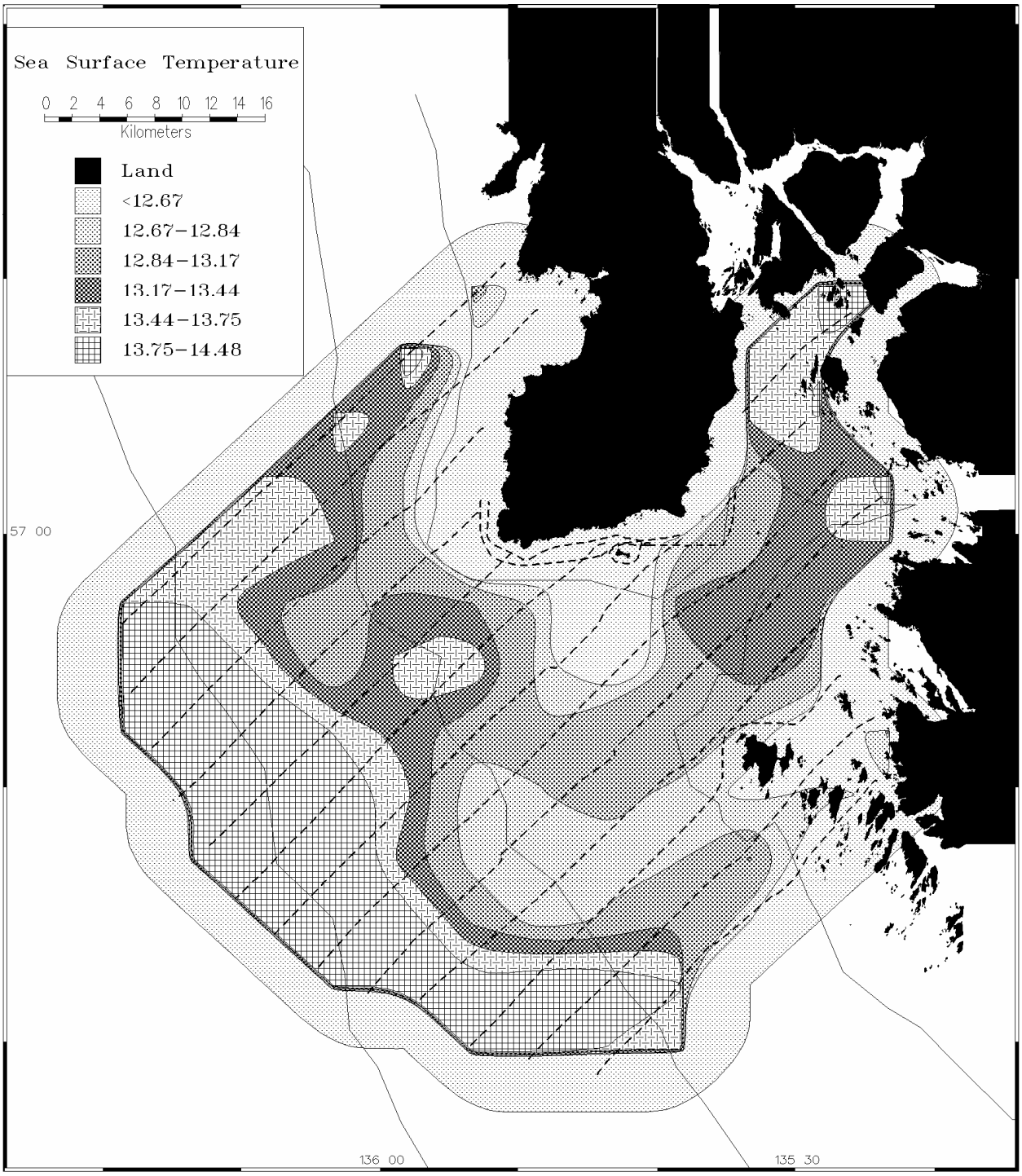


Figure 26. Sea surface temperatures interpolated from thermosalinograph records on transects surveyed in and near Sitka Sound, Alaska in 2000. Note that contour mapping created an artificial lower temperature band around high temperature areas offshore.

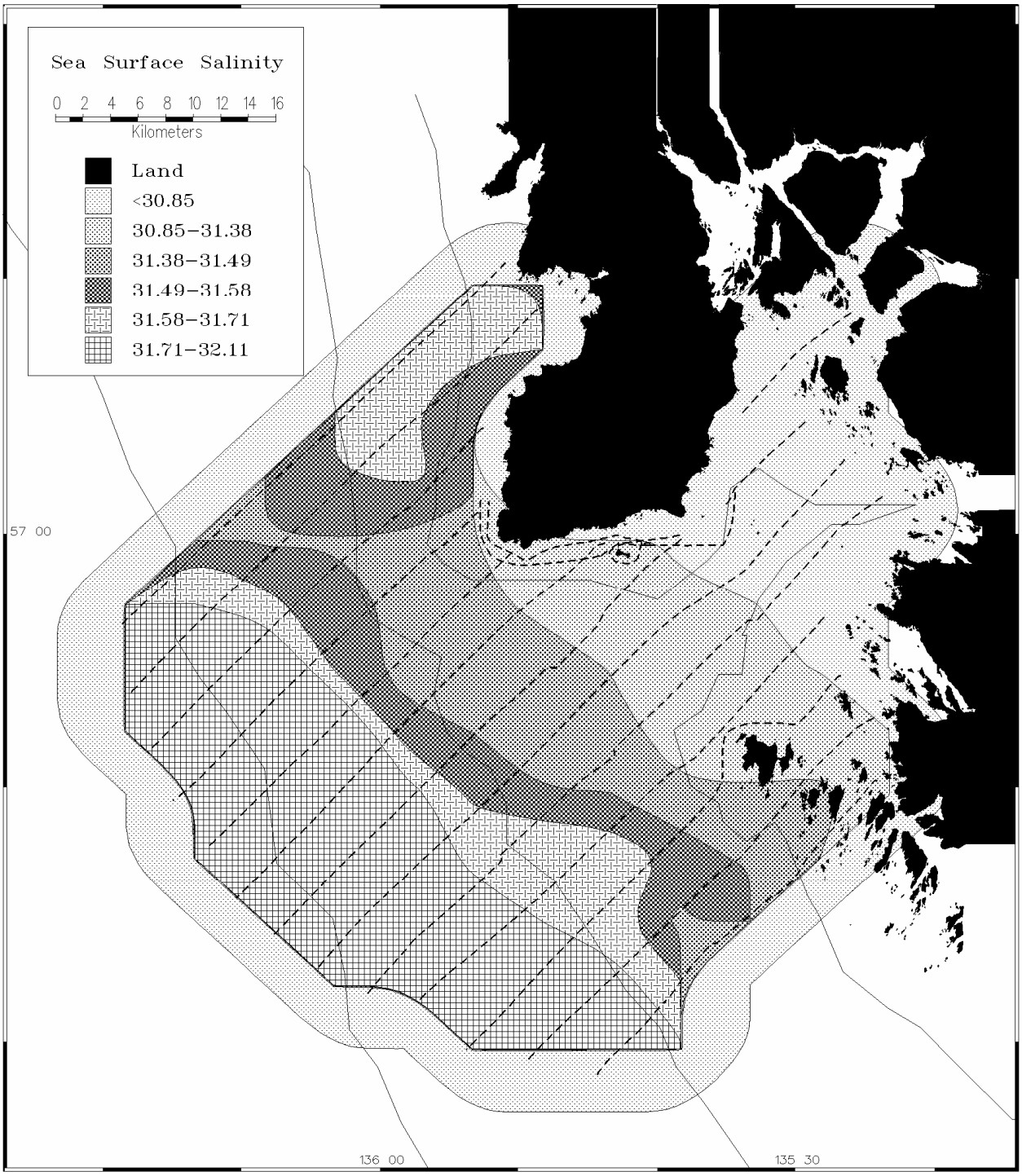


Figure 27. Sea surface salinities interpolated from thermosalinograph records on transects surveyed in and near Sitka Sound, Alaska in 2000. Note that contour mapping created an artificial lower salinity band around high salinity areas offshore.

Appendix A. Numbers of seabirds observed on 19 transects in and near Sitka Sound, Alaska during July 2000.

Species/ Transect Number	4	5	6	7	8	9	10	11	12	13	14	15	16	19	20	21	22	23	24
Common Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Yellow-billed Loon	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1
Black-footed Albatross	4	6	4	3	5	6	6	9	33	3	1	0	0	0	0	0	0	0	0
Unidentified Albatross	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
Northern Fulmar	20	36	19	5	10	39	34	13	26	7	11	1	7	0	0	0	0	0	0
Sooty Shearwater	6	2	1	1	0	1	1	12	11	0	0	4	15	0	0	3	0	0	0
Short-tailed Shearwater	0	0	0	0	0	0	0	1	3	0	56	0	1	0	0	0	0	0	0
Unidentified Shearwater	2	0	0	2	5	0	1	13	1	0	3	37	1	0	0	0	0	0	0
Fork-tailed Storm-petrel	14	12	3	8	4	11	16	38	13	1	2	0	2	0	0	0	0	0	0
Leach's Storm-petrel	0	1	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified Storm-petrel	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0
Double-crested Cormorant	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Pelagic Cormorant	0	5	0	0	16	1	0	2	0	2	9	7	2	6	0	27	12	51	5
Unidentified Cormorant	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
White-winged Scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0
Unidentified Scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0
Bald Eagle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Black Turnstone	0	0	0	0	0	2	0	0	3	0	0	0	0	0	0	0	0	0	0
Red-necked Phalarope	0	12	3	0	0	8	9	0	8	18	0	0	0	0	0	0	0	0	0
Unidentified Phalarope	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parasitic Jaeger	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mew Gull	0	0	3	0	1	0	0	0	9	0	0	0	0	0	0	1	0	0	0

Appendix A. Numbers of seabirds observed on 19 transects in and near Sitka Sound, Alaska during July 2000 (continued).

Species/ Transect Number	4	5	6	7	8	9	10	11	12	13	14	15	16	19	20	21	22	23	24
Herring Gull	0	3	0	3	2	1	2	4	0	0	1	1	0	0	0	9	4	0	0
Glaucous-winged Gull	0	18	0	3	2	6	4	194	3	2	8	12	24	13	0	6	25	0	1
Unidentified Gull[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	230	0	0	0
Common Murre	1	5	1	1	2	1	26	84	14	16	33	4	1	9	0	30	334	7	1
Thick-billed Murre	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2	0	0
Unidentified Murre	0	3	0	0	2	0	0	11	2	1	0	0	0	0	0	0	0	21	1
Pigeon Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	3	0
Marbled Murrelet	0	0	0	0	0	0	2	159	5	1	51	5	0	82	1	30	0	48	5
Unidentified *Brachyramphus* Murrelet	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Ancient Murrelet	11	0	0	0	1	0	3	2	7	0	4	0	0	0	0	0	0	0	3
Cassin's Auklet	73	31	4	0	0	0	0	1	9	13	5	2	0	0	0	0	0	0	0
Parakeet Auklet	0	0	2	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified small dark Alcid	0	0	0	0	0	2	0	1	0	0	0	0	1	0	0	0	0	0	0
Rhinoceros Auklet	18	20	12	4	19	0	37	94	44	8	13	3	7	51	0	46	4	5	9
Horned Puffin	0	0	1	0	1	0	0	6	2	0	0	0	0	0	0	2	0	11	0
Tufted Puffin	6	8	1	0	0	1	6	33	5	6	2	5	7	0	0	2	39	1	0

[a]Mixed flock.

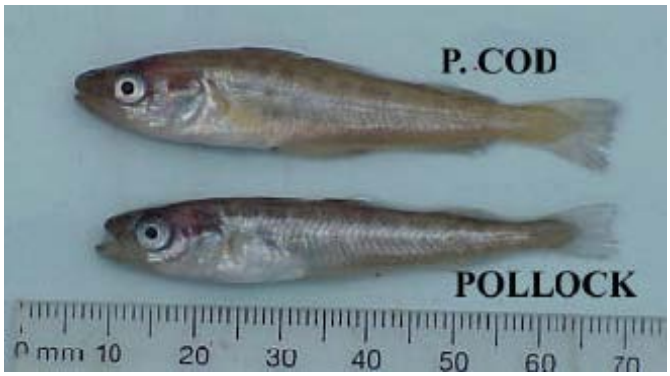
Appendix B. Numbers of marine mammals observed on 19 transects in and near Sitka Sound, Alaska during July 2000.

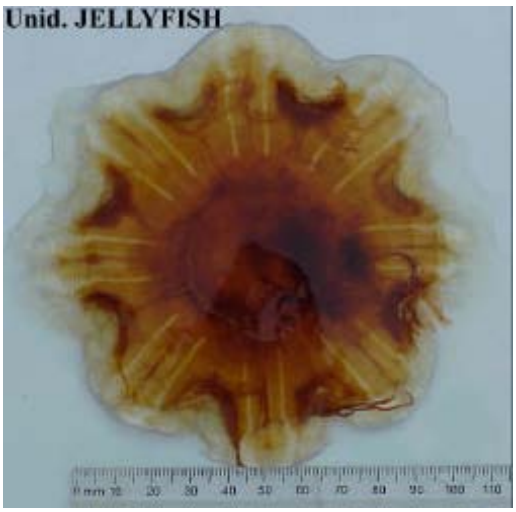
Species/ Transect Number	4	5	6	7	8	9	10	11	12	13	14	15	16	19	20	21	22	23	24
Pacific White-sided Dolphin	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
Harbor Porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Dall's Porpoise	0	0	4	0	4	7	0	0	0	0	4	0	0	0	0	0	0	0	0
Sei Whale	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Humpback Whale	1	1	0	0	0	0	2	1	0	0	0	1	0	3	0	0	0	0	0
Sea Otter	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	1	1	1	0
Steller Sea Lion	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Harbor Seal	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

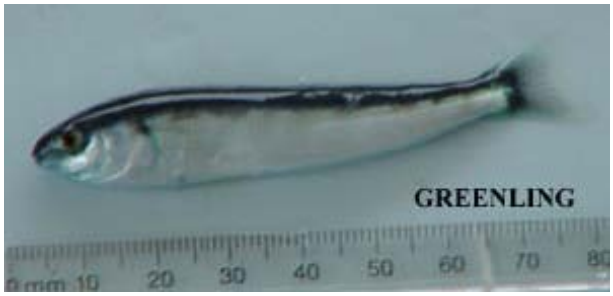
Appendix C. Numbers of fishes observed on 19 transects near St. Lazaria Island, Alaska during July 2000.

Species/ Transect Number	4	5	6	7	8	9	10	11	12	13	14	15	16	19	20	21	22	23	24
Unidentified Shark	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Unidentified Salmon	0	6	4	3	1	2	0	11	18	3	10	12	5	0	0	0	0	7	1

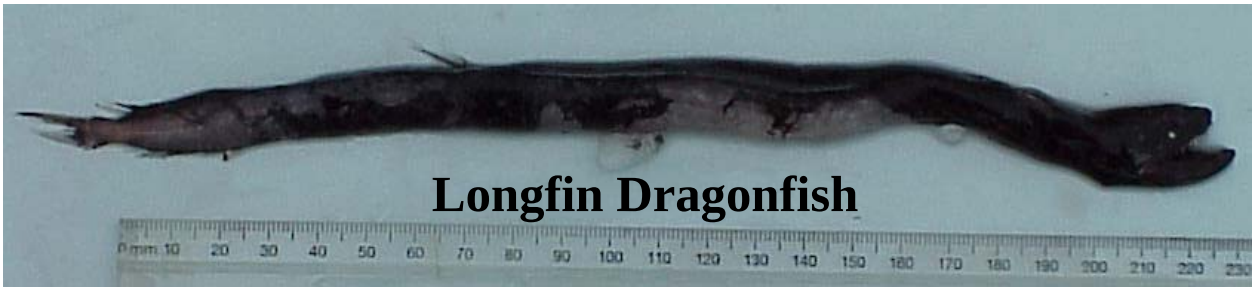
Appendix D. Photographs of species captured during the SMMOCI cruise in and near Sitka Sound, Alaska in 2000 (all by Jeff Williams).

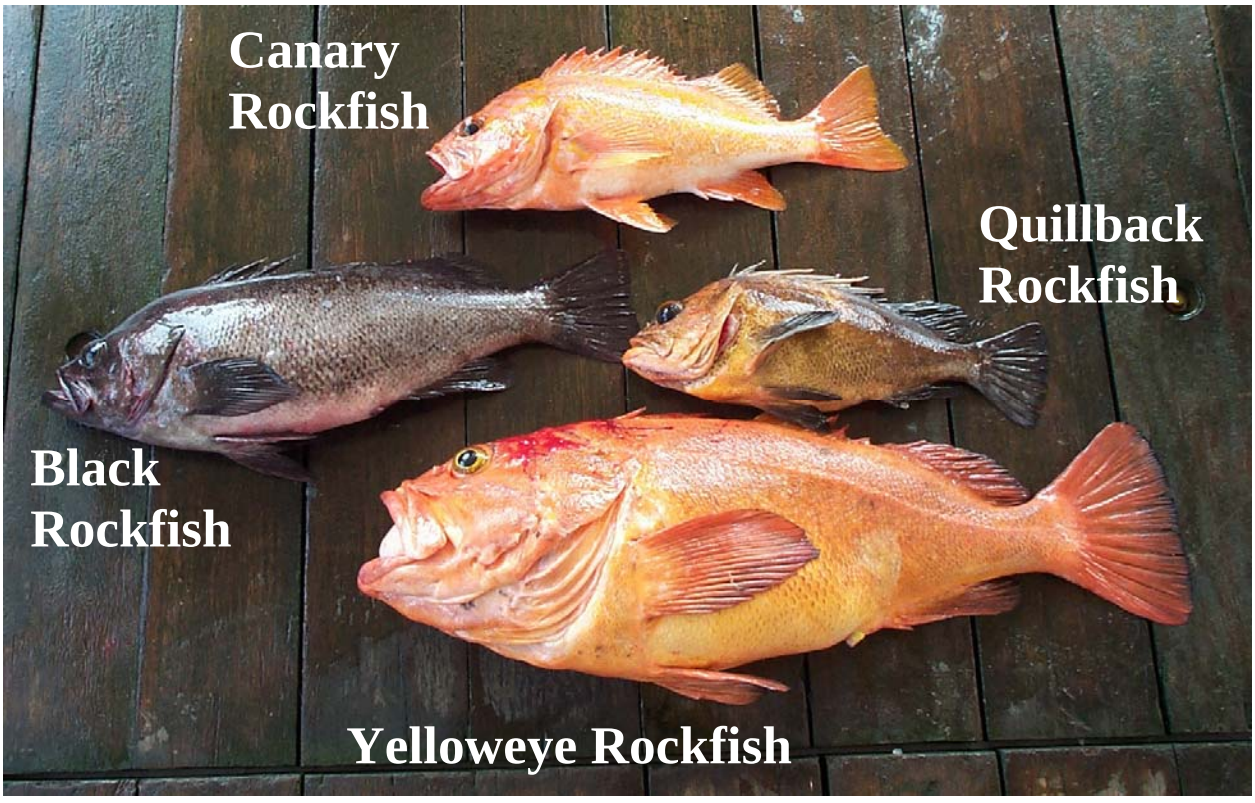




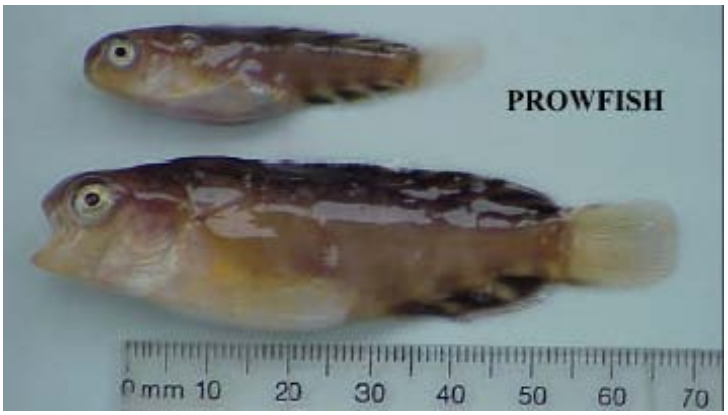


Appendix D (continued).





Appendix D (continued).



Partial catch from mid-water trawl consisting primarily of young walleye pollock.