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SEABIRD, FISHERIES, MARINE MAMMAL, AND OCEANOGRAPHIC INVESTIGATIONS AROUND KASATOCHI, KONIUJI, AND ULAK ISLANDS, AUGUST, 1996 (SMMOCI 96-3)

by

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INTRODUCTION

Although islands in the Aleutians are known to support some of the highest densities of seabirds in the world, their remoteness has limited systematic research on the at-sea distribution of seabirds near these colonies. Kasatochi, Koniuji, and Ulak islands, in the central Aleutian Islands, together comprise one of nine ecological sites monitored once every 5 years on an annual rotation since 1996 by the Alaska Maritime National Wildlife Refuge (AMNWR). To supplement annual colony monitoring and examine seabird distribution away from colony sites, the AMNWR personnel in conjunction with U.S. Geological Survey (USGS) researchers, conducted a pelagic survey of the waters around these 3 islands in 1996.

Previous research in this area has focused on the seabird colony sites located on Kasatochi, Koniuji, and Ulak islands. Although boat-based circumnavigations have been used to evaluate colony populations (Early et al. 1981; Bailey and Trapp 1986; Byrd and Williams 1994; Byrd 1995a, 1995b), wide ranging pelagic surveys to examine foraging patterns had not previously been conducted near the islands. The goal of this survey was to examine foraging patterns of the seabirds nesting in the study area and identify factors that may explain seabird distribution patterns.

STUDY AREA

Kasatochi, Koniuji, and Ulak islands, 287, 110, and 46.5 ha respectively, are located on the southern edge of the Aleutian Basin (Fig. 1) in the Andreanof Island group of Alaska's central Aleutian Islands. Weather in the study area is typical of a northern maritime climate, with moderate year-round temperatures and strong winds. High humidity and precipitation are common and violent storms are frequent. Summer time sea-surface temperatures are commonly in the range of 4-9°C with increasing temperatures as summer progresses. Average annual precipitation is 166 cm. Snow accumulation at sea level is minimal and there is no permafrost. Vegetation on the islands is composed of maritime and alpine tundra and consists mostly of grasses, sedges, sphagnum mosses, lichens, and a variety of forbs. Scharf (1998) provides a thorough description of the 3 islands. Bathymetry of the area is generally shallow near the islands in the chain, with deep troughs to the north and south (Fig. 2).

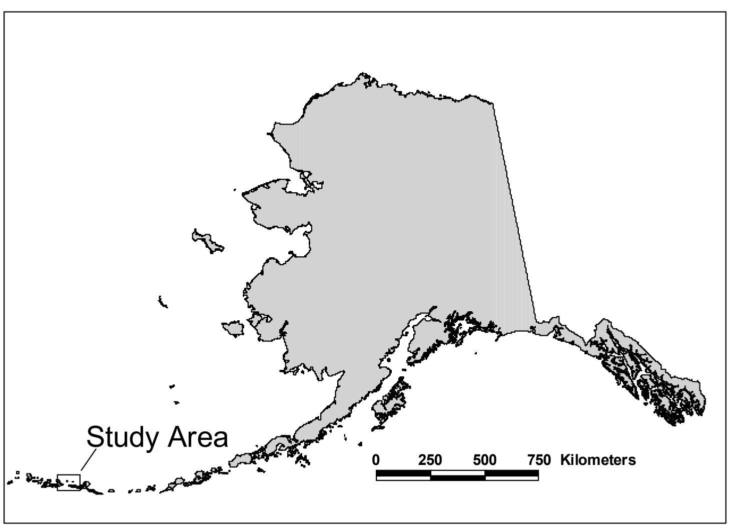


Figure 1. Location of the survey area in the Aleutian Islands.

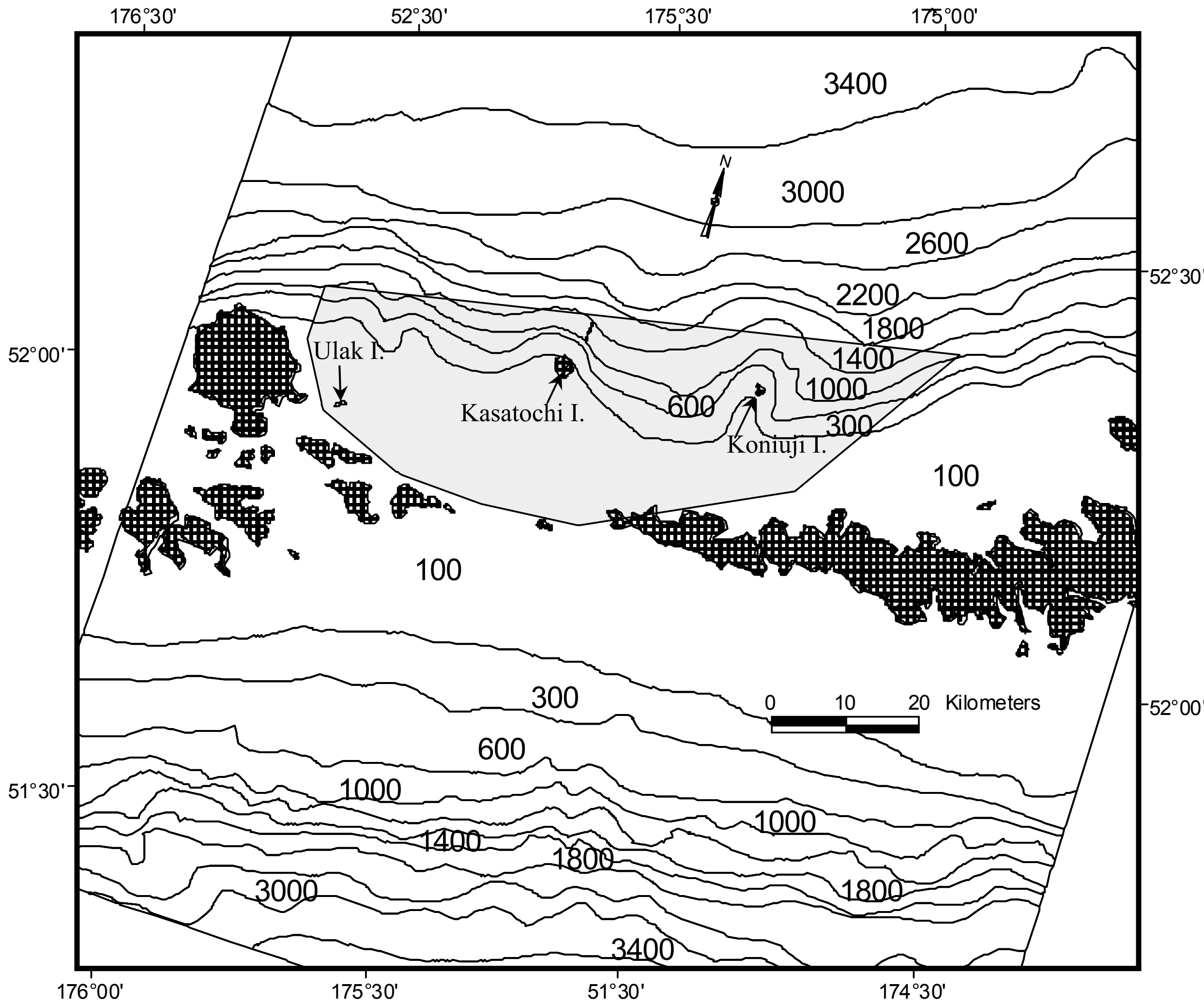


Figure 2. Bathymetry (m) of the area around Kasatochi I. in the central Aleutian Islands. The shaded area represents the areal extent of the 1996 pelagic survey.

METHODS

Surveys were conducted between 2-5 August 1996 from the U.S. Fish and Wildlife Service (USFWS) vessel M/V *Tiĝlax̂* (see Appendix 1 for personnel and schedule). . The survey was originally planned to include a series of north-south transects that would, along with circumnavigations of the islands, provide detailed spatial coverage in the vicinity of seabird local colonies. Weather, sea conditions and time constraints forced minor modification of the planned route, but coverage was nonetheless fairly complete (Fig. 3). Transects covered 360 km of linear distance.

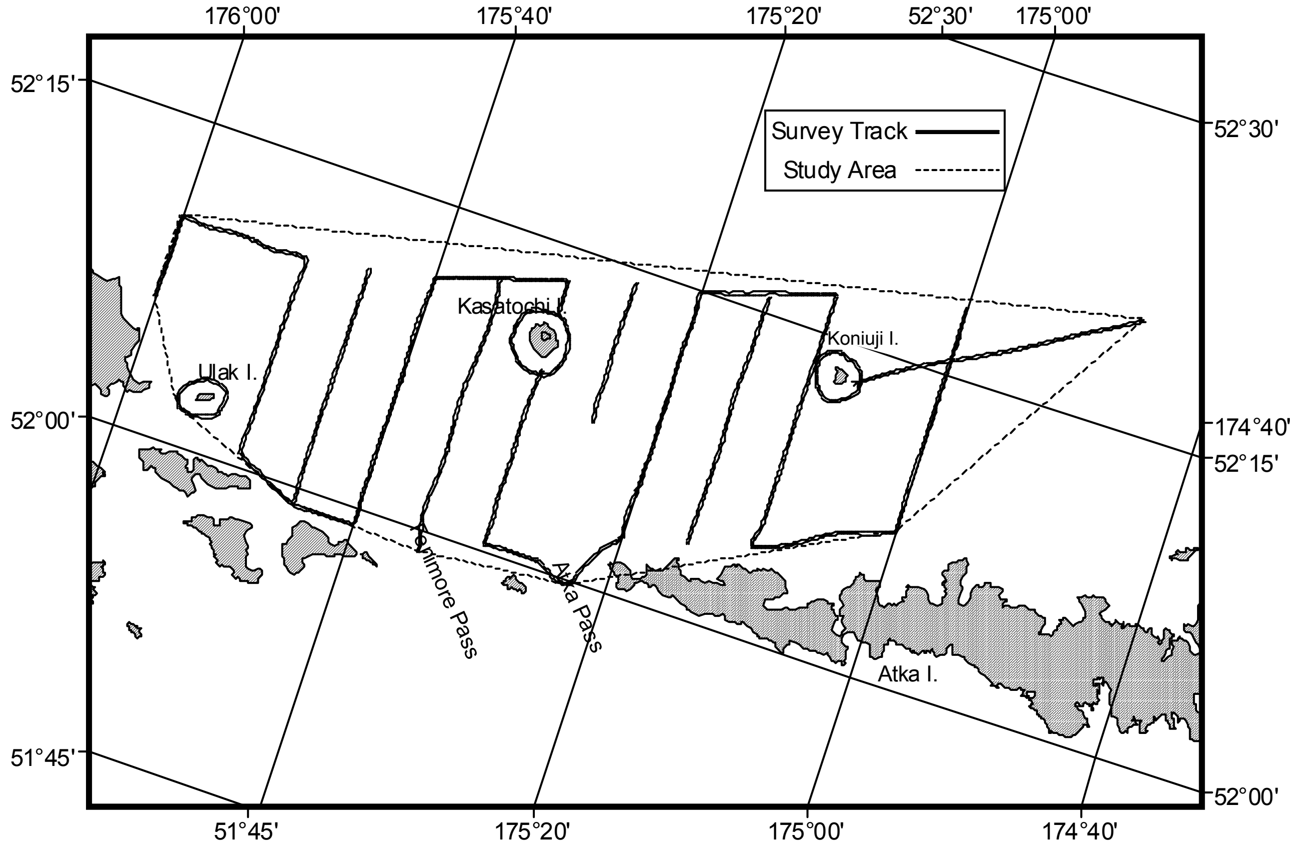


Figure 3. Survey track of the pelagic survey around Kasatochi, Koniuji, and Ulak islands; the survey was conducted August 2-5, 1996.

Oceanographic Data

Sea surface temperature (SST) and salinity (SSS) were monitored using a hull mounted (3 m depth) continuously recording thermosalinograph (TS) (Sea-bird Electronics Inc., Bellevue WA) on all survey transects. TS data were collected at 15 second intervals, but binned in 1 minute blocks. The latitude, longitude, and depth were merged with the original TS data based on the 1 minute bins. In addition to the on-board TS, two CTD (Conductivity [salinity], Temperature, Depth) transects were also conducted. These transects provided data to augment the surface TS data by adding a third dimension (depth). On CTD transect lines (Fig. 4), water column profiles were obtained using a Seacat 19-03 Conductivity - Temperature - Depth recorder (Sea-Bird Electronics Inc., Bellevue WA).

Fishing

To document fish resources available in the study area; two bottom trawls, three long-line sets, and one mid-water (Methot) trawl were conducted during the cruise (Table 1). The majority of fishing was conducted at night to avoid conflict with seabird/marine mammal surveys conducted during the day.

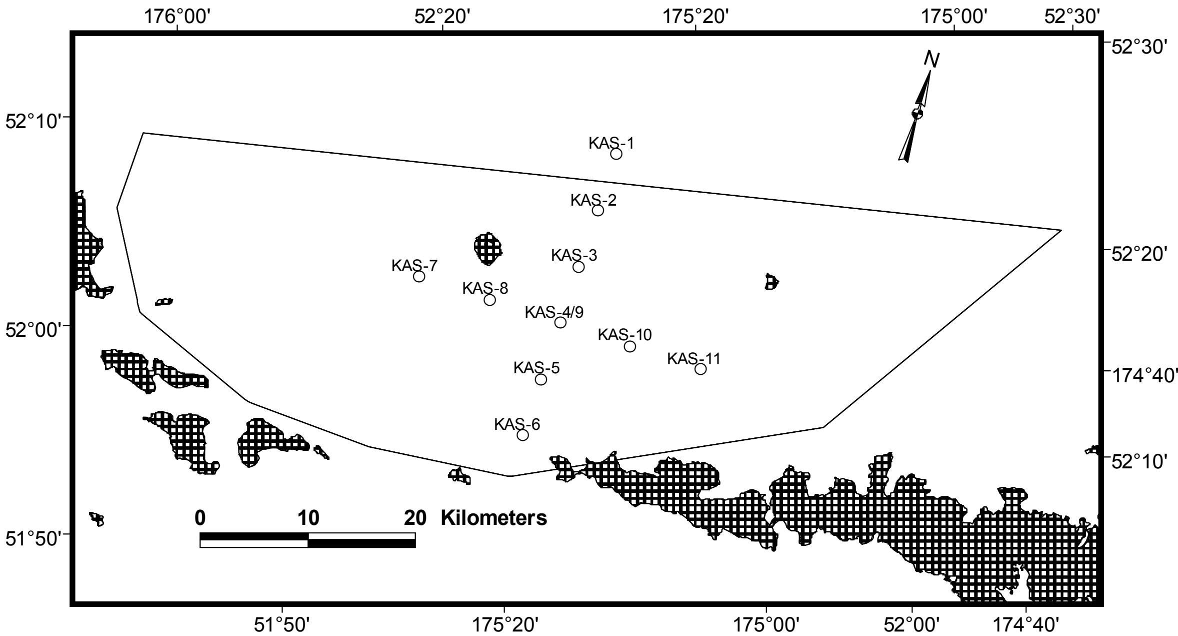


Figure 4. Locations of vertical CTD casts taken from the M/V *Tiĝlax̂* August 2-5, 1996.

A 3.05-m plumb staff beam trawl with a double tickler chain was used to sample juvenile ground fishes. The net body was 7-mm square mesh with a 4-mm stretched mesh cod end. Tow durations were 10 and 5 minutes respectively. A Methot trawl was used for mid-water sampling of forage fish. Long-line sets were approximately 500 m long and set with snap gear using 5.0 and 3.0 hook sizes. Hooks were baited with salted herring and spaced at approximately 5 m intervals for a total of 125 baited hooks per set. Sets were made at night and retrieved 3-4 hours later. Depths at long-line sites varied from 24 to 98 m. The stomachs of halibut and cod were collected and preserved in 10% formalin and sent to the National Marine Fisheries Service's Alaska Fisheries Science Center in Seattle for analysis of contents. The Methot trawl had a 5-m^2 net opening, 2x3-mm mesh in the main net body, and a 1-mm mesh at the cod end. Limited time in the study area dictated that we could only
conduct a single mid-water trawl.

Table 1. Locations and dates of fishing efforts in the central Aleutian Islands, 1996.

Type[a]	Date	Time[b]	Latitude (N)	Longitude (W)	Depth (m)
BOTR 1	3 Aug.	2030	52° 02.91'	175° 58.78'	62
BOTR 2	4 Aug.	2107	52° 12.84'	175° 08.45'	32
LOLI 1	2 Aug.	2026	52° 10.30'	175° 32.22'	24-34
LOLI 2	3 Aug.	2000	52° 03.77'	175° 58.00'	36-50
LOLI 3	4 Aug.	1950	52° 12.59'	175° 07.55'	60-98
MWTR 1	4 Aug.	1410	51° 59.13'	175° 34.11'	Not recorded

[a] BOTR = Bottom trawl, LOLI = Long-line set, MWTR = Mid-water trawl.
[b] Start of tow or set (Aleutian Daylight Time).

Bird and Marine Mammal Observations

Seabird and marine mammal surveys were conducted according to protocols developed by the USFWS (Gould et al. 1982, Gould and Forsell 1989). Seabirds and marine mammals were censused within a survey "window" 300 m-wide (150 m to each side) by 300 m long (measured from the centerline of the survey vessel to 300 m forward. Counts were summed over 10-min time intervals (hereafter referred to as transects). All swimming birds and marine mammals were tallied by species. Instantaneous counts of flying birds were made three times during a 10-min transect, which combined with swimming birds, provided the total numbers of birds on transect with which to calculate densities.

When looking at seabird distributions, determining important foraging sites can be problematic. Loafing near colony sites, as well as birds in transit to and from colony sites, tend to make identification of foraging areas difficult. While little can be done about loafing birds we examined distribution of flying birds and those sighted on the water separately to limit the bias associated with the transit to and from colonies.

Hydroacoustic Surveys

Hydroacoustic surveys were conducted concurrently with bird surveys. Acoustic data were collected using a hull-mounted BIOSONICS Model 281 Echosounder (120 kHz) transducer located 4 m below the sea surface. Transmit power was set at 217 dB, gain at -125.4 dB, bandwidth at 5 kHz, trigger interval at 0.5 sec, and pulse width at 0.5 ms for all surveys. Fish and plankton echo signals were integrated in real time over 1 min. time intervals and over 5, 10, 25, or 50m depth strata using a BIOSONICS Model 121 Digital Echo Integrator with 20 LogR amplification. Signals were integrated over each time/depth block and later converted to relative acoustic biomass. In the absence of sampling, we used a target strength of -64 dB/g, which was calculated from regression equations for fish with closed swimbladders (Foote 1987, Piatt et al. 1991). The contribution of zooplankton to echo signals was assumed to be negligible. The accuracy of calculated biomass is therefore approximate, but estimates serve as precise relative measures of fish biomass.

Geographic Information System

A geographic information system (GIS) was developed to visualize environmental (temperature and salinity) and biological variables (birds and acoustic biomass). Point measurements were krieged (smoothed) to interpolate point data and develop smoothed maps for comparative analysis.

RESULTS

Oceanographic Data

Patterns of sea surface temperature (SST) and sea surface salinity (SSS) data from the continuous surface TS recorder on the *Tiĝlax̂* reveled that upwelling occurs on the north sides of Atka and Fenimore passes, as indicated by the lower temperatures and higher salinities (Fig. 5).

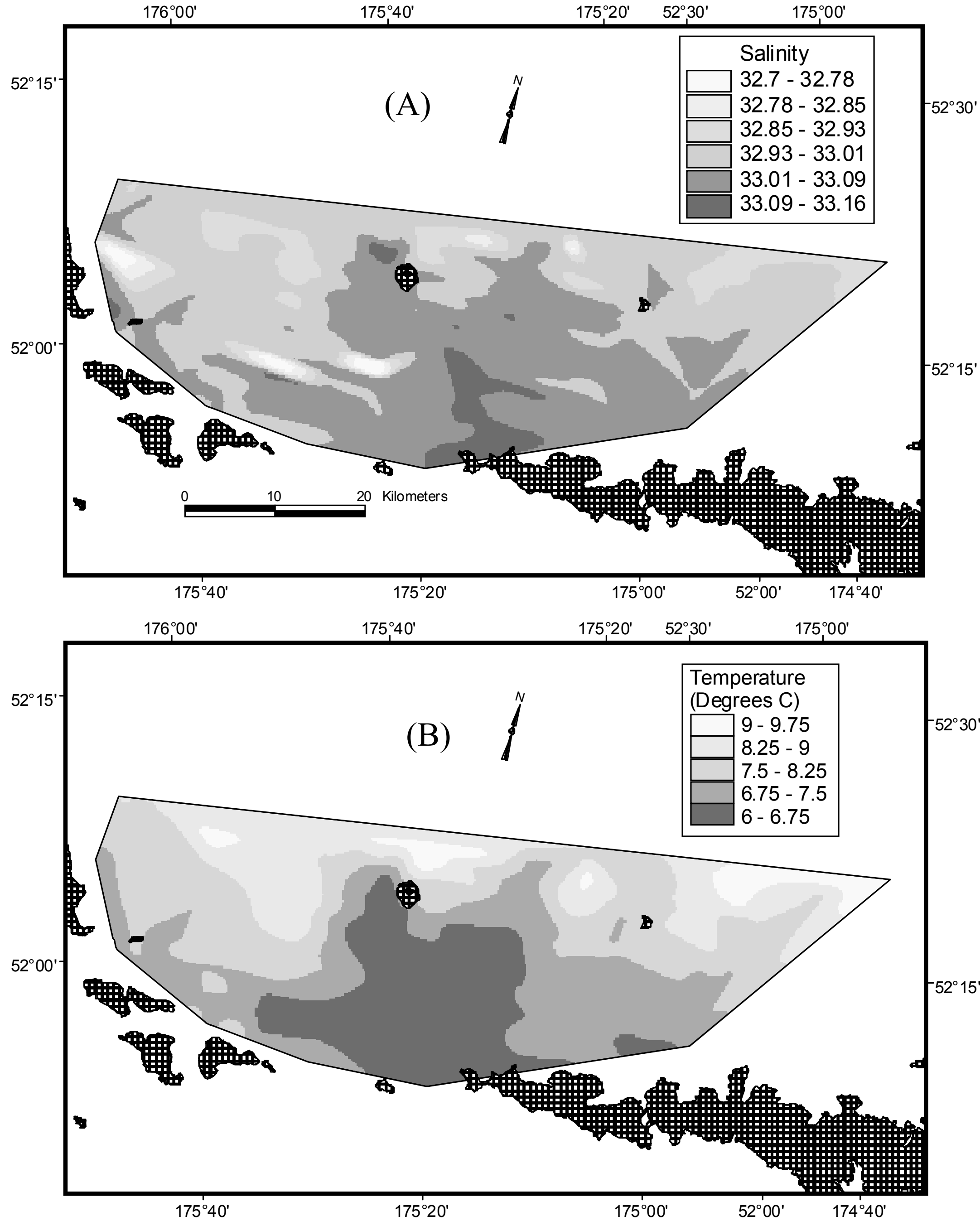


Figure 5. Salinity (A) and temperature (B) interpolations from the hull-mounted thermosalinograph data collected by the M/V Tiĝlax̂ August 5-8 1996.

thermosalinograph, vertical profiles were constructed from the series of vertical CTD drops centered on the study area (Fig. 4, Appendix 2). These vertical profiles show that the colder, more saline water is not just a surface phenomenon. This water from the Gulf of Alaska appears to strike the rising bathymetry along the Aleutian Chain and move north through Atka and Fenimore passes. Specifically, the north-south line shows the warmer less saline waters with pronounced stratification to the North (Fig. 6). The stations nearer to Atka Pass were characterized by well-mixed water that was colder and more saline. Stratification can also be seen to the east on the east-west line. Stations influenced by the currents through the passes (Fig. 4 -casts 7, 8, and, 9) are well mixed, colder and more saline than the more sheltered stations (Fig. 4 -casts 10 and 11) to the east (Fig. 6). These profiles indicate that the waters coming through Atka and Fenimore passes generate a substantial frontal region on the north side of the passes.

Hydroacoustic Surveys

Acoustic data, collected with the M/V *Tiĝlax̂'s* hull-mounted echosounder, indicated several areas of high acoustic biomass. Specifically, 3 notable concentrations were (1) northwest of Kasatochi I. on the steeply descending slope, (2) several kilometers west of Fenimore Pass, and (3) in the middle of Atka Pass (Fig. 7). Additionally, we found that acoustic biomass was not evenly distributed within the water column. Shallow biomass concentrations were clearly associated with Atka Pass and to a lesser extent Fenimore Pass (Fig. 8). The concentrations west of Fenimore pass and northwest of Kasatochi were predominately greater than 30 m deep. The lack of fishing during the survey precludes identification of the species present at these locations; however, we suspect that acoustic biomass concentrations in the passes were zooplankton. Regions of upwelling are commonly associated with increased primary productivity and zooplankton concentration (Iverson et al. 1979, Richardson 1985, Schneider et al. 1990). Relative acoustic biomass over the study area is summarized in Appendix 3.

Fishing Assessment

Gastropods, crabs (especially crangons), sculpins and flat fish made up the bulk of the catch in the first bottom trawl (Table 2). Rock jingles, green sea urchins, sculpins and flatfish predominated in the second bottom trawl (Table 2). The diameter of sea urchins ranged from less than 1 mm to 10 mm (Fig. 9).

Nine species of fishes were caught during three long-line sets. Pacific cod were the most numerous species in all three sets (Table 3). Pacific halibut also were caught in every set, but were most numerous in long-line 3 (Table 3). The mean length of Alaska skate caught in long-lines was 776 mm (Fig. 10). Long-line caught Pacific cod averaged 692 mm (Fig.11). Red Irish lords captured during long-lining tended to be slightly smaller on average than yellow Irish lords (Figs. 12 and 13). The average length of Pacific halibut from long-lines was 724 mm (Fig. 14).

Crab and other invertebrates occurred in a higher percentage of Pacific cod stomachs than did fish. However, fish remains accounted for a higher percentage of the weight of the contents in cod stomachs (Fig. 15). The contents of the one dusky rockfish stomach that was analyzed consisted entirely of Gammarid amphipod remains.

Invertebrates such as amphipods and gastropods were the most common items found in stomachs of rock greenling taken on long-lines in the central Aleutian Islands in 1996 (Fig. 16). Greenling and amphipods made up the bulk of the weight of prey remains from rock greenling stomachs. Brittle stars were the most common prey item found in the stomachs of both red and yellow Irish lords and also made up the highest percentage of prey by weight in these two fish species (Figs. 17 and 18). Hermit crabs were found in the highest percentage of Pacific halibut stomachs, along with several species of fish and octopods (Fig. 19). Hermit crab also comprised the largest portion by weight of halibut diets.

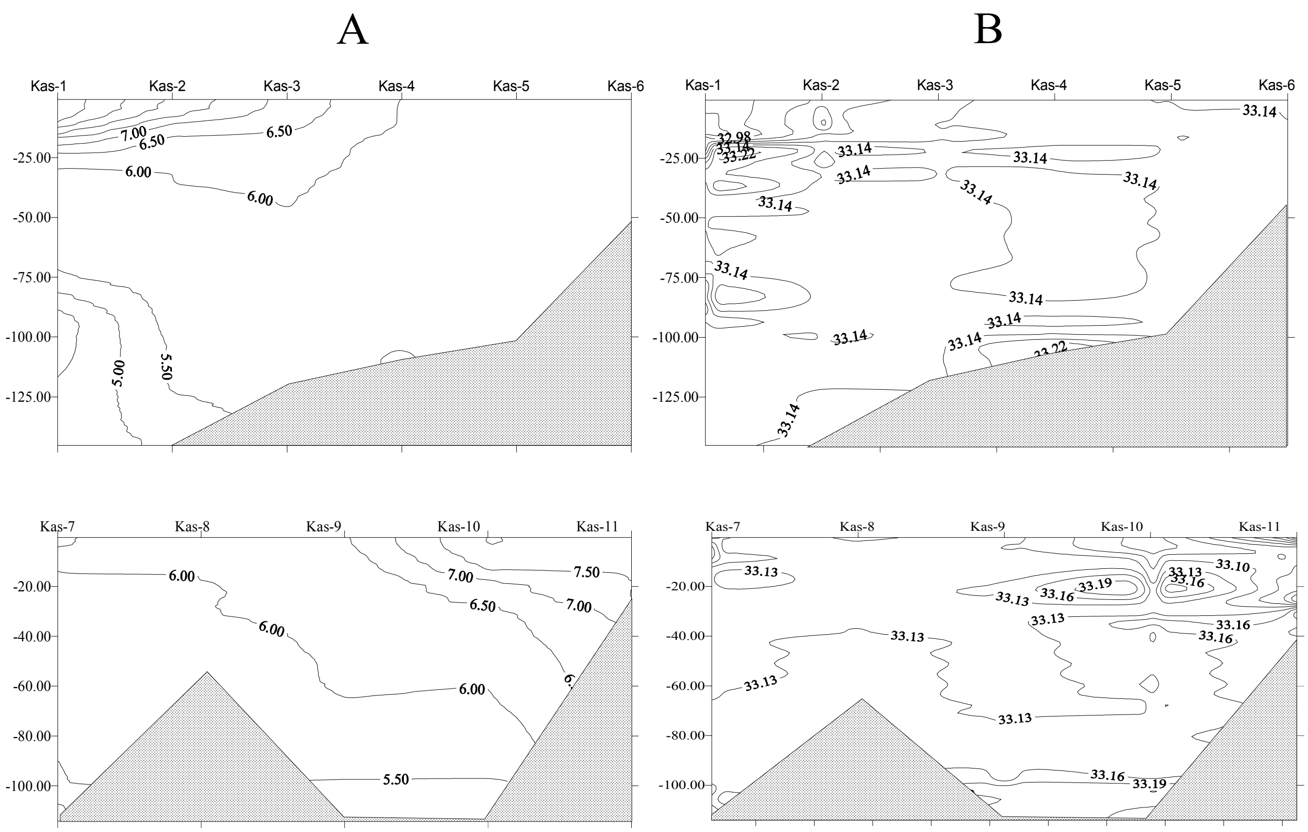


Figure 6. Vertical profiles of temperature (A) and salinity (B) from the Kasatochi study area. The north-south line (Kas-1-Kas-6; top) shows the change from stratified water in the north to mixed waters in the south. The east-west line (Kas-7-Kas-11; bottom) shows a similar though less dramatic change from mixed waters in the west to more stratified waters in the east.

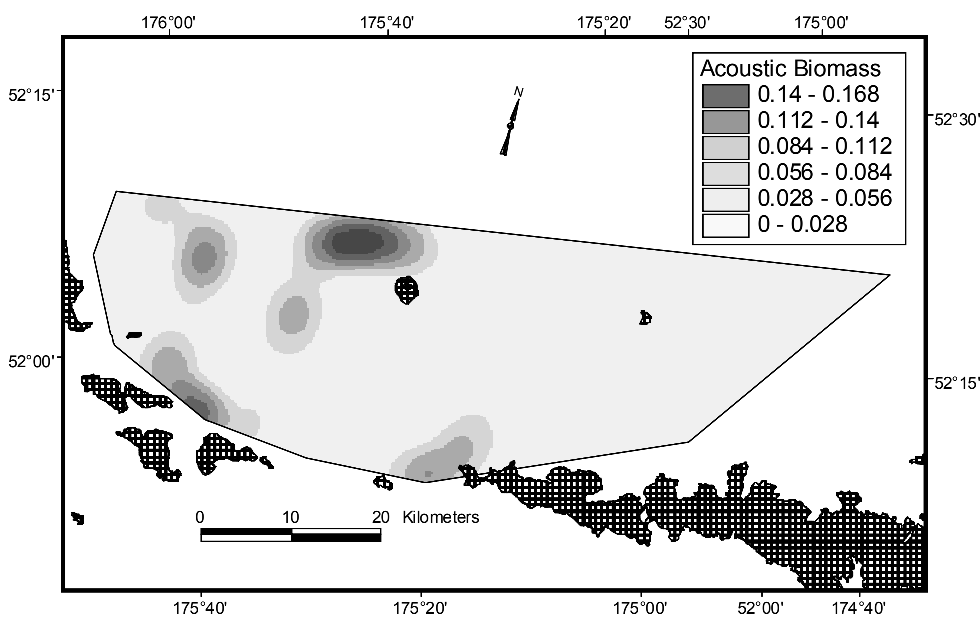


Figure 7. Relative acoustic biomass from the August 5-8, 1996 pelagic survey.

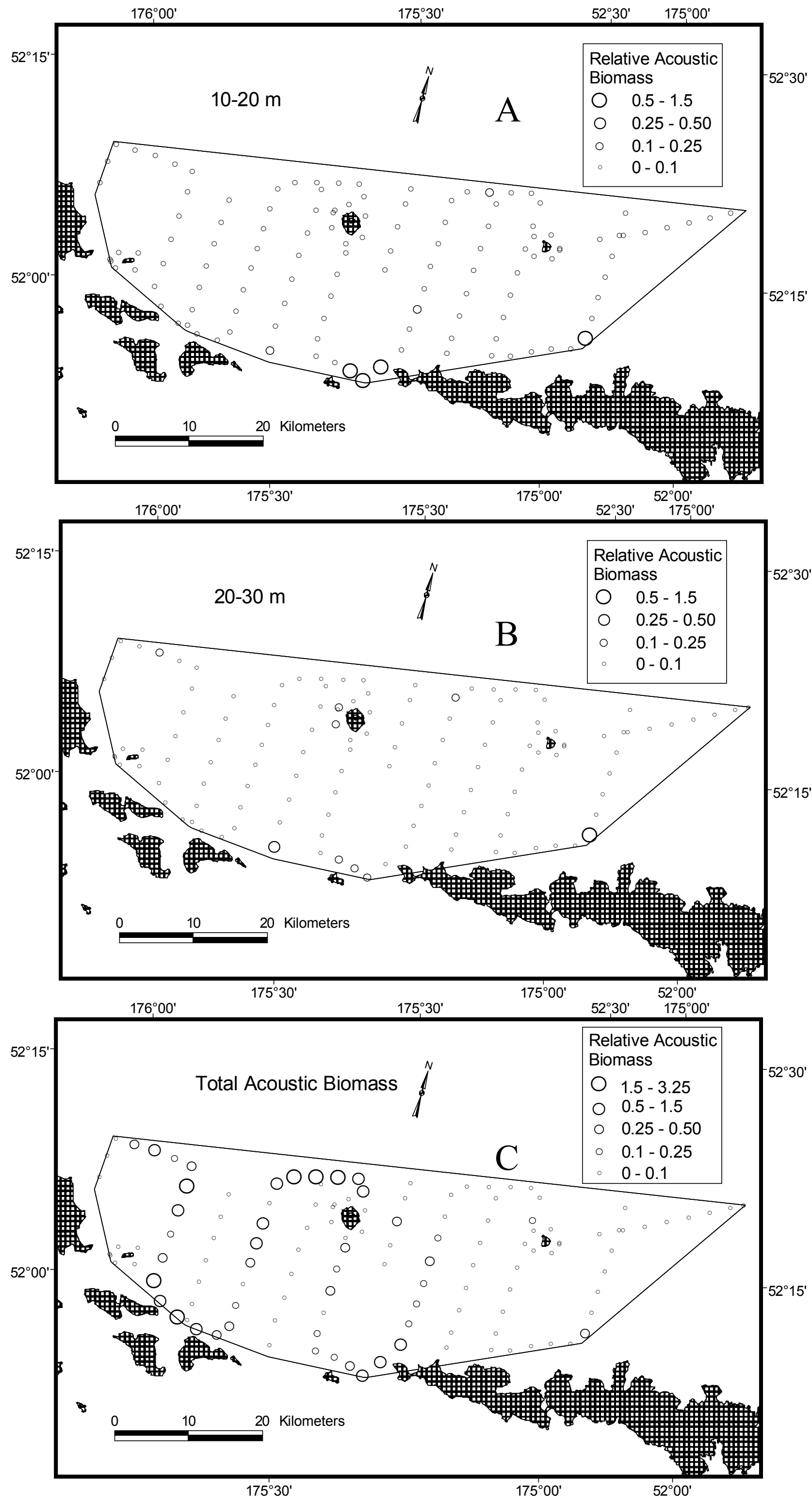


Fig. 8. Distribution of acoustic biomass in the Kasatochi study area August 5-8, 1996. The shallow depth strata 10-20 m (A) and 20 – 30 m (B) show a different pattern of biomass than the sum over the complete water column. A summary of relative biomass across all depth strata (C) shows the high biomass associated with the northern shelf break in the northern portion of the study area.

Table 2. Species captured during bottom trawls in the central Aleutian Islands, 1996.

Species	BOTR1	BOTR2
Gastropod (*Margarites* spp.)	11	0
Grand slipper shell (*Crepidula grandis*)	2	0
Aleutian moon snail (*Nautica aleutica*)	4	0
Unidentified gastropod (possibly *Amauropsis* spp.)	51	0
Rock jingle (*Pododesmus macroschisma*)	0	23
Gammarid amphipod (*Gammaricanthus loricatus*)	9	0
Nelson's argid (*Argis levior*)	1	0
Ridged crangon (*Crangon dalli*)	2	0
Northern crangon (*Crangon alaskesis*)	180	1
Hermit crab (*Pagurus* spp.)	24	0
Decorator Crab (*Oregonia gracilis*)	0	2
Brittle star (*Ophiura sarsi*)	1	0
Sand dollar (*Dendraster excentricus*)	7	0
Green Sea Urchin (*Strongylocentrotus droebachiensis*)	0	210
Sea squirt (*Aplidium spp*.)	1	0
Walleye pollock (*Theragra chalcogramma*)	5	0
Irish lord (*Hemilepidotus* spp.)	0	13
Roughspine sculpin (*Triglops macellus*)	1	0
Northern sculpin (*Icelinus borealis*)	146	11
Unidentified sculpin (*Myoxocephalus* spp.)	0	4
Sawback poacher (*Leptagonus frenatus*)	0	1
Gray starsnout (*Bathyagonus alascanus*)	1	0
Unidentified snailfish (Liparididae)	0	1
Pacific halibut (*Hippoglossus stenolepis*)	13	2
Arrowtooth flounder (*Atherestes stomias*)	8	1
Southern rock sole (*Lepidopsetta bilineata*)	165	63

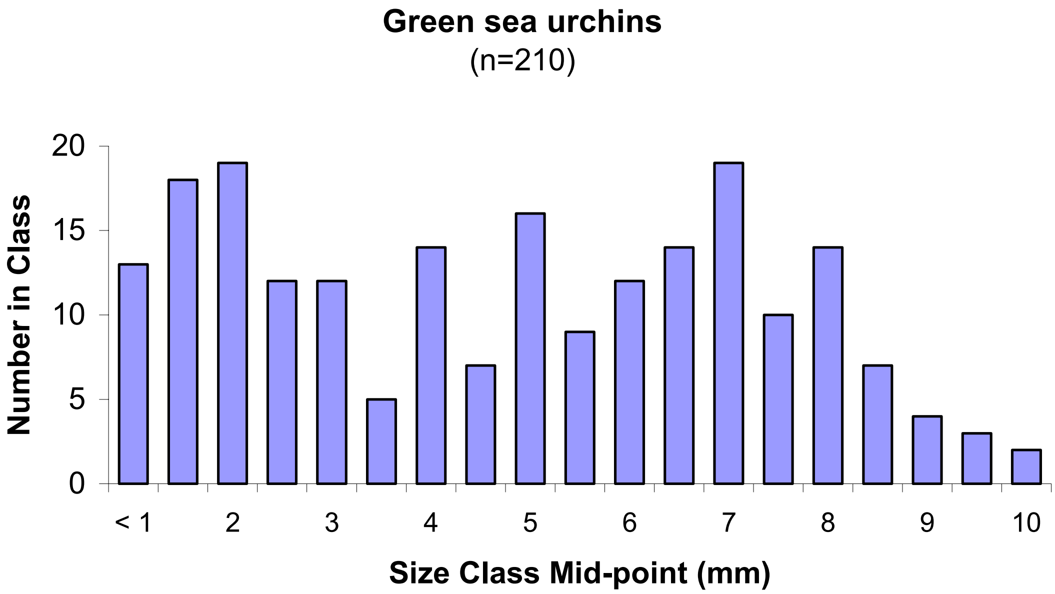


Fig 9. Diameters of green sea urchins (*Strongylocentrotus droebachiensis*) caught during bottom trawls in the central Aleutian Islands, 1996.

Table 3. Species captured during long-line sets in the central Aleutian Islands, 1996.

Species	LOLI 1[a]	LOLI 2[b]	LOLI 3[c]
Alaska skate (*Bathyraja parmifera*)	0	2	5
Pacific cod (*Gadus macrocephalus*)	31	9	32
Dusky rockfish (*Sebastes ciliatus*)	1	0	0
Kelp greenling (*Hexagrammos decagrammus*)	1	0	0
Rock greenling (*Hexagrammos lagocephalus*)	1	1	0
Red Irish lord (*Hemilepidotus hemilepidotus*)	13	0	1
Yellow Irish lord (*Hemilepidotus jordani*)	5	0	0
Pacific Halibut (*Hippoglossus stenolepis*)	5	2	11
Southern rock sole (*Lepidopsetta bilineata*)	0	0	1

[a]125 hook long-line set at Kasatochi Island, Alaska, on 2 August 1996 between 2026-2245, in 24-34 m of water. Salted herring was used for bait.
[b]125-hook long-line set near Ulak Island, Alaska, on 3 August 1996 between 2000-2200, in 36-50 m of water. Salted herring was used for bait.
[c]125 hook long-line set at Koniuji Island, Alaska, on 4 August 1996 between 2000-2200, in 60-98 m of water. Salted herring was used for bait.

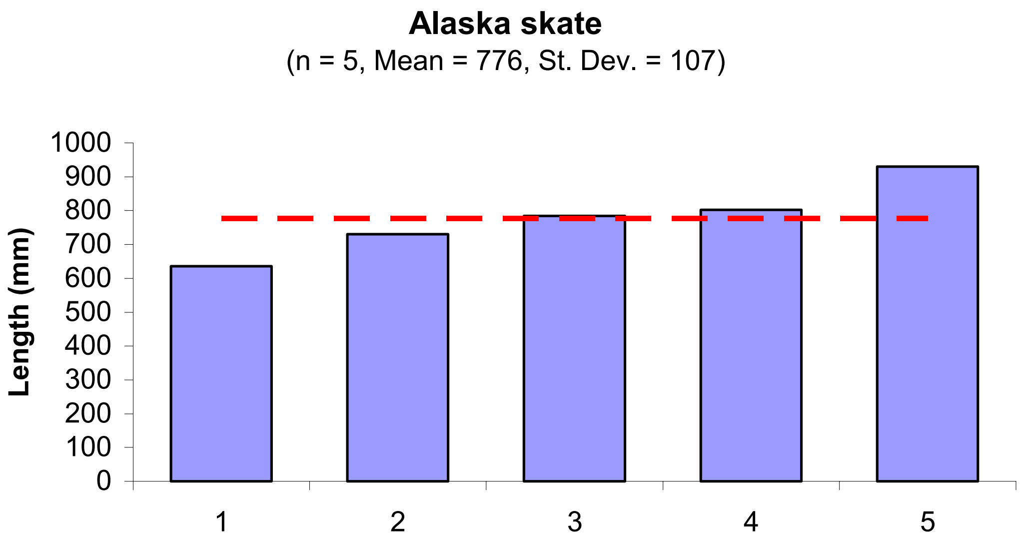


Fig 10. Lengths of Alaska skates (*Bathyraja parmifera*) caught during long-line sets in the central Aleutian Islands, 1996.

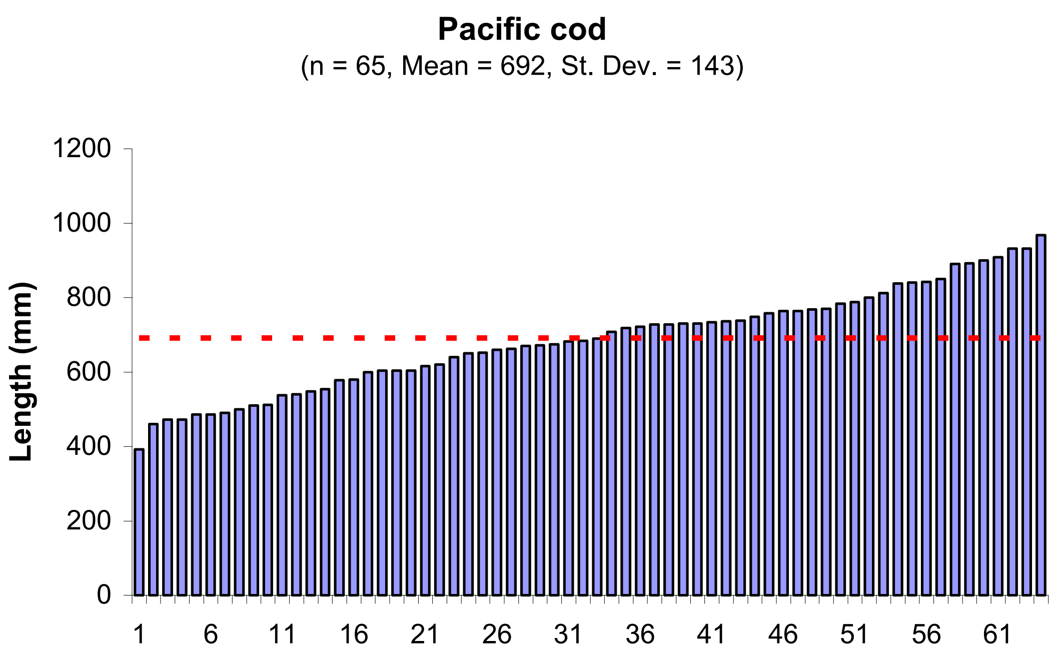


Fig 11. Lengths of Pacific cod (*Gadus macrocephalus*) caught during long-line sets in the central Aleutian Islands, 1996.

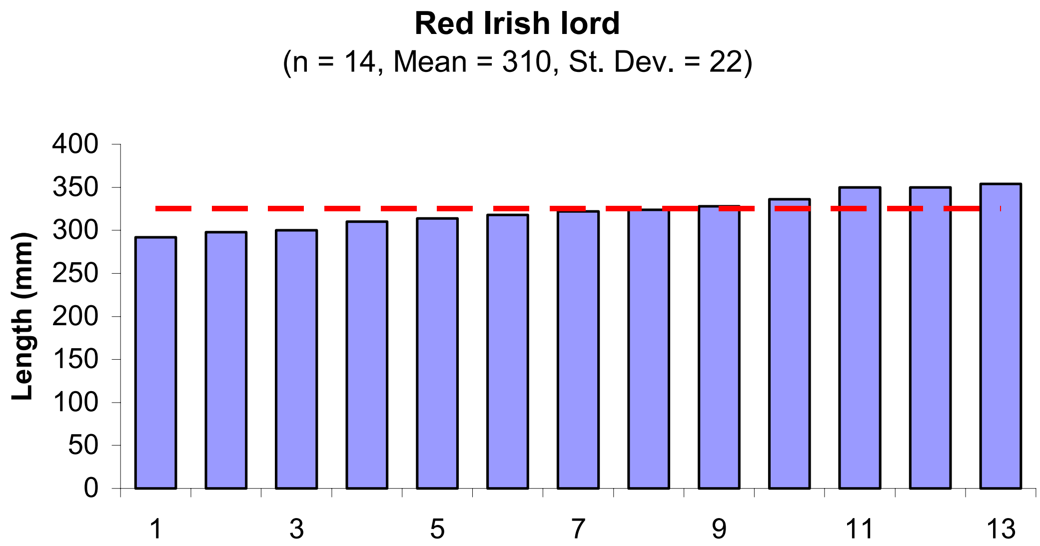


Fig 12. Lengths of Red Irish lords (*Hemilepidotus hemilepidotus*) caught during long-line sets in the central Aleutian Islands, 1996.

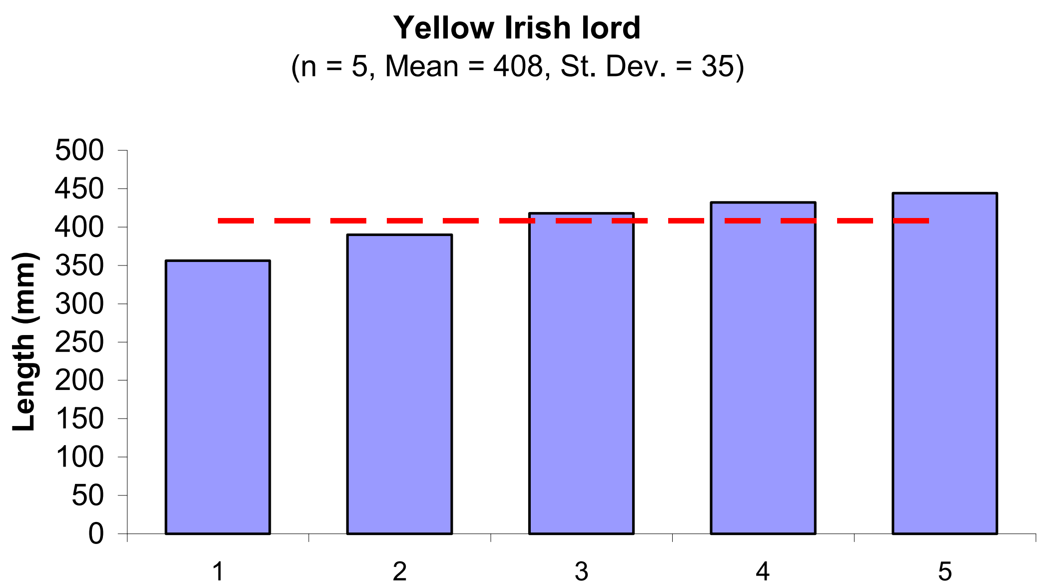


Fig 13. Lengths of Yellow Irish lords (*Hemilepidotus jordani*) caught during long-line sets in the central Aleutian Islands, 1996.

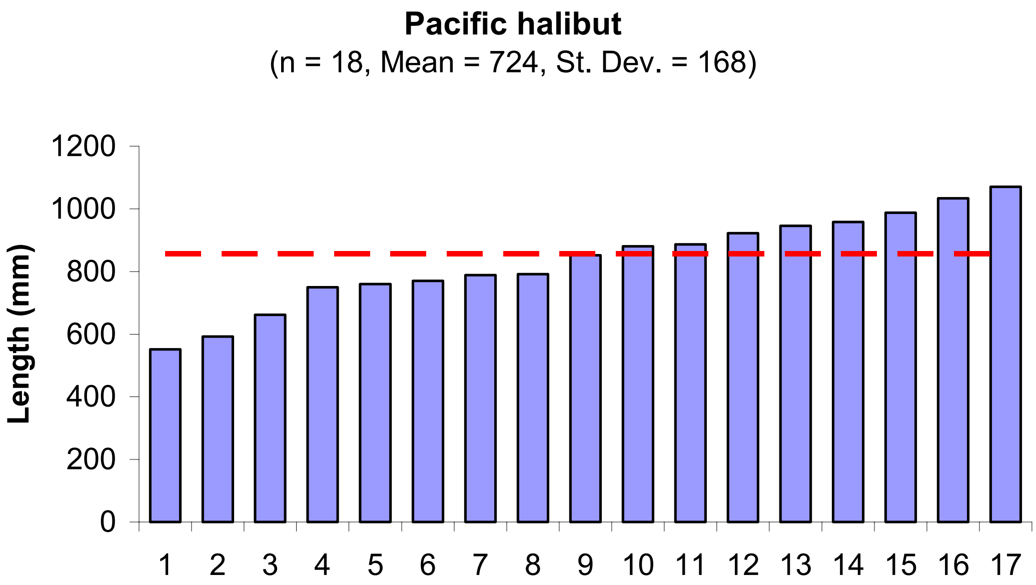
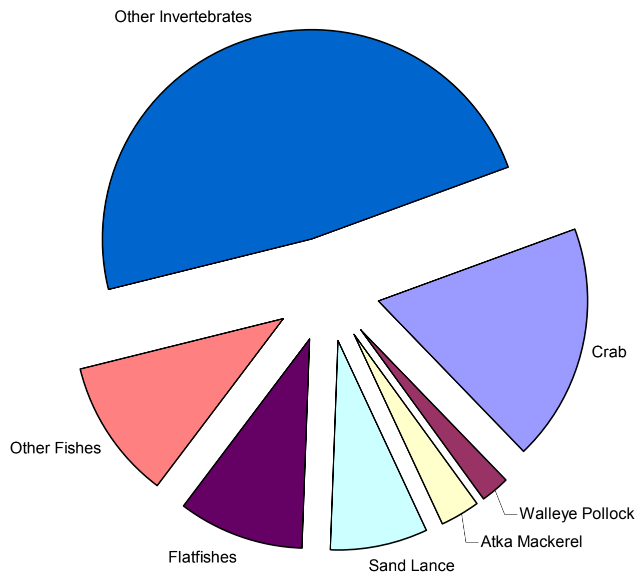


Fig 14. Lengths of Pacific halibut (*Hippoglossus stenolepis*) caught during long-line sets in the central Aleutian Islands, 1996.



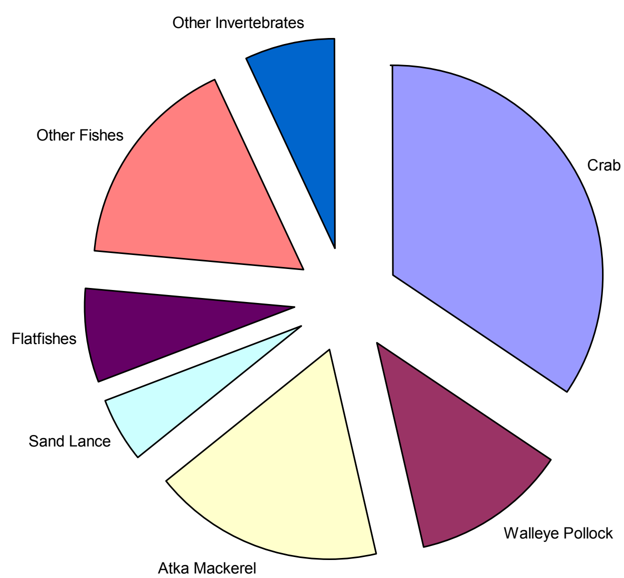


Figure 15. Percent frequency of occurrence (top) and percent total weight (bottom) of prey taken from stomach contents of Pacific cod (*Gadus macrocephalus*) caught on long-line gear near Kasatochi Island, Alaska in 1996 (n = 51 non-empty stomachs).

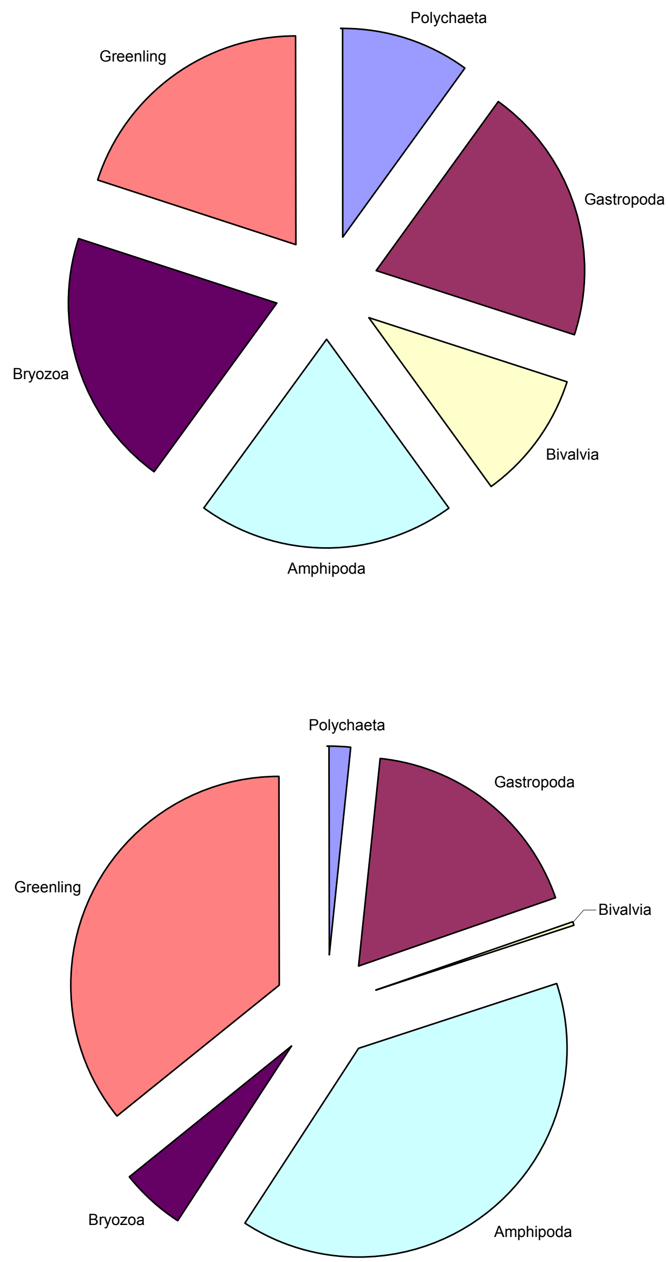


Figure 16. Percent frequency of occurrence (top) and percent total weight (bottom) of prey taken from stomach contents of rock greenling (*Hexagrammos lagocephalus*) caught on long-line gear near Kasatochi Island, Alaska in 1996 (n = 2 non-empty stomachs).

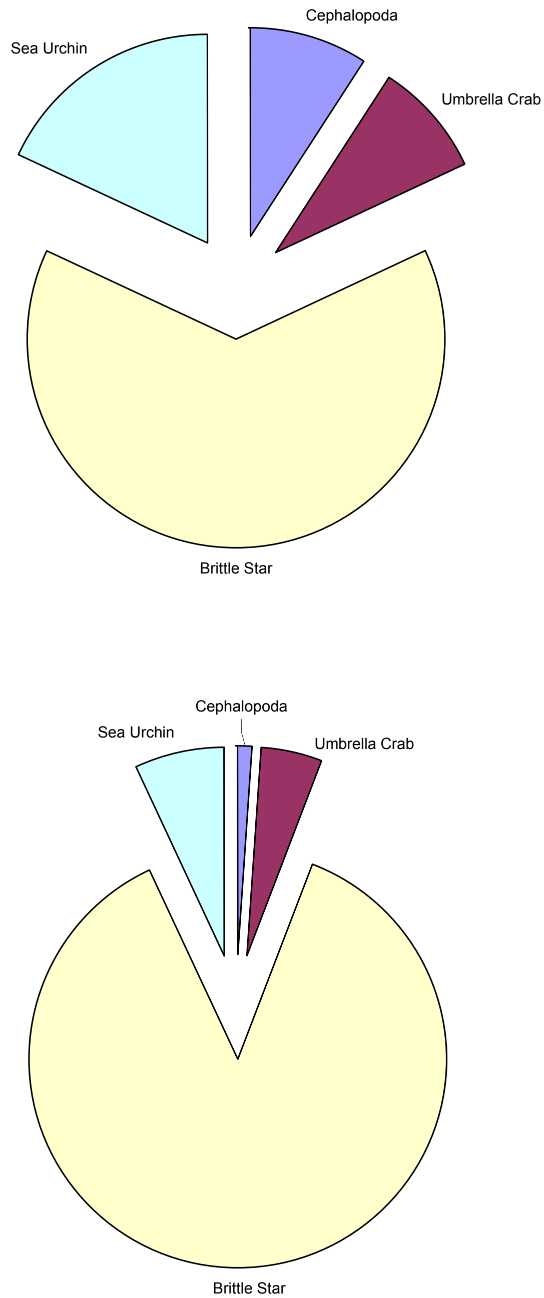
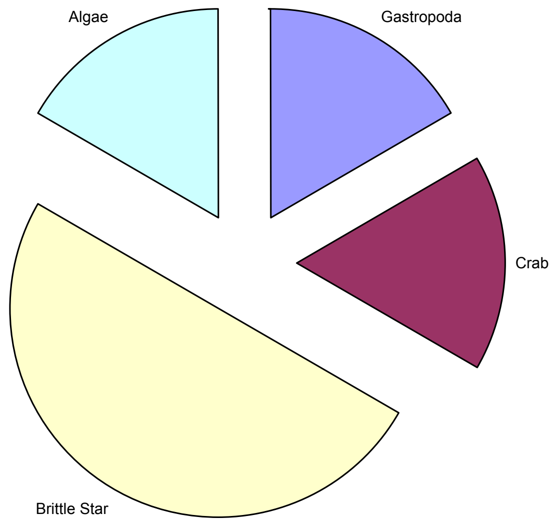


Figure 17. Percent frequency of occurrence (top) and percent total weight (bottom) of prey taken from stomach contents of red Irish lord (*Hemilepidotus hemilepidotus*) caught on long-line gear near Kasatochi Island, Alaska in 1996 (*n* = 7 non-empty stomachs).



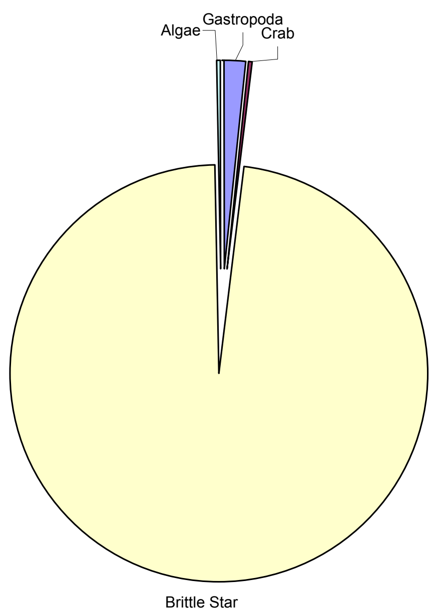
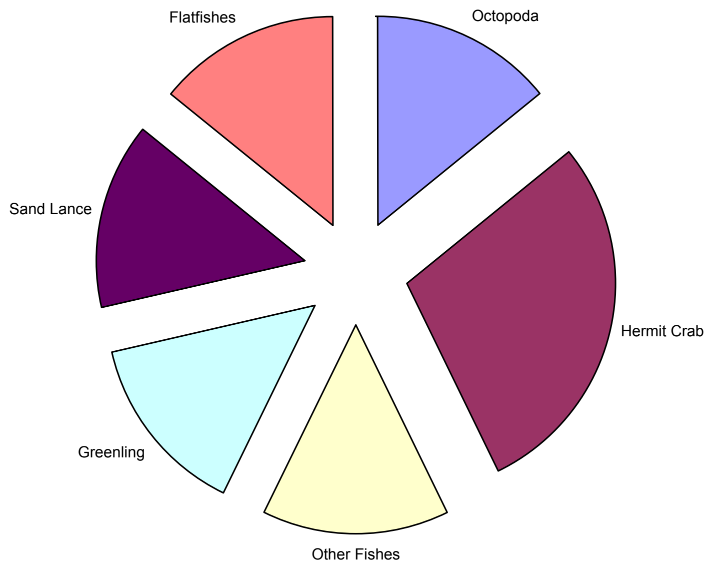


Figure 18. Percent frequency of occurrence (top) and percent total weight (bottom) of prey taken from stomach contents of yellow Irish lord (*Hemilepidotus jordani*) caught on long-line gear near Kasatochi Island, Alaska in 1996 (*n* = 3 non-empty stomachs).



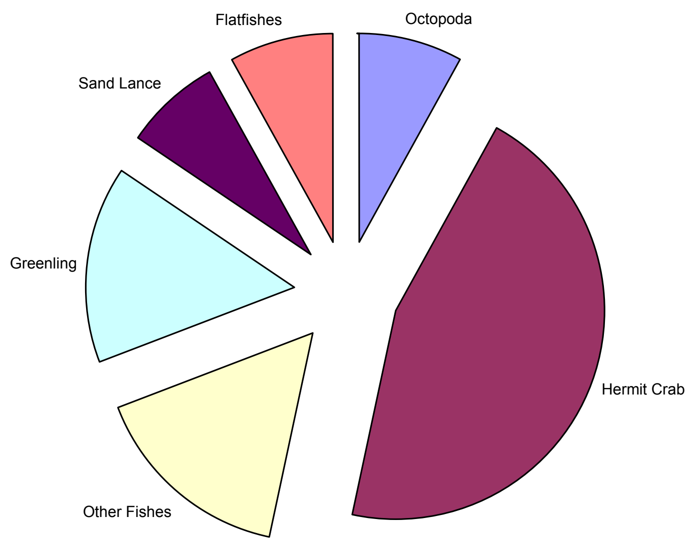


Figure 19. Percent frequency of occurrence (top) and percent total weight (bottom) of prey taken from stomach contents of Pacific halibut (*Hippoglossus stenolepis*) caught on long-line gear near Kasatochi Island, Alaska in 1996 (*n* = 5 non-empty stomachs).

Marine Predator Observations

A total of 11,840 seabirds and 66 mammals were counted along the survey tracks (Table 4). Crested auklets (*Aethia cristatella*) were the most common seabird sighted, making up 55% (6,369) of all counted birds. Other commonly sighted species, in decreasing order, were shearwater spp. (*Puffinus spp*.), tufted puffins (*Fratercula cirrhata*), whiskered auklets (*A. pygmaea*), and least auklets (*A. pusilla*) (Fig. 20).

Table 4. Summary of birds and mammals counted along survey tracks in the vicinity of Kasatochi I., August 2-5, 1996. Numbers and density represent totals for the actual area surveyed, both flying and on the water.

Common Name	Species	Number Sighted	Density (#/km^2)
Crested Auklet	*(Aethia cristatella)*	6369	58.97
Short-Tail Shearwater	*(Puffinus tenuirostris*)	2232	20.67
Tufted Puffin	*(Fratercula cirrhata)*	1187	10.99
Whiskered Auklet	*(Aethia pygmaea)*	533	4.94
Least Auklet	*(Aethia pusilla)*	500	4.63
Glaucous-winged Gull	*(Larus glaucescens)*	262	2.43
Thick-billed Murre	*(Uria lomvia)*	153	1.42
Northern Fulmar	*(Fulmarus glacialis)*	153	1.42
Parakeet Auklet	*(Cyclorrhynchus psittacula)*	109	1.01
Laysan Albatross	*(Diomedea immutabilis)*	75	0.69
Common Murre	*(Uria aalge)*	60	0.56
Horned Puffin	*(Fratercula corniculata)*	43	0.40
Sooty Shearwater	*(Puffinus griseus)*	36	0.33
Black-legged Kittiwake	*(Rissa tridactyla)*	28	0.26
Unidentified auklet		25	0.23
Black-footed Albatross	*(Diomedea nigripes)*	15	0.14
Pigeon Guillemot	*(Cepphus columba)*	13	0.12
Peregrine Falcon	*(Falco peregrinus)*	9	0.08
Red Phalarope	*(Phalaropus fulicaria)*	8	0.07
Fork-tailed Storm-petrel	*(Oceanodroma furcata)*	6	0.06
All Brachyramphus	*(Brachyramphus spp.* total*)*	6	0.06
Cassin's Auklet	*(Ptychoramphus aleuticus)*	5	0.05
Long-tailed Jaeger	*(Stercorarius longicaudus)*	4	0.04
Common eider	*(Somateria mollissima)*	3	0.03
Unidentified Cormorant		1	0.01
Short-tailed Albatross	*(Diomedea albatrus)*	1	0.01
Ruddy Turnstone	*(Arenaria interpres)*	1	0.01
Red-faced Cormorant	*(Phalacrocorax urile)*	1	0.01
Pomarine Jaeger	*(Stercorarius pomarinus)*	1	0.01
Leach's Storm-petrel	*(Oceanodroma leucorhoa)*	1	0.01
	Totals	11840	109.63

	Mammal Species	Number Sighted	Density (#/km^2)
Dall Porpoise	*(Phocoenoides dalli)*	63	0.58
Minke Whale	*(Balaenoptera acutorostrata)*	2	0.02
Sea Otter	*(Enhydra lutris)*	1	0.01
	Totals	66	0.61

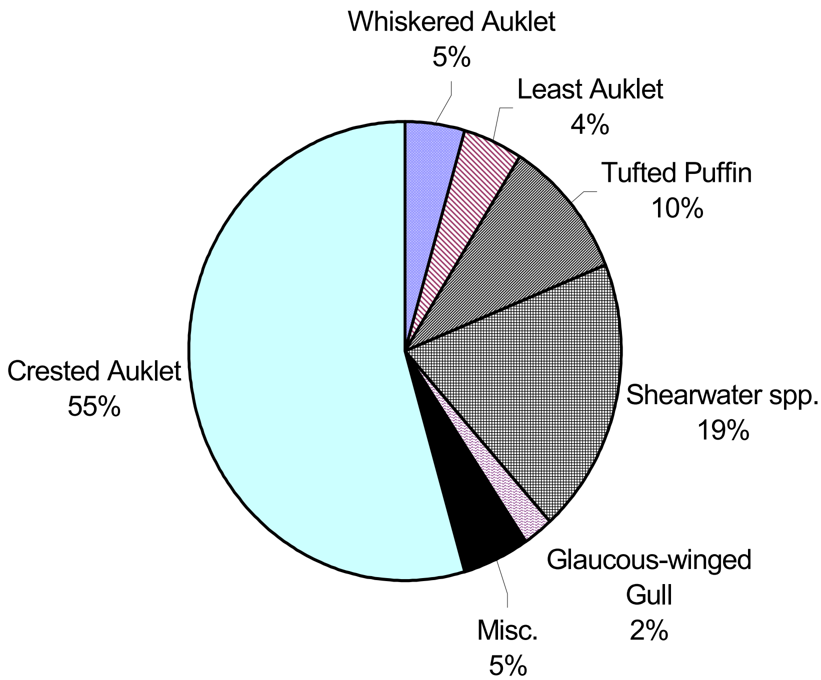


Figure 20. Percentages of the most common birds sighted on the August 1996 Kasatochi pelagic bird survey.

Auklets were the most abundant seabirds sighted on the survey; however, there was a marked difference in the spatial distribution of various auklet species. Overlap in forage areas between auklet species was limited. Crested auklets were the most common species sighted. They were common throughout much of the study area, but were aggregated in high densities at several locations (Fig. 21-A). A density map showed that crested auklets were predominantly located in Atka Pass and to a smaller extent Fenimore Pass (Fig. 21-B). Whiskered auklets were less widely distributed in the study area (Fig. 22-A). Density contours indicate that whiskered auklets were most common between Atka Pass and Fenimore Pass (Fig. 22-B). Least auklets were found primarily in the central portion of the study area (Fig. 23-A). The density map indicated that least auklets were most common around Fenimore Pass and the area approximately 10 km north of Atka pass (Fig. 23-B). Parakeet auklets were not present in large numbers in the study area (Fig. 24-A). Glaucous-winged gulls were sighted throughout much of the study area, but were not present in high numbers (Fig. 25-A). The density map further indicated the lack of glaucous-winged gull concentrations (Fig. 25-B). Short-tailed shearwater were found in relatively high numbers, being most common in the central and eastern portions of the study area (Fig. 26-A). Density contours suggested that the shearwaters in the study area were concentrated in two areas, one in Atka Pass and another at the most easterly portion of the study area (Fig. 26-B). Tufted puffins were widely distributed across the study area (Fig. 27-A). Density contours revealed that there were several concentrations of tufted puffins, most notably around Atka Pass and surrounding Koniuji I. where there are large numbers of breeding birds (Fig. 27-B). Northern fulmars were seen across the study area, however, few were sighted on the water (Fig. 28-A). Density contours showed that the only portion of the study area with any concentration of northern fulmars was in the stratified waters to the north-east (Fig. 28-B).

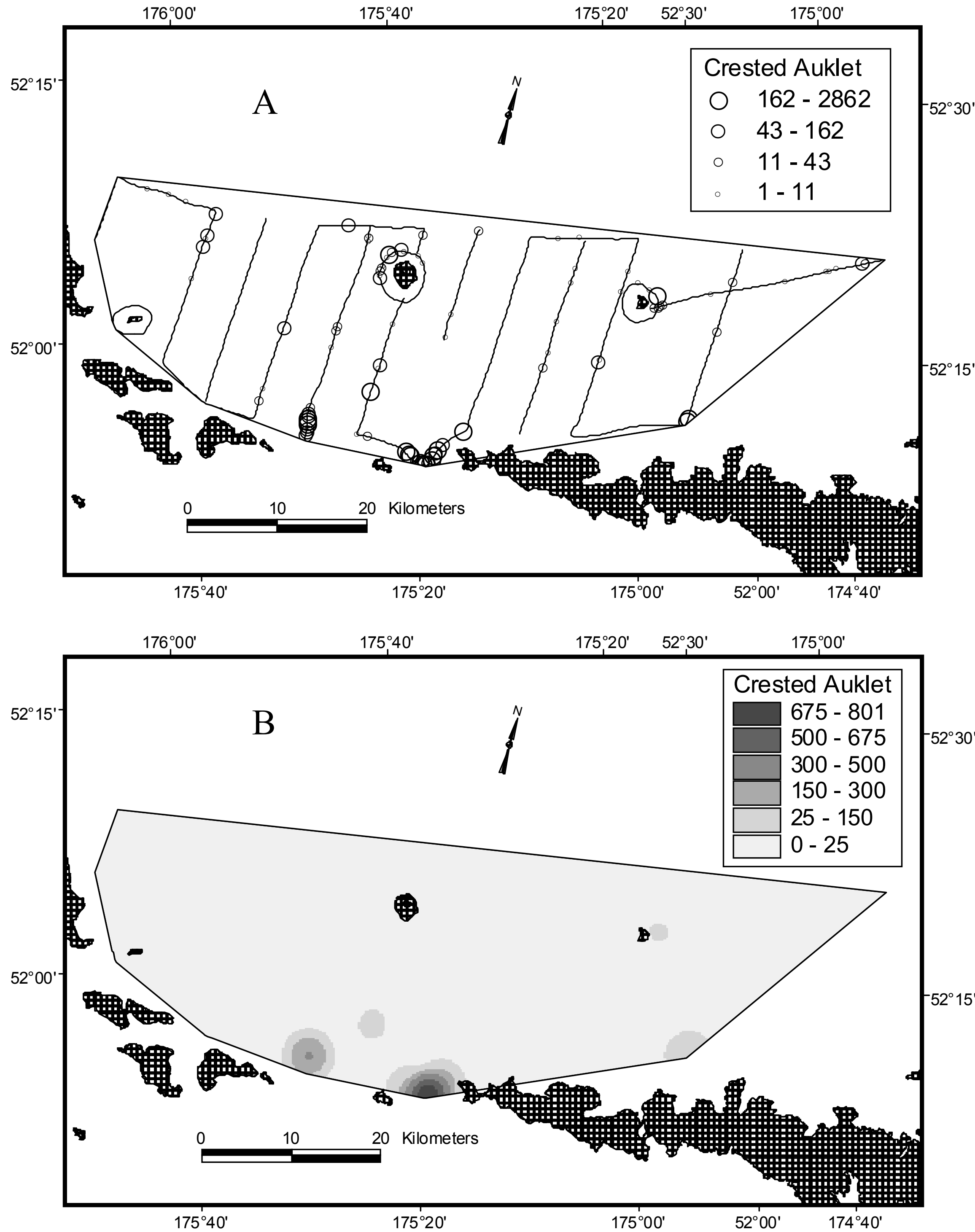


Figure 20. Numbers (A) and density contours (B) for crested auklets sighted on the water during the August 5-8, 1996 pelagic survey in the vicinity of Kasatochi Island.

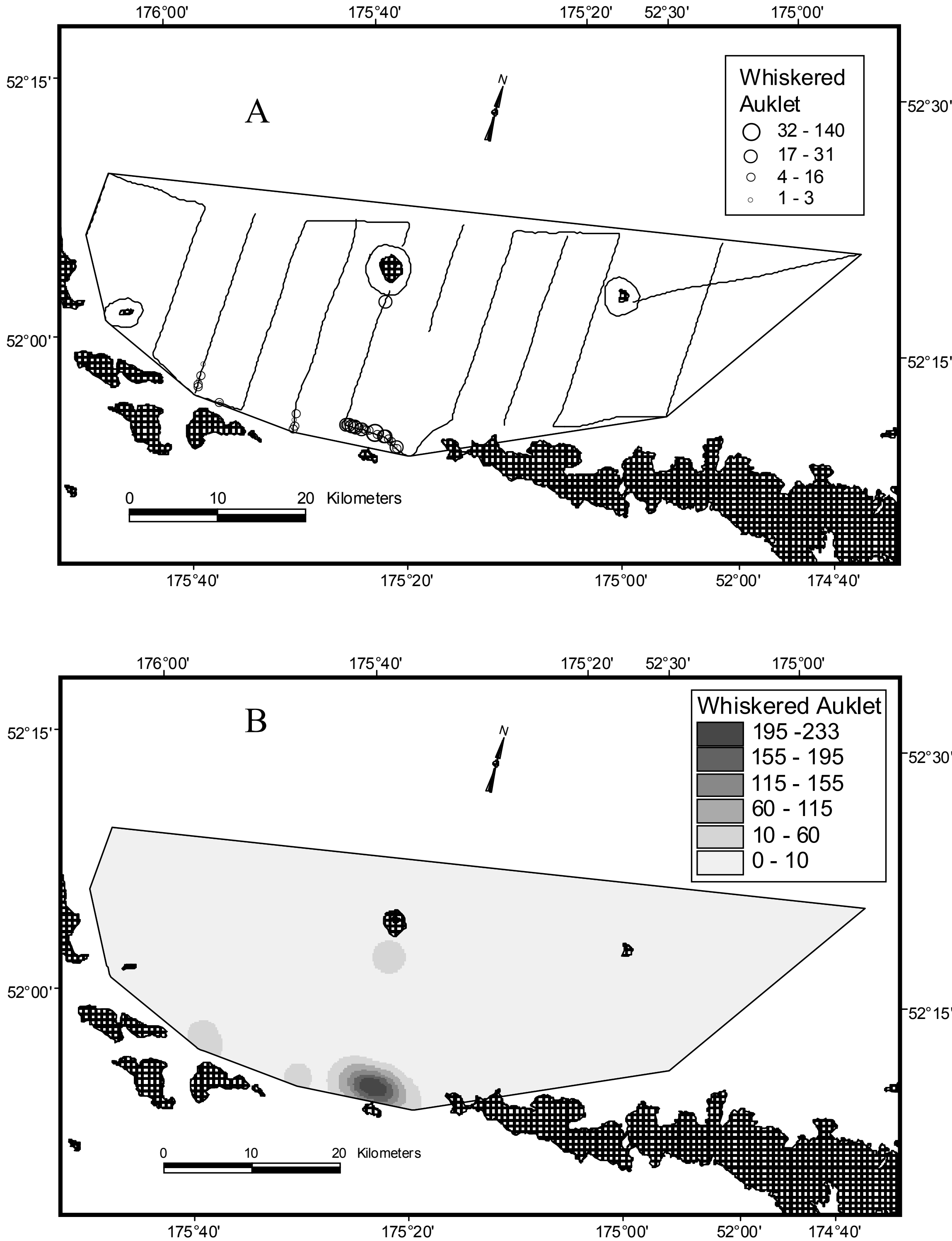
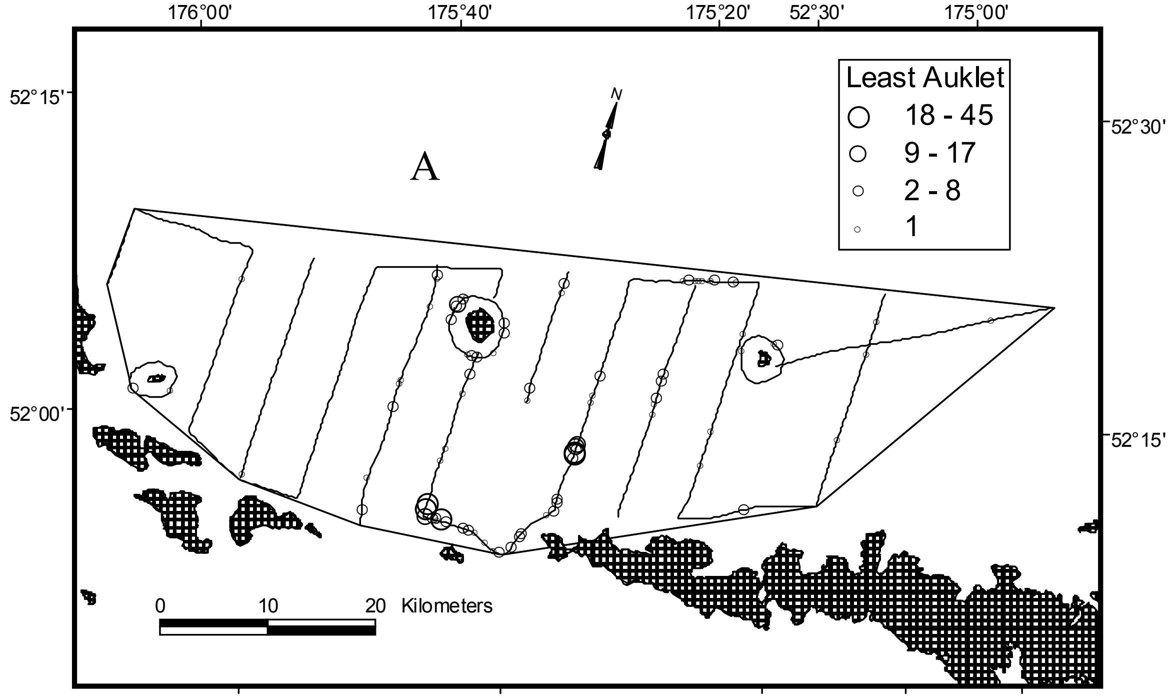


Figure 21. Numbers (A) and density contours (B) for whiskered auklets sighted on the water during the August 5-8, 1996 pelagic survey in the vicinity of Kasatochi Island.



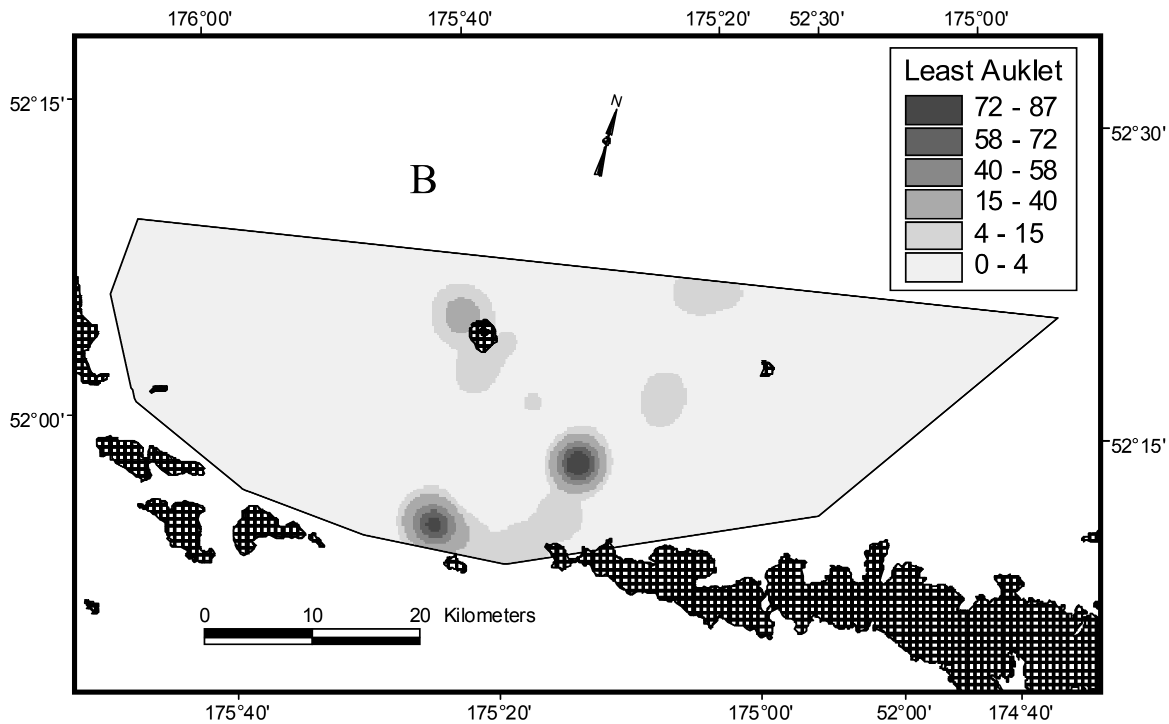


Figure 22. Numbers (A) and density contours (B) for least auklets sighted on the water during the August 5-8, 1996 pelagic survey in the vicinity of Kasatochi Island.

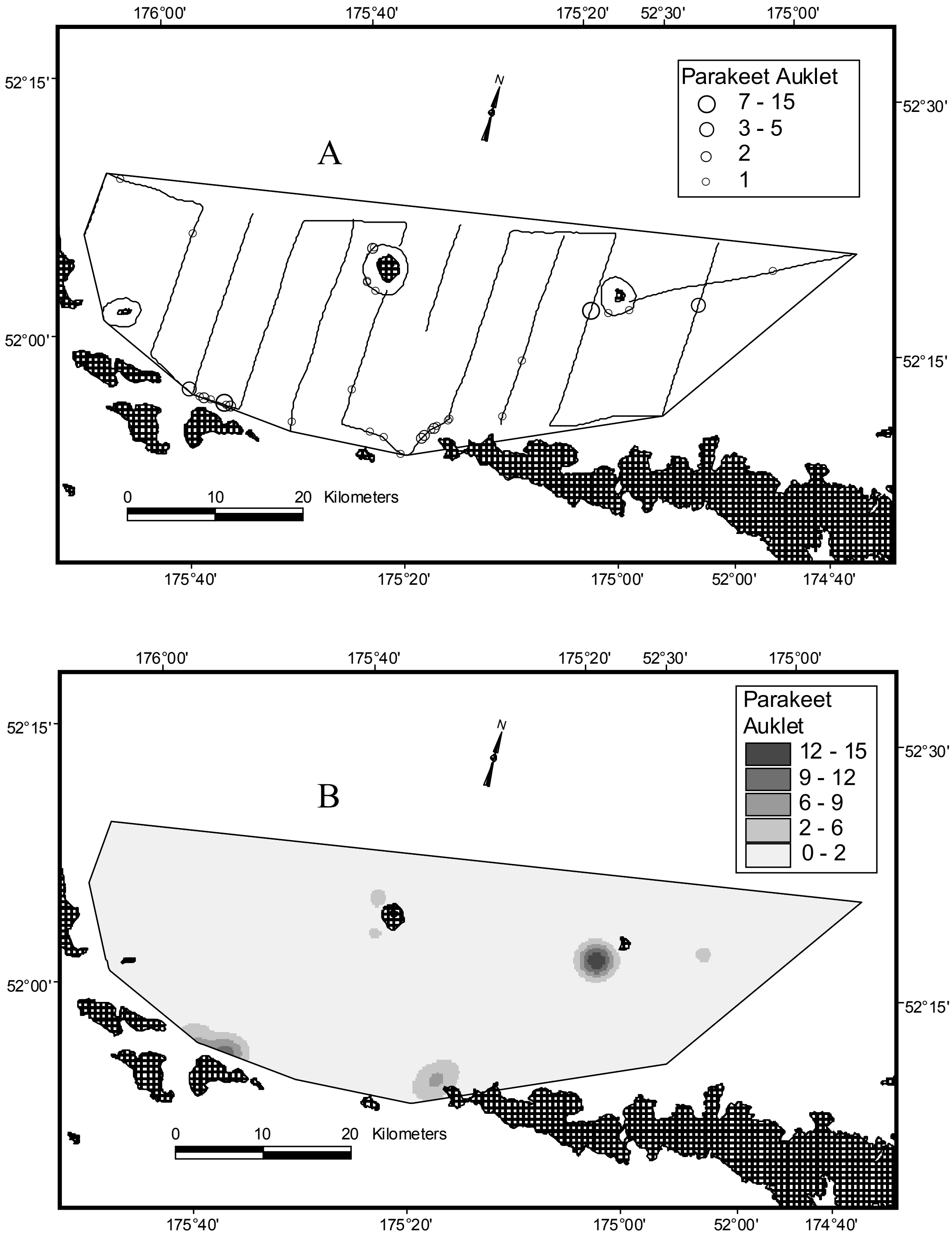


Figure 23. Numbers (A) and density contours (B) for parakeet auklets sighted on the water during the August 5-8, 1996 pelagic survey in the vicinity of Kasatochi Island

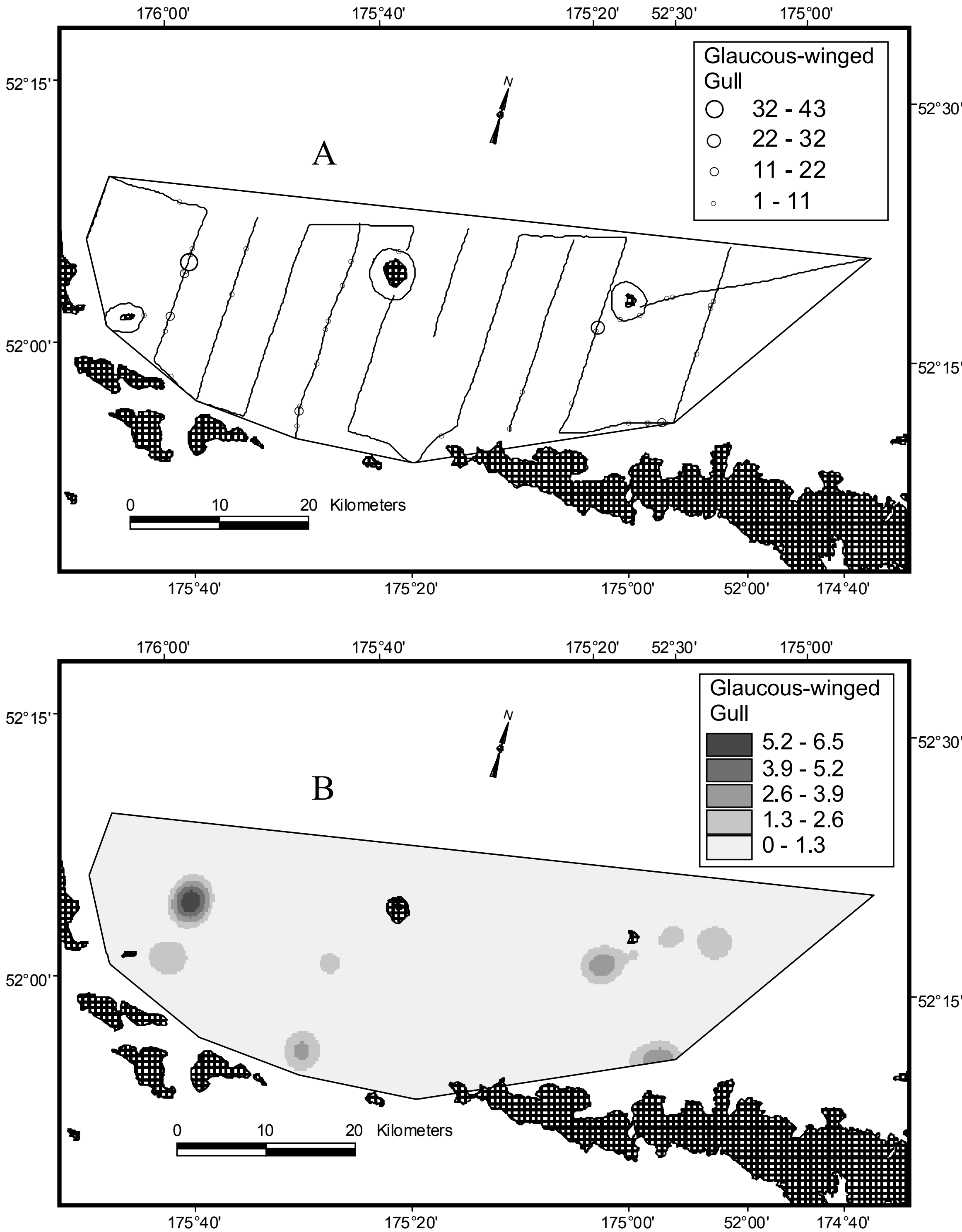
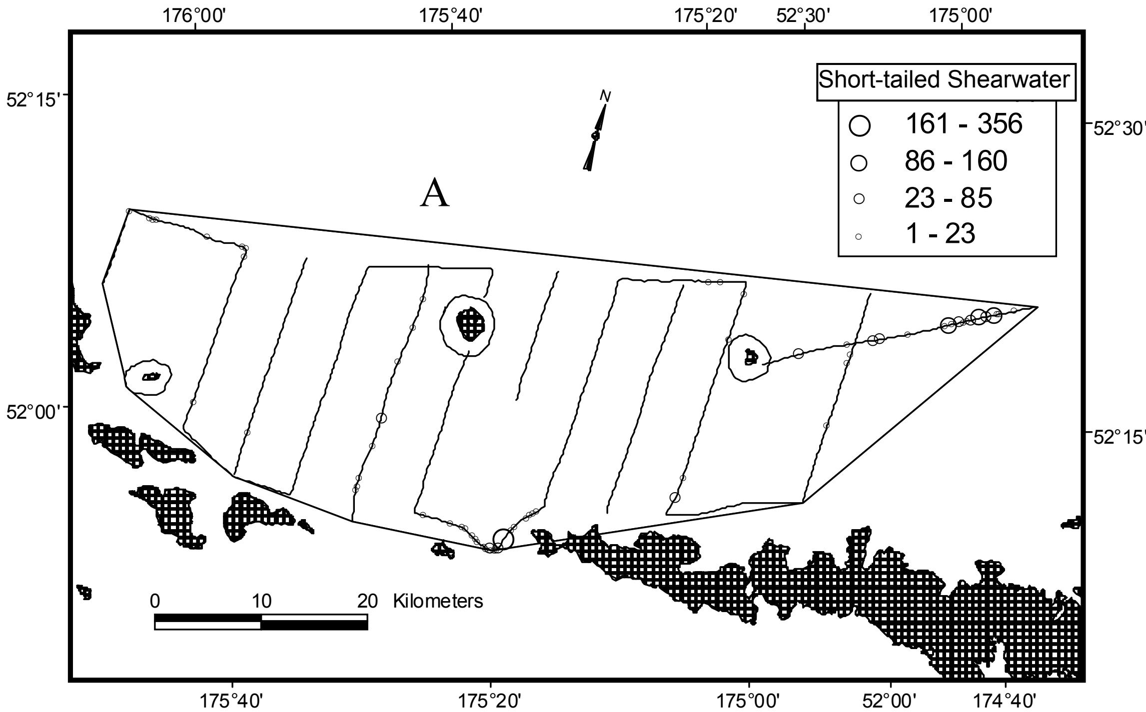


Figure 24. Numbers (A) and density contours (B) for glaucous-winged gulls sighted on the water during the August 5-8, 1996 pelagic survey in the vicinity of Kasatochi Island.



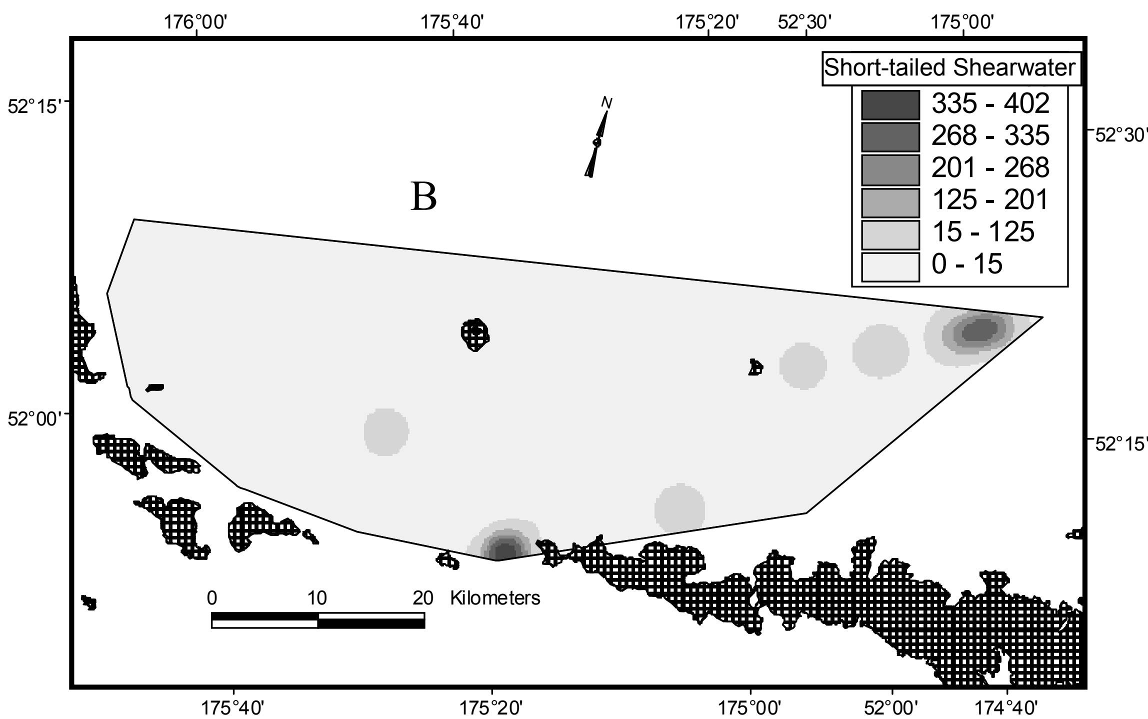


Figure 25. Numbers (A) and density contours (B) for Short-tailed shearwater sighted on the water during the August 5-8, 1996 pelagic survey in the vicinity of Kasatochi Island.

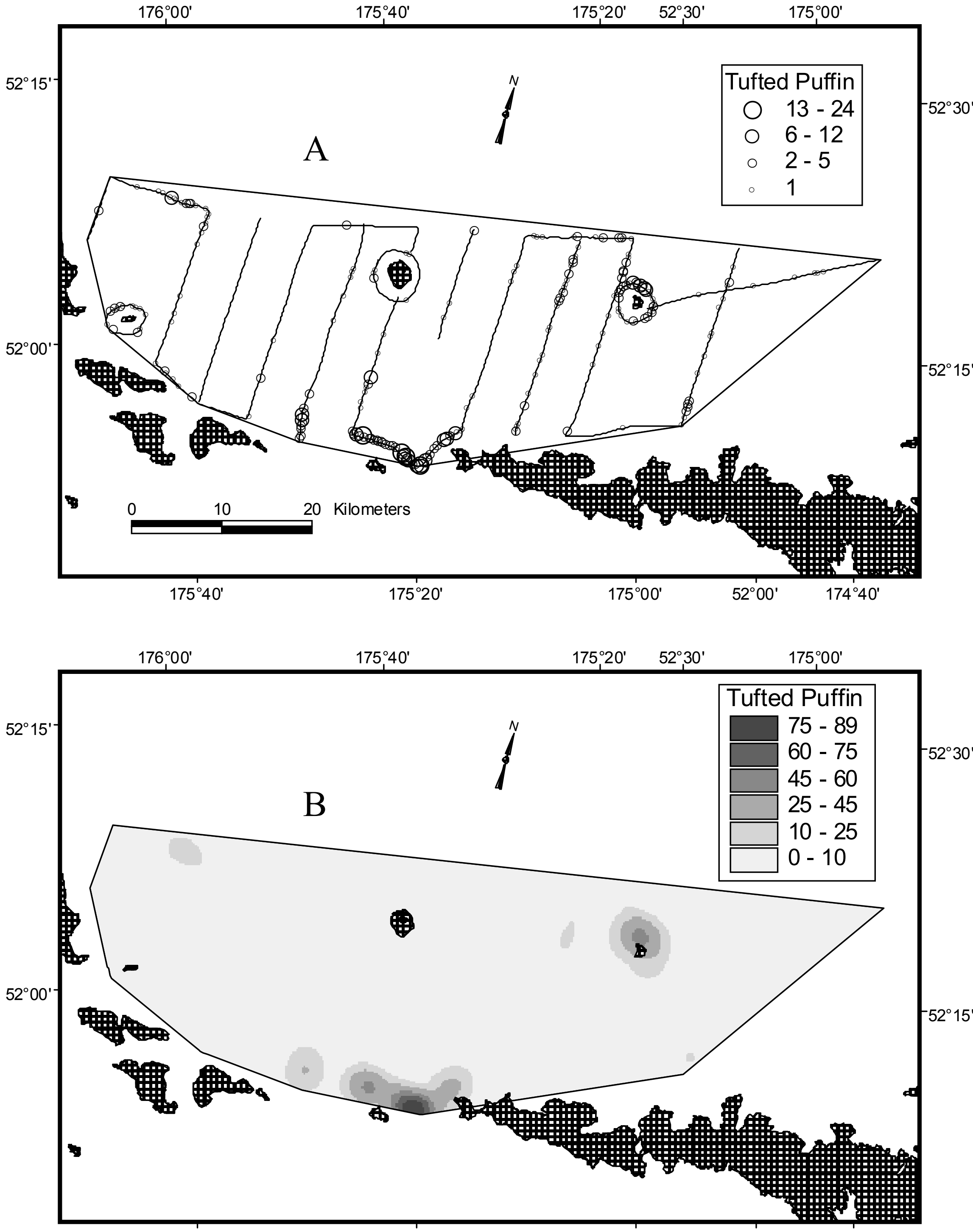
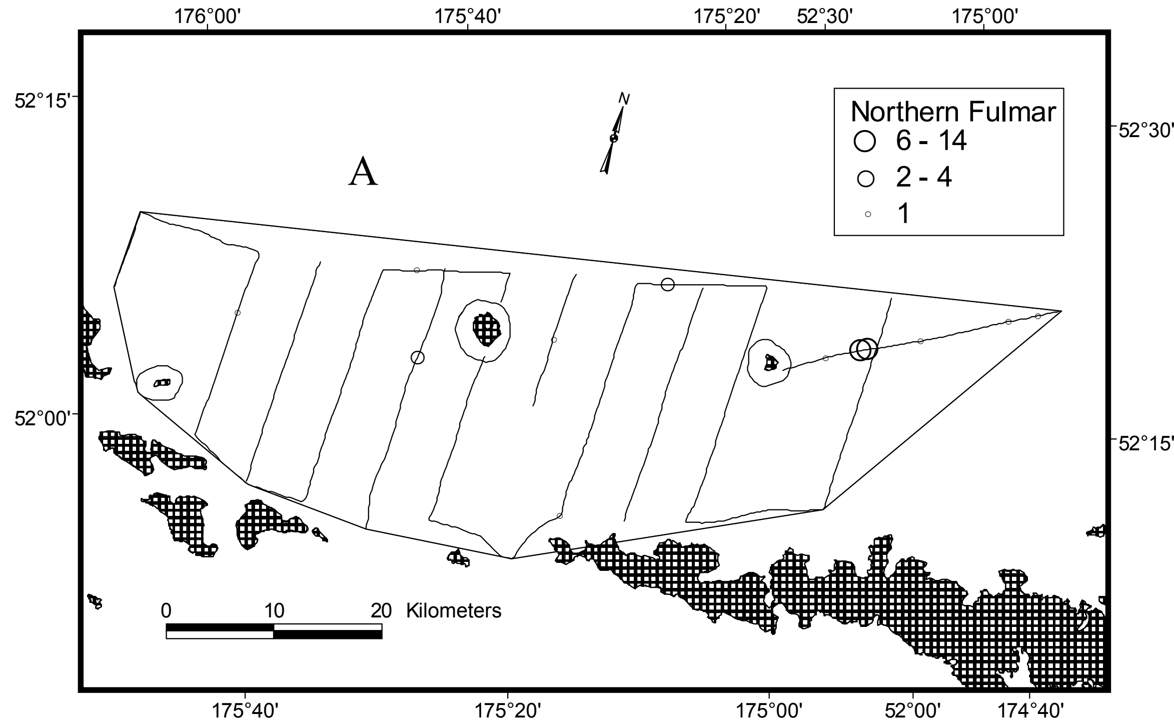


Figure 26. Numbers (A) and density contours (B) for tufted puffins sighted on the water during the August 5-8, 1996 pelagic survey in the vicinity of Kasatochi Island.



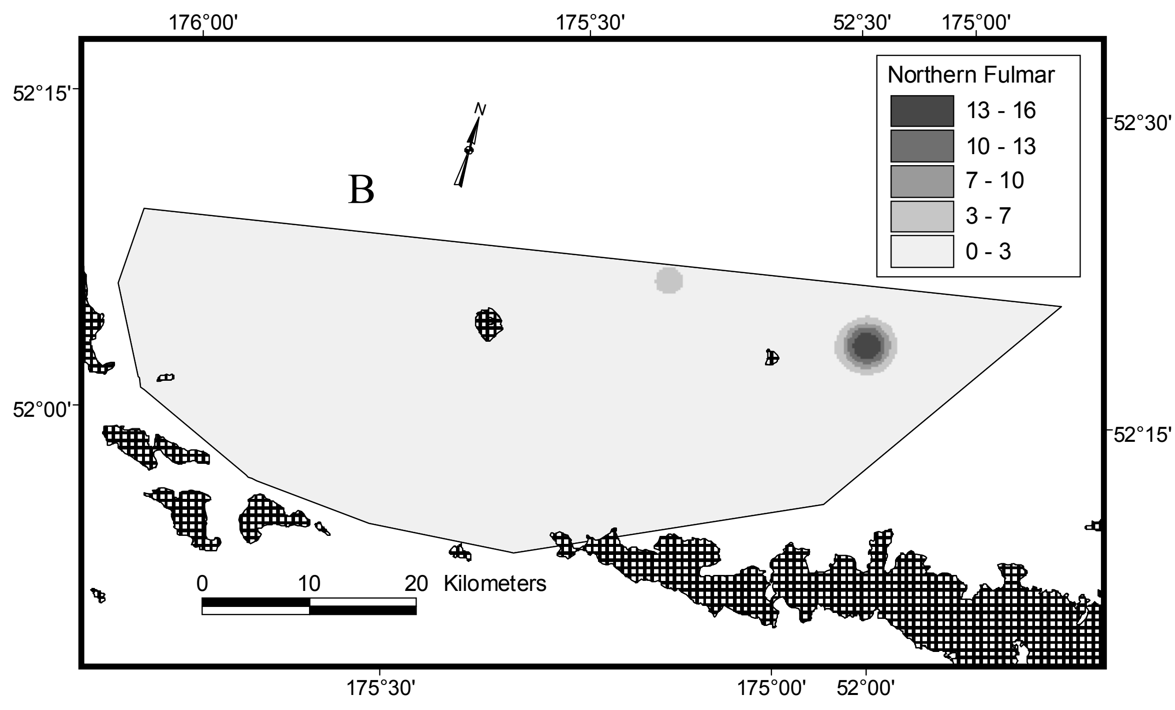


Figure 27. Numbers (A) and density contours (B) for northern fulmar sighted on the water during the August 5-8, 1996 pelagic survey in the vicinity of Kasatochi Island

DISCUSSION

Measurements of acoustic biomass indicated that there were several patches of high biomass in the study area. The highest biomass was west of Kasatochi Island, however, most of this biomass was located in relatively deep water (170-190 m) and was not available to seabirds. A second zone of high acoustic biomass was located in Atka Pass. This concentration was located in the more accessible 10-20 m depth strata. The foraging distributions of many planktivorous birds overlapped with this shallow concentration of prey as indicated by hydroacoustics.

The limited amount of time available for fishing did not allow for extensive sampling of fisheries resources, however, the combination of techniques (mid-water trawl, bottom trawl, long-lining, and stomach content analysis) did provide information on a wide range of fish and invertebrate resources in the area.

The study of pelagic seabird distribution has focused on the distribution of prey and the role of physical processes in making prey available (Schneider, et al. 1990, Piatt et al. 1992, Hunt et al. 1998, Hunt et al. 1999). The overall density of seabirds sighted in this survey was relatively high (>109 birds/km^2). The largest concentration of sightings was in and about Atka and Fenimore Passes. Thermosalinograph data indicated that this was an area of mixed water associated with a cold-water upwelling. The persistent Alaska current appears to interact with the extremely steep bathymetric landscape in the area to generate this upwelled water mass. Given its origins we expect that this upwelling is a persistent feature. The concentration of seabird foraging activity in frontal areas is well documented (Schneider, et al. 1990, Piatt et al. 1992, Hunt et al. 1998, Hunt et al. 1999). The presence of a predictable source of food may in turn account for the high numbers of birds nesting on the islands in this area (Scharf and Williams 1997).

The density contours of the auklet species were particularly interesting. There was a clear segregation between the auklet species. This is consistent with the findings of Hunt et al. (1993, 1998), in which variations in prey selection led to different spatial distributions of auklets. Although we did not directly measure seabird diets, data from colony work on Kasatochi Island during 1996 found that crested auklets fed primarily on euphausiids, while least auklets fed primarily on copepods (Scharf et al. 1996). This suggests that physical oceanography in the Atka Pass area is providing distinct foraging micro-habitats that different auklet species are exploiting differentially.

Future sampling in the Kasatochi area may benefit from an expansion of the study area, particularly to the South. The current design does not provide enough information to understand why there is such a large difference in the use of Atka and Fenimore passes by seabirds. Increased fishing effort is also recommended. More information about the interaction between seabirds and specific prey species may explain differential use of areas by seabirds.

ACKNOWLEDGEMENTS

Pat Livingston and Mei-Sun Yang (NMFS, Alaska Fisheries Science Center, Seattle, WA) kindly agreed to analyze the stomach contents of fishes captured during this cruise. Additionally, we would like to thank the crew of the M/V *Tiĝlax̂* for their enthusiasm and hospitality.

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Appendix 1.

Personnel

U.S. Geological Survey: John Piatt, Tom Van Pelt, Vinay Lodha, and Brad Congdon

U.S. Fish and Wildlife Service: Doug Palmer, Jeff Williams, Andrew Durand, and Vernon Byrd

Tiĝlax̂ crew: Kevin Bell, Greg Snedgen, Eric Fellows, John Jamieson, Eric Nelson, and Bob Ward

Cruise Schedule

Personnel boarded the M/V *Tiĝlax̂* at the port of Homer, Alaska on 30 July 1996. The *Tiĝlax̂* arrived in the study area on 2 August and transects began immediately.

August 2

Arrive Koniuji I. (14:30 h.)
Count ledge-nesting seabirds (14:40-17:30)
Check kittiwake nests for productivity (during counts).
Collect birds for prey analysis (14:45-17:00)
Conduct long-line sampling near Kasatochi - LL01 (20:26-22:45)
Resupply Kasatochi camp
Process fish stomach samples (23:00-02:00)
Process bird stomach samples (17:30-22:00)

August 3

Conduct CTD casts during early morning hours (00:20-05:20)
Run transects (07:00-19:30)
Conduct long-line sampling near Ulak - LL02 - (20:00-22:00)
Conduct bottom trawl sampling near Ulak - BT01 - (20:30-20:40)
Preserve samples from fishing (22:30-01:00)

August 4

Run transects (07:00-21:00)
Conduct mid-water trawl near Atka Pass - MW01 - (14:10-14:50)
Conduct long-line sampling near Koniuji - LL03 - (20:00-22:00)
Conduct bottom trawl near Koniuji - BT02 - (21:07-21:12)
Process fish samples (22:30-02:00)

August 5

Conduct CTD casts (23:50-01:00)
Arrive Adak (07:00)

Appendix 2.

Locations of CTD casts in the vicinity of Kasatochi Island, Alaska, in August 1996.

Station Number	Date	Time	Latitude	Longitude	Bottom Depth (m)
KAS-1	Aug. 3	0405	52 17.0N	175 23.0W	2116
KAS-2	Aug. 3	0439	52 14.0N	175 23.0W	1818
KAS-3	Aug. 3	0520	52 11.0N	175 23.0W	732
KAS-4	Aug. 4	2359	52 08.0N	175 23.0W	116
KAS-5	Aug. 5	0030	52 05.0N	175 23.0W	113
KAS-6	Aug. 5	0102	52 02.0N	175 23.0W	64
KAS-7	Aug. 3	0025	52 08.0N	175 35.0W	112
KAS-8	Aug. 3	0910	52 08.0N	175 29.0W	53
KAS-9	Aug. 3	0201	52 08.0N	175 17.0W	210
KAS-10	Aug. 3	0240	52 08.0N	175 11.0W	130
KAS-11	Aug. 4	2120	52 13.0N	175 08.6W	31

Appendix 3. Relative acoustic biomass over the Kasatochi study area. Data were summarized at 10 minute intervals (vertical axis) and 10 meter depth intervals (horizontal axis). Values > 0.2% are outlined and those > 1% are shaded.

		Depth Strata (10 m)																		10 Minute Total
Latitude	Longitude	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	(%)
52.338	174.780	0.0010																		0.0010
52.330	174.804	0.0014																		0.0014
52.317	174.840	0.0102	0.0082	0.0179	0.0026	0.0037	0.0002	0.0021												0.0449
52.304	174.876	0.0032	0.0020	0.0044	0.0001	0.0002	0.0002	0.0040												0.0141
52.290	174.914	0.0106	0.0060	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0051	0.0018	0.0155	0.0171	0.0217	0.0392	0.0084	0.0024	0.0167	0.0010	0.1455
52.276	174.953	0.0027	0.0003	0.0004	0.0001	0.0023	0.0010	0.0021	0.0013	0.0011	0.0047	0.0055	0.0406	0.0894	0.0239	0.0064	0.0077	0.0079	0.0121	0.2095
52.264	174.992	0.0033	0.0026	0.0003	0.0017	0.0003	0.0047	0.0012	0.0013	0.0040	0.0020	0.0066	0.0172	0.0262	0.0089	0.0176	0.0362	0.0215	0.0228	0.1785
52.251	175.033	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
52.223	175.102	0.0008	0.0006	0.0002	0.0002	0.0004	0.0041	0.0004	0.0019	0.0012	0.0009	0.0016	0.0017	0.0042	0.0110	0.0084	0.0169	0.0242	0.0322	0.1107
52.290	175.000	0.0021	0.0285	0.0015	0.0409	0.0299	0.0111	0.0000	0.0035	0.0252	0.0257	0.0175	0.0139	0.0066						0.2066
52.263	175.000	0.0030	0.0008	0.0010	0.0031	0.0014	0.0051	0.0000	0.0026	0.0045	0.0060	0.0057	0.0029	0.0011	0.0084	0.0056	0.0040	0.0007	0.0085	0.0644
52.236	175.000	0.0024	0.0036	0.0303	0.0002	0.0001	0.0005	0.0048	0.0029	0.0021	0.0042	0.0179	0.0898	0.1881	0.2606	0.0084	0.0568		0.0115	0.7895
52.210	175.000	0.0010	0.0023	0.0093	0.0181	0.0318	0.0448	0.0643	0.0878	0.1079	0.1384	0.1567	0.1915	0.1996	0.2588	0.2940	0.3313	0.3716	0.4589	2.7681
52.183	175.001	0.0028	0.0029	0.0002	0.0000	0.0004	0.0004	0.0004	0.0034	0.0007	0.0101	0.0060	0.0088	0.0089	0.0044	0.0009				0.0502
52.158	175.001	0.0031	0.0002	0.0005	0.0277	0.1393	0.4646	0.6450	0.0254	0.0003	0.0010									1.3071
52.131	175.000	1.3531	0.5414	0.2883	0.2305	0.0698	0.2586	0.9756	0.3257											4.0432
52.114	175.022	0.0020	0.0018	0.0008	0.0005	0.0011	0.0095													0.0157
52.107	175.058	0.0012	0.0047	0.0042	0.0006															0.0107
52.096	175.093	0.0006	0.0015	0.0006	0.0095	0.0003														0.0125
52.083	175.129	0.0003	0.0087	0.0008	0.0005	0.0018	0.0005													0.0126
52.076	175.165	0.0004	0.0007	0.0070	0.0185	0.0231	0.0101													0.0599
52.098	175.167	0.0010	0.0002	0.0004	0.0006	0.0037	0.0280													0.0339
52.125	175.166	0.0007	0.0035	0.0013	0.0015	0.0042	0.0041	0.0038	0.0056	0.0024	0.0001									0.0272
52.153	175.167	0.0014	0.0001	0.0002	0.0003	0.0007	0.0025	0.0022	0.0012	0.0041	0.0110	0.0129	0.0201	0.0414	0.1307					0.2287
52.181	175.167	0.0006	0.0071	0.0714	0.0466	0.1182	0.4615	0.5326	0.4521	0.1128	0.0107	0.0064	0.0151	0.0273	0.0541	0.0179	0.0268	0.0472	0.0458	2.0542
52.211	175.167	0.0015	0.0017	0.0002	0.0014	0.0017	0.0025	0.0057	0.0005	0.0001	0.0031	0.0051	0.0069	0.0161	0.0100	0.0004	0.0009	0.0000	0.0000	0.0578
52.241	175.167	0.0022	0.0054	0.0120	0.0137	0.0195	0.0307	0.0424	0.0483	0.0547	0.0628	0.1067	0.1363	0.1760	0.2374	0.2651	0.3302	0.3501	0.4478	2.3413
52.270	175.167	0.0001	0.0001	0.0003	0.0039	0.0005	0.0031	0.0007	0.0006	0.0084	0.0267	0.0361	0.0257	0.0179	0.0192	0.0104	0.0309	0.0044	0.0300	0.2191
52.278	175.189	0.0034	0.0016	0.0007	0.0009	0.0003	0.0011	0.0005	0.0012	0.0009	0.0014	0.0045	0.0122	0.0208	0.0314	0.0250	0.0348	0.0407	0.0246	0.2059
52.270	175.228	0.0031	0.0013	0.0002	0.0000	0.0003	0.0003	0.0016	0.0001	0.0003	0.0001	0.0010	0.0046	0.0232	0.0504	0.0075	0.0197	0.0208	0.0167	0.1512
52.262	175.269	0.2169	0.0005	0.0002	0.0002	0.0004	0.0000	0.0000	0.0000	0.0002	0.0000	0.0004	0.0139	0.0003	0.0005	0.0055	0.0116	0.0100	0.0070	0.2677
52.254	175.311	0.0001	0.0005	0.0001	0.0005	0.0011	0.0022	0.0000	0.0000	0.0000	0.0108	0.0011	0.0005	0.0019	0.0036	0.0004	0.0002	0.0008	0.0136	0.0374
52.239	175.334	0.0008	0.1788	0.0613	0.0551	0.0050	0.0210	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0001	0.0001	0.0009	0.0034	0.0010	0.0080	0.3359
52.211	175.333	0.0305	0.0019	0.0001	0.0011	0.0001	0.0002	0.0000	0.0000	0.0001	0.0000	0.0035	0.0007	0.0048	0.0004	0.0004	0.0079	0.0032	0.0025	0.0575
52.184	175.333	0.0015	0.0030	0.0059	0.0154	0.0248	0.0355	0.0509	0.0643	0.0717	0.1005	0.1234	0.1243	0.1461	0.1673	0.1829	0.1881	0.1953	0.2154	1.7162
52.155	175.333	0.0009	0.0002	0.0002	0.0001	0.0002	0.0007	0.0017	0.0009	0.0155	0.0150	0.0461	0.0109	0.0159	0.0092	0.0128	0.0200	0.0079	11.1985	11.3568
52.127	175.332	0.0002	0.0004	0.0001	0.0002	0.0003	0.0007	0.0017	0.0004	0.0017	0.0243	0.0333	0.0103	0.0167	0.0360	0.0435	0.0151	0.1323		0.3169
52.101	175.333	0.2231	0.0004	0.0004	0.0002	0.0016	0.0027	0.0140	0.1033	0.0303										0.3760
52.075	175.335	0.0002	0.0002	0.0110	0.0051	0.0021	0.0036	0.0051	0.0063											0.0335
52.049	175.337	0.0124	0.0103	0.0810	0.0752	0.0022	0.0012													0.1824
52.021	175.363	1.5038	0.0011	0.2465																1.7514
51.999	175.389	1.0129	0.1682																	1.1811
52.005	175.417	1.2787	0.2502	0.0006																1.5295
52.008	175.453	0.0414	0.1594	0.0247																0.2255
52.009	175.491	0.0100	0.0070	0.0149	0.0020															0.0339

Appendix 3. Continued.

Latitude	Longitude	Depth Strata (10 m) 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	10 Minute Total (%)
52.028	175.499	0.0013	0.0007	0.0027	0.0020	0.0012														0.0079
52.055	175.501	0.0288	0.0068	0.0025	0.0006	0.0045	0.0005													0.0437
52.082	175.500	0.0118	0.0050	0.0031	0.0079															0.0278
52.110	175.502	0.0004	0.0030	0.0016	0.0005															0.0055
52.138	175.500	0.0009	0.0002																	0.0011
52.209	175.501	0.0092	0.0047	0.0138	0.0257	0.0366	0.0495	0.0676	0.0748	0.0946	0.1213	0.1489	0.2317	0.2378	0.2275	0.2648	0.2900	0.2934	0.3799	2.5717
52.222	175.517	0.0077	0.0518	0.0044	0.0078	0.0099	0.0098	0.0275	0.0147	0.0466	0.0059	0.0462	0.0371	0.1543	0.1792	0.2425	0.6003	0.1411	0.1215	1.7084
52.214	175.556	0.0058	0.0098	0.0054	0.0020	0.0000	0.0005	0.0001	0.0180	0.1673	0.0898	0.1859	0.1008	0.0663	0.0861	0.0954	0.6134	1.2806	1.2806	4.0079
52.207	175.597	0.0113	0.0016	0.0013	0.0186	0.0045	0.0386	0.0169	0.2151	0.1765	0.0340	0.1882	0.4634	0.2236	0.1104	0.1556	0.1227	0.4538	0.2826	2.5186
52.198	175.638	0.0463	0.0047	0.0004	0.0005	0.0003	0.0012	0.0012	0.0226	0.1766	0.2156	0.5827	0.1175	0.0382	0.0770	0.0499	0.0555	0.1639	0.1280	1.6820
52.185	175.666	0.0139	0.0001	0.0005	0.0012	0.0460	0.0291	0.0372	0.0364	0.1071	0.1992	0.2816	0.4656	0.3195	0.1679	0.0601	0.0712	0.0609	0.1019	1.9992
52.159	175.669	0.0032	0.0044	0.0008	0.0020	0.0001	0.0008	0.0036	0.0112	0.0397	0.0222	0.0499	0.0125	0.0146	0.0324	0.0995	0.1820	0.1779	0.1709	0.8278
52.133	175.668	0.0645	0.0282	0.0052	0.0102	0.0254	0.0464	0.0647	0.0489	0.0730	0.0963	0.0858	0.1334	0.1636	0.1180	0.0592	0.0300	0.0759	0.0896	1.2182
52.108	175.667	0.0470	0.0014	0.0001	0.0003	0.0022	0.0119	0.0277	0.0743	0.0000	0.0000									0.1648
52.083	175.667	0.0040	0.0004	0.0003	0.0009	0.0005	0.0004	0.0001	0.0003	0.0026	0.0440									0.0535
52.056	175.668	0.0033	0.0687	0.0056	0.0020	0.0013	0.0018	0.0027	0.0035	0.0017										0.0906
52.029	175.667	0.0006	0.0169	0.0010	0.0009	0.0095	0.0155	0.0082	0.0137	0.0015										0.0678
52.002	175.666	0.0003	0.0002	0.0009	0.0041	0.1530	0.0256	0.0020												0.1861
51.988	175.685	0.0031	0.0012	0.0024	0.0061															0.0129
51.987	175.727	0.0393	0.0047	0.0039	0.0044	0.0051	0.0007													0.0582
51.992	175.768	0.0995	0.0042	0.0003	0.0062	0.0251	0.0668	0.0151	0.0137											0.2308
52.005	175.810	0.0157	0.0529	0.0063	0.0003	0.0029	0.0121													0.0902
52.025	175.834	0.0016	0.0009	0.0031	0.0052	0.0058	0.0026	0.0030	0.0029	0.0046	0.0286	0.0563	0.1435							0.2582
52.055	175.833	0.0131	0.0004	0.0004	0.0004	0.0054	0.0020	0.0015	0.0013	0.0087	0.0087	0.0156	0.0622							0.1199
52.085	175.833	0.0043	0.0007	0.0018	0.0007	0.0008	0.0007	0.0011	0.0002	0.0016	0.0023	0.0000	0.0000							0.0142
52.115	175.833	0.0084	0.0012	0.0010	0.0016	0.0106	0.0050	0.0045	0.0034	0.0000	0.0000	0.0000	0.0000							0.0357
52.145	175.833	0.0021	0.0018	0.0081	0.0060	0.0132	0.0486	0.0577	0.0613	0.0449	0.0334	0.0200	0.0184	0.0128	0.0061	0.3883	0.1107	0.0226	0.0199	0.8759
52.171	175.837	0.0183	0.0105	0.0015	0.0006	0.0016	0.0002	0.0004	0.0285	0.0196	0.0593	0.1611	0.1591	0.2423	0.3439	0.6721	1.1569	1.1213	1.0702	5.0674
52.172	175.873	0.0086	0.0060	0.0020	0.0013	0.0013	0.0023	0.0042	0.0017	0.0009	0.0075	0.0364	0.0541	0.0631	0.0290	0.0381	0.0236	0.0399	0.0724	0.3926
52.174	175.914	0.0140	0.1527	0.5063	0.2835	0.1006	0.0611	0.0373	0.0886	0.1911	0.3001	0.3256	0.5495	0.8454	1.3481	2.0324	2.3814	2.2292	1.9810	13.4280
52.173	175.956	0.0027	0.0015	0.0039	0.0893	0.1721	0.2100	0.2350	0.2697	0.2618	0.2333	0.2816	0.2517	0.2095	0.2049	0.2570	0.3510	0.3857	0.4447	3.8654
52.171	175.994	0.0024	0.0029	0.0010	0.0008	0.0002	0.0002	0.0106	0.0113	0.0418	0.0693	0.0685	0.0769	0.0533	0.0157	0.0564	0.0424	0.0418	0.1597	0.6552
52.149	176.000	0.0266	0.0176	0.0219	0.0331	0.0423	0.0671	0.0462	0.0541	0.0663	0.0981	0.0880	0.1058	0.0989	0.1113	0.1173	0.1380	0.1585	0.2722	1.5631
52.122	176.001	0.0032	0.0011	0.0007	0.0004	0.0009	0.0741	0.2220	0.0018	0.0014	0.0018	0.0023	0.2380	0.0005	0.0002	0.0021	0.0127	0.0352	0.0150	0.6135
52.038	175.934	0.0032	0.0003	0.0003	0.0001	0.0020	0.0003	0.0002	0.0000	0.0001	0.0000	0.0002								0.0068
52.030	175.918	0.0092	0.0019	0.0024	0.0011	0.0003	0.0004	0.0006	0.0007	0.0004	0.0001	0.0000								0.0172
52.036	175.881	0.0020	0.0015	0.0020	0.0013	0.0002	0.0083	0.0003	0.0002	0.0011	0.0026	0.0049								0.0245
52.056	175.885	0.0014	0.0015	0.0009	0.0005	0.0002	0.0001	0.0029	0.0000	0.0000	0.0000	0.0000								0.0075
52.049	175.922	0.0023	0.0005	0.0010	0.0004	0.0004	0.0005	0.0006	0.0047	0.0030	0.0000	0.0039								0.0175
52.036	175.931	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000											0.0002
51.993	175.748	0.0011	0.0002	0.0001	0.0004	0.0034	0.0049	0.0029	0.0192											0.0323
52.013	175.750	0.0135	0.0021	0.0147	0.0019	0.0044	0.0037	0.0061	0.0132											0.0597
52.041	175.750	0.0005	0.0025	0.0010	0.0034	0.0014	0.0018	0.0013												0.0118
52.069	175.750	0.0004	0.0015	0.0031	0.0010	0.0000	0.0008	0.0027	0.0042	0.0013	0.0024	0.0005								0.0179
52.097	175.750	0.0005	0.0008	0.0022	0.0005	0.0006	0.0005	0.0005	0.0003	0.0008	0.0016	0.0014								0.0097
52.124	175.750	0.0007	0.0010	0.0078	0.0018	0.0010	0.0025	0.0039	0.0024	0.0001	0.0000	0.0000								0.0212
52.153	175.750	0.0168	0.0057	0.0030	0.0080	0.0002	0.0005	0.0001	0.0024	0.0031	0.0019	0.0304	0.0381	0.0146	0.0132	0.0075	0.0089	0.0399	0.2373	0.4316

Appendix 3. Continued.

Latitude	Longitude	Depth Strata (10 m) 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	10 Minute Total (%)
52.179	175.547	0.0025	0.0085	0.0214	0.0390	0.0487	0.0700	0.0993	0.0812	0.0661	0.0641	0.0629	0.0969	0.1081	0.1165	0.1458	0.2009	0.1768	0.2182	1.6268
52.161	175.541	0.0013	0.1235	0.1323	0.1463	0.2127														0.6161
52.148	175.505	0.0000	0.0000	0.0000	0.0000	0.0000														0.0000
52.162	175.478	0.0024	0.0002	0.0002	0.0001	0.0017	0.0009	0.0003	0.0004	0.0002	0.0036	0.0081	0.0123	0.0101	0.0025	0.0005	0.0013	0.0456	0.0367	0.1270
52.187	175.485	0.0053	0.0024	0.0008	0.0002	0.0017	0.0007	0.0025	0.0053	0.0061	0.0016	0.0054	0.0128	0.0053	0.0107	0.0180	0.0157	0.0311	0.0284	0.1539
52.195	175.523	0.0123	0.0013	0.0003	0.0001	0.0006	0.0000	0.0001	0.0011	0.0001	0.0024	0.0007	0.0044	0.0033	0.0050	0.0049	0.0066	0.0100	0.0379	0.0910
52.182	175.546	0.0065	0.1893	0.0583	0.0274	0.0506	0.0697	0.0742	0.1653	0.0014	0.0022	0.0023	0.0098	0.0030	0.0069	0.0282	0.0067	0.0082	0.0062	0.7161
52.200	175.585	0.0006	0.0003	0.0005	0.0002	0.0000	0.0000	0.0000	0.0000	0.0001	0.0007	0.0014	0.0047	0.0020	0.0027	0.0035	0.0055	0.0336	0.0538	0.1096
52.174	175.581	0.0006	0.0022	0.0017	0.0044	0.0058	0.0084	0.0123	0.0199	0.0347	0.0408	0.0584	0.0747	0.0869	0.0756	0.0814	0.0990	0.1189	0.1487	0.8743
52.145	175.583	0.0017	0.0039	0.0074	0.0009	0.0009	0.0003	0.0019	0.0013	0.0024	0.0022	0.0010	0.0001	0.0002	0.0001					0.0241
52.116	175.586	0.0005	0.0083	0.0397	0.0307	0.0010	0.0023	0.0030	0.0054											0.0910
52.086	175.584	0.0008	0.0032	0.0005	0.0040	0.0870	0.2127	0.0399	0.0037											0.3518
52.057	175.582	0.0006	0.0001	0.0001	0.0003	0.0013	0.0012	0.0483												0.0521
52.027	175.585	0.0003	0.0010	0.0015	0.0024	0.0048	0.0014													0.0115
51.997	175.580	0.2381	0.3895	0.2201	0.1360	0.2245														1.2081
52.133	175.416	0.0006	0.0006	0.0005	0.0008	0.0009	0.0044	0.0077	0.0790											0.1362
52.158	175.417	0.0085	0.0002	0.0010	0.0019	0.0025	0.0026	0.0063	0.0018	0.0041	0.0047	0.0026	0.0078	0.0144	0.0056	0.0024	0.0049	0.0031	0.0098	0.0840
52.187	175.418	0.0013	0.0319	0.0132	0.0207	0.0293	0.0469	0.0669	0.0891	0.0953	0.1155	0.1436	0.1635	0.1832	0.2678	0.4932	1.8128	4.5890	0.2013	8.3645
52.217	175.418	0.0106	0.0063	0.0435	0.0173	0.0139	0.1696	0.0131	0.0399	0.0174	0.0331	0.0854	0.0547	0.0513	0.1877	0.2436	0.0610	0.0190	0.0082	1.0758
52.237	175.417	0.0029	0.0000	0.0008	0.0017	0.0021	0.0054	0.0164	0.0252	0.0406	0.0599	0.2012	0.0435	0.0417	0.1103	0.0604	0.0661	0.0614	0.1006	0.8403
52.251	175.249	0.0487	0.0005	0.0030	0.0000	0.0000	0.0001	0.0002	0.0014	0.0040	0.0024	0.0020	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0634
52.223	175.249	0.0498	0.0095	0.0002	0.0088	0.0375	0.0156	0.0004	0.0014	0.0023	0.0015	0.0006	0.0005	0.0015	0.0017	0.0001	0.0000	0.0005	0.0012	0.1331
52.195	175.251	0.0399	0.0020	0.0007	0.0093	0.0030	0.0140	0.0000	0.0003	0.0173	0.0128	0.0375	0.0645	0.0819	0.1025	0.1341	0.2028	0.2080	0.2675	1.1982
52.167	175.251	0.0147	0.0058	0.0646	0.0084	0.0195	0.0592	0.0789	0.0811	0.0694	0.0872	0.0604	0.0635	0.0625	0.0544	0.0430	0.0364	0.0511	0.0425	0.9025
52.138	175.249	0.0033	0.0015	0.0026	0.0064	0.0015	0.0011	0.0001	0.0002	0.0101	0.0056	0.0084	0.0150	0.0041	0.0053	0.0073	0.0458	0.0455	0.0020	0.1658
52.109	175.249	0.0029	0.0008	0.0004	0.0007	0.0319	0.0062	0.0073	0.0044	0.0016	0.0005	0.0009	0.0016							0.0592
52.082	175.250	0.0003	0.0001	0.0024	0.0011	0.0025	0.0282	0.0194	0.0006	0.0003										0.0550
52.062	175.251	0.0115	0.0002	0.0004	0.0151	0.0009														0.0281
52.225	175.104	0.0021	0.0003	0.0001	0.0006	0.0001	0.0000	0.0002	0.0002	0.0015	0.0010	0.0045	0.0021	0.0041	0.0031	0.0413	0.0150	0.0116	0.0242	0.1119
52.237	175.128	0.0058	0.0022	0.0023	0.0032	0.0041	0.0046	0.0125	0.0044	0.0015	0.0025	0.0063	0.0037	0.0179	0.0059	0.0100	0.0067	0.0063	0.0201	0.1201
52.229	175.158	0.0006	0.0009	0.0012	0.0445	0.0005	0.0015	0.0130	0.0094	0.0534	0.0636	0.1656	0.1527	0.0280	0.0048	0.0066	0.0052	0.0286	0.0200	0.5999
52.207	175.147	0.0052	0.0013	0.0005	0.0018	0.0140	0.0000	0.0008	0.0017	0.0408	0.0299									0.0961
52.211	175.111	0.0080	0.0026	0.0009	0.0010	0.0002	0.0005	0.0007	0.0002	0.0010	0.0035	0.0008	0.0031	0.0011	0.0001	0.0005	0.0000	0.0001		0.0241
Strata Total (%)		6.8173	2.7095	2.1768	1.6617	1.9960	2.9542	3.8083	2.8842	2.4670	2.6821	4.1392	4.8172	4.5231	5.4054	6.8451	9.9281	13.5319	20.6111	100
Strata Average		0.0700	0.0460	0.0506	0.0560	0.0701	0.0922	0.1193	0.1264	0.1467	0.1689	0.2124	0.2620	0.2940	0.3291	0.3808	0.4564	0.5418	0.6949	
Starta Max		1.5038	0.5414	0.5063	0.2835	0.2245	0.4646	0.9756	0.4521	0.2618	0.3001	0.5827	0.5495	0.8454	1.3481	2.0324	2.3814	4.5890	11.1985	