

SEABIRD, FISH, MARINE MAMMAL AND OCEANOGRAPHY COORDINATED
INVESTIGATIONS (SMMOCI) IN THE CENTRAL ALEUTIAN ISLANDS, ALASKA,
JULY-AUGUST 2003



By
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Executive Summary

We conducted surveys of seabirds, fish, marine mammals and oceanographic conditions in the central Aleutian Islands, Alaska from the *M/V Tiġlaġ* during 30 July-4 August 2003 as part of the Seabird, Fish, Marine Mammal and Oceanography Coordinated Investigations (SMMOCI) project. The objective was to characterize the marine environment in the vicinity of Kasatochi, Koniuji and Ulak islands, which together form one of nine seabird colonies monitored annually by the Alaska Maritime National Wildlife Refuge. The study area in 2003 was similar to that in 1996, except that we added transects that extended through Atka, Fenimore and Tagalak passes.

In addition to surveying seabirds and marine mammals on transects, we characterized local oceanography by measuring water temperature and salinity continuously at the sea surface and by taking profiles of the water column.

We measured the relative abundance of zooplankton and fish biomass using a dual-frequency echosounder and sampled with a mid-water trawl net to help determine which species were associated with observed acoustic sign. We set long-lines to catch large demersal fish species, used bottom trawls to describe the bottom fauna and sampled plankton at several sites.

In 2003 we counted a total of 15,372 birds on 26 transects that covered 441 linear km of surveys, resulting in an average density of approximately 118 birds/km² over an area of some 130 km²; similar to the density found during the 1996 survey of the area.

The whiskered auklet was the most numerous bird seen in 2003, followed by least auklet, northern fulmar, tufted puffin and crested auklet. The greater numbers of whiskered and least auklets in 2003 compared to 1996 were likely the result of our surveying through the passes (an area not covered in the earlier survey) and the high concentrations of these two species in the passes (especially Tagalak Pass). We counted far fewer short-tailed shearwaters than in 1996, but a much higher number of northern fulmars.

Similar to 1996, we found that the highest acoustic biomass occurred northwest of Kasatochi Island as well as in Atka and Fenimore passes. The majority of the acoustic biomass in the northwestern corner of the study area appeared to be at depths greater than 100m, whereas the areas of relatively strong acoustic sign occurred at both shallow and deep depths in the passes; making the prey more available to seabirds.

CTD profiles from both 1996 and 2003 indicated a generally more stratified water column at the north end of the line and more mixed waters to the south. The patterns of sea surface temperature and salinity in 2003 also were similar to those found in 1996; with warmer, less saline conditions to the north and colder, more saline waters near the passes to the south, indicating upwelling of north Pacific water through the passes.

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Introduction

We conducted surveys of seabirds, fish, marine mammals and oceanographic conditions in the central Aleutian Islands, Alaska (Figs. 1 and 2) from the *M/V Tiġlaġ* during 30 July-4 August 2003 as part of the Seabird, Fish, Marine Mammal and Oceanography Coordinated Investigations (SMMOCI) project. The objective was to characterize the marine environment in the vicinity of Kasatochi, Koniuji and Ulak islands, which together form one of nine seabird colonies monitored annually by the Alaska Maritime National Wildlife Refuge (Dragoo et al. 2004).

In addition to surveying seabirds and marine mammals on transects, we characterized local oceanography by measuring water temperature and salinity continuously at the sea surface and by taking profiles of the water column at numerous stations on a series of CTD (conductivity, temperature and depth) transects. We measured the relative abundance of zooplankton and fish biomass using a dual-frequency echosounder. We sampled with a mid-water trawl net to help determine which species were associated with observed acoustic sign. We set long-lines to catch large demersal fish species, used bottom trawls to describe the bottom fauna and sampled plankton at several sites. This report summarizes the data collected from the 2003 SMMOCI cruise to the central Aleutian Islands.

Personnel

Bird Crew.—Jeff Williams, Brad Benter, Heather Renner, Jennifer Wetzell, Kirsten Lindquist, Dan Barton

Fish Crew.—Brenda Holladay, Kitty Mecklenburg, Jeff Anderson, Ken Gates

Hydroacoustics/Electronics.—Don Dragoo

Tiġlaġ Crew.—Kevin Bell, John Faris, Dennis Haunschild, Eric Nelson, Billy Pepper, Bob Ward

Methods

Bird and Marine Mammal Observations

We counted birds using strip transect methods described by Gould and Forsell (1989), and employed on previous SMMOCI cruises. Two observers, stationed on the flying bridge of the *M/V Tiġlaġ* (one on each side of the ship), continuously recorded all birds observed on the water within 150 meters on either side of, and 300 meters in front of, the vessel, while the vessel traveled at 9-10 knots. Distances were estimated based on the angle of view from the ship's flying bridge to the object on the water. We counted flying birds on 360° 'scans' every three minutes. We radioed observations to a data recorder who entered the data into a logging computer using dLog (R. G. Ford Consulting, Portland, OR) which assigned all records GPS positions in real time.

We conducted surveys on 26 transects, which included circumnavigations of Kasatochi, Koniuji and Ulak islands at approximately one nm offshore, and surveys through Atka, Fenimore and Tagalak passes (Table 1, Fig. 3). We counted marine mammals on the same transects as birds, mapped bird and marine mammal distributions using Camris® (R. G. Ford Consulting, Portland, OR), and estimated densities from these data.

Hydroacoustic Surveys

We recorded acoustics data along the same transects and concurrently with marine bird and mammal observations (Fig. 3). We determined relative prey abundance on all transects using a dual frequency (38 and 120 kHz) Simrad EK500 echosounder. The threshold for data collection was set at -80 dB. We echo integrated acoustic data to a maximum depth of 250 m, excluding the surface bubble layer, bad data regions and the bottom. Data were exported in 100 m long bins. We used ordinary kriging to produce interpolations over a 2 km-interval grid to generate maps of relative prey abundance, as implemented in the R package *geoR* (R Core Development Team 2006, Ribeiro and Diggle 2001), at 0-50 m, 0-100 m and 0-250 m depths. 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; 38 kHz data were archived but are not reported.

Fishing

Trawls and Tows.—We conducted several types of trawls to relate mid-water and surface community composition with the hydroacoustic record of biomass. Mid-water tows utilized a 6 m modified herring trawl (with a PVC collecting bucket containing 1 mm mesh at the end), towed for about 10 to 20 minutes at 2-3 kts speed through the water. We attached a depth sounder to the foot rope of the mid-water trawl to give real-time feedback on fishing depth. We identified mid-water trawl collections to the lowest practical taxonomic level, counted invertebrates and fishes, and measured total length of fishes to the nearest mm (a subsample only).

To evaluate surface zooplankton we towed a neuston net (0.3 m by 0.5 m mouth opening; 505 micron mesh size) for about 10 min at 2-3 kts. We also sampled plankton in the water column by deploying and recovering a plankton net vertically (not obliquely) as near to the bottom as practical while the vessel was drifting. The vertical net was a paired 60 cm diameter bongo trawl with 505 micron mesh. Plankton from the neuston and vertical nets was preserved for later identification. After removing the noticeably larger or less common animals in the sample (100% split), the remaining sample was split using a Folsom splitter to achieve a target of at least 100 individuals per haul. We probably underestimated abundance of some of the zooplankton species, since the larger animals (e.g., shrimps, euphausiids) swim strongly enough that they are not expected to be caught quantitatively with the gear we used (Brenda Holladay, Institute of Marine Science/University of Alaska Fairbanks).

We conducted bottom trawls using a 3.05 m plumb staff beam trawl with 4 mm stretched mesh at the cod end which was towed for five to 10 minutes in the direction of the water current at approximately 1.5 kts. We identified samples to the lowest practical taxonomic level, counted them, measured a sample of fishes to the nearest mm (total length) and preserved some specimens for later use.

Long-line Sets.—For each long-line set, we deployed a single skate of about 100 hooks (sizes 3.0 and 5.0) baited with salted herring and soaked for about two to three hours. We identified fishes to species, measured them to the nearest mm (total length), weighed them and removed some of their stomachs for later diet analysis.

Oceanographic Data

Water Column Temperature and Salinity Profile.—We deployed a portable CTD (Sea-Bird Seacat SBE-19 Profiler) approximately every two nautical miles along three transect lines (09, 12 and 26, Fig. 3) and at the end of each fishing event (trawl, tow or long-line set). In this way we obtained temperature and salinity data at depth for the water column from the surface to near the bottom. We used Ocean Data View[®] (Schlitzer 2004) to produce water column temperature and salinity profiles (using the VG gridding algorithm).

Sea Surface Temperature and Salinity.—We continuously recorded sea surface temperature and salinity during transects using a Sea-Bird Seacat SBE21 thermosalinograph. We used Ocean Data View[®] (Schlitzer 2004) to generate temperature and salinity contour maps (using the VG gridding algorithm) as a way of illustrating the occurrence of surface structures such as fronts.

Results

Bird and Marine Mammal Observations

In 2003 we counted a total of 15,372 birds on 26 transects that covered 441 linear km of surveys (Table 2, Appendix A). This translated into an average density of approximately 118 birds/km² over an area of some 130 km².

Procellariids.—All of the Laysan and black-footed albatrosses we encountered occurred in the deeper water north of the 50 fathom line (Fig. 3). Northern fulmars were widely distributed in the survey area, with the highest concentrations near Fenimore Pass (Fig. 4). All five mottled petrels we saw occurred in Fenimore Pass as well. Most of the shearwaters identified to species were short-tailed shearwaters (Table 2). Shearwaters were widely distributed with an area of concentration on transect 19 near Kasatochi Island (Fig. 5). All of the fork-tailed storm-petrels we observed were in the deeper water north of the 50 fathom line. We sighted a Salvin's shy albatross (*Thalassarche cauta salvini*) 18 km northwest of Kasatochi Island (off transect) on 4 August; the first record of this species in Alaska (Benter et al. 2005).

Cormorants.—We generally observed cormorants inshore and in the passes.

Shorebirds.—The only shorebirds we saw during surveys were phalaropes (almost entirely red phalaropes, Table 2), which were mostly concentrated in the relatively shallow water south of Kasatochi Island (Fig. 6).

Raptors.—We counted 16 peregrine falcons on transects, distributed throughout the study area (Table 2).

Gulls.—We observed glaucous-winged gulls in both deep and relatively shallow waters throughout the survey area (Fig. 7). The few black-legged kittiwakes we saw were distributed mainly in the deeper waters.

Murres and Guillemots.—We found that murres exhibited a somewhat patchy distribution with concentrations near Koniuji and Ulak islands, as well as in Fenimore Pass (Fig. 8). Most of the murres we recorded were thick-billed murres (Table 2). We observed pigeon guillemots only in the relatively shallow water near Kasatochi Island and in the passes.

Murrelets and Auklets.—All of the ancient murrelets we observed were in passes. We found the highest concentrations of Cassin's, parakeet, least, whiskered and crested auklets in or near the passes as well, although we also found all five auklet species in lower concentrations in deeper water (Figs. 9-13).

Puffins.—Horned puffins had a patchy distribution throughout the survey area, mostly in shallower nearshore waters. We observed tufted puffins over most of the study area, with higher concentrations near Koniuji and Ulak islands, and in or near the passes (Fig. 14).

Marine Mammals.—We saw three minke whales, one sperm whale and several groups of Dall's porpoise on transects (including one group of 15 porpoises on transect 23 near Koniuji Island, Fig. 15).

Prey

Acoustic Surveys.—In general, acoustic biomass was greatest in the deeper waters in the northern portion of our study area, particularly in the northwest section (Figs. 16-18). Other areas of relatively high biomass were to the southwest of Kasatochi Island, and in Fenimore and Atka passes. This was true for all depth bins but was especially evident in the 0-250 m bin (Fig. 18).

Mid-water Trawls.—We conducted 10 mid-water trawls in 2003 (Table 3, Fig. 19). The most numerous invertebrates we caught were jellyfishes and crustaceans, especially euphausiids (Table 4). The most numerically abundant fishes captured were Atka mackerel, northern lampfish and walleye pollock (Table 5). Mean total lengths of selected fish species are presented in Table 6. See Appendix B for photographs of a sample of fish species we caught.

Bottom Trawls.—We conducted 12 bottom trawls in 2003 (Table 3, Fig. 19). We caught a wide variety of both invertebrates and fish species. The highest number of any single species captured consisted of 1436 yellowleg pandalid shrimp, most of which were from just two tows (Table 7). Other species for which we caught several hundred individuals included the ubiquitous brittle star and green urchin (Table 7). We captured just a few individuals of most fish species but some were more numerous (e., g., sculpins, snailfish and northern rock sole, Table 8). See Appendix B for photographs of a sample of fish species we caught. Mean total lengths of selected fish species are presented in Table 9.

Long-line Sets.—We set the long-line gear three times in 2003 (Table 3, Fig. 19). Pacific cod and Pacific halibut were the most numerous fishes we caught (Table 10). Total lengths and

weights of selected species are presented in Table 11. No particular prey item dominated by frequency of occurrence in the diet of Pacific halibut, whereas the largest component by weight consisted of walleye pollock remains (Table 12). The prey that occurred most frequently in Pacific cod stomach samples was shrimp and other crustaceans but fish remains outweighed crustaceans (Table 13).

Plankton Tows.—We conducted two neuston (surface) plankton tows and three vertical plankton tows in 2003 (Table 3, Fig. 19). Copepods were the numerically dominant animals we caught in both neuston and vertical tows, although the principal species differed between the two types of tows (Table 14).

Oceanography

Water Column Profile.—We conducted 40 CTD casts in 2003, 19 of which were at stations along CTD lines and which were used to generate profiles (Table 15, Fig. 20). All profiles indicated a stratified water column in the north with mixed water nearer the passes and intrusions of cooler, more saline water from below in places that probably were associated with local bathymetry and currents (Fig. 21).

Sea Surface Temperature and Salinity.—Maps of sea surface temperature (Fig. 22) and salinity (Fig. 23) indicated that relatively warmer, less saline water occurred in the deeper offshore waters to the north while cooler, more saline conditions predominated in the shallower portions of the southern part of the study area.

Discussion

The study area in our 2003 central Aleutian SMMOCI cruise was similar to that in 1996 (see Drew et al. 2003, Fig.3), except that we added transects that extended through Atka, Fenimore and Tagalak passes. The overall density of seabirds we encountered on transects in 2003 was similar to that found in 1996 (Table 16).

The whiskered auklet was the most numerous bird seen during our survey, followed by least auklet, northern fulmar, tufted puffin and crested auklet. The greater numbers of whiskered and least auklets that we counted in 2003 compared to 1996 were likely the result of our surveying through the passes (an area not covered in the earlier survey) and the high concentrations of these two species in the passes (especially Tagalak Pass). We counted far fewer short-tailed shearwaters than in 1996, but a much higher number of northern fulmars.

Similar to Drew et al. (2003), we found that the highest acoustic biomass occurred northwest of Kasatochi Island as well as in Atka and Fenimore passes. The majority of the acoustic biomass in the northwestern corner of the study area appeared to be at depths greater than 100m, whereas the areas of relatively strong acoustic sign occurred at both shallow and deep depths in the passes; making the prey more available to seabirds.

CTD profiles from 1996 indicated a generally more stratified water column at the north end of the line and more mixed waters to the south (Drew et al. 2003). We found this also to be the general pattern in 2003. The patterns of sea surface temperature and salinity we recorded in 2003 also were similar to those found in 1996; with warmer, less saline conditions to the north

and colder, more saline waters near the passes to the south, indicating upwelling of north Pacific water through the passes.

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I would like to thank all of the people who helped gather data during the 2003 central Aleutian Island SMMOCI survey. Their perseverance, professionalism and good cheer were much appreciated. Brenda Holladay (University of Alaska Fairbanks) identified plankton samples. Acoustic data were analyzed and prey distribution maps produced by Martin Renner. The fish photos are by Catherine W. (Kitty) Mecklenburg, Point Stephens Research, Auke Bay, Alaska. The cover photo is by Ian L. Jones. Vernon Byrd, Kitty Mecklenburg and Martin Renner reviewed drafts of this report. I appreciate their thoughtful comments. I would also like to thank the staff of Alaska Maritime National Wildlife Refuge for their help and support. Finally, I would like to express my sincere thanks to the captain and crew of *M/V Tiglaġ* without whose enthusiasm, professionalism and patience this work would not have been possible.

Literature Cited

- Benter, R. B., H. M. Renner, M. Renner. 2005. First record of a shy albatross in Alaska. *Western Birds* 36:135-137.
- Byrd, G. V., R. L. Merrick, J. F. Piatt, and B. L. Norcross. 1997. Seabird, marine mammal and oceanography coordinated investigations (SMMOCI) near Unimak Pass, Alaska. Pp. 351-364 *in*: Forage Fishes in Marine Ecosystems. Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems. Alaska Sea Grant College Program Report No. 97-01. University of Alaska Fairbanks.
- Dragoo, D. E. 2006a. Seabird, fish, marine mammal and oceanography coordinated investigations (SMMOCI) in the Semidi Islands, Alaska, July 2001 and 2004. U. S. Fish and Wildlife Service Report AMNWR 06/01.
- _____. 2006b. Seabird, fish, marine mammal and oceanography coordinated investigations (SMMOCI) near Bluff, Norton Sound, Alaska, July 2002. U. S. Fish and Wildl. Serv. Report AMNWR 06/03.
- _____, and G. V. Byrd. 1998. Seabird, marine mammal, and oceanography coordinated investigations in the Pribilof Islands, Alaska, in July 1997 (SMMOCI 97-3). U. S. Fish and Wildlife Service Report AMNWR 98/06.
- _____. 1999. Seabird, marine mammal, and oceanography coordinated investigations at Buldir Island, Aleutian Islands, Alaska, July 1998 (SMMOCI-98-3). U. S. Fish and Wildlife Service Report AMNWR 99/05.
- _____, and D. B. Irons. 2004. Breeding status, population trends and diets of seabirds in Alaska, 2002. U. S. Fish and Wildlife Service Report AMNWR 04/15.

- Drew, G. S., J. F. Piatt, G. V. Byrd, and D. E. Dragoo. 2003. Seabird, fisheries, marine mammal, and oceanography coordinated investigations around Kasatochi, Koniuji and Ulak islands, August 1996 (SMMOCI 96-3). U. S. Fish and Wildlife Service Report AMNWR 03/06.
- Gould, P. J., and D. J. Forsell. 1989. Techniques for shipboard surveys of marine birds. U. S. Fish and Wildlife Service Technical Report 25, Washington, D. C.
- Piatt, J. F. 1994. Oceanic, Shelf and Coastal Seabird Assemblages at the Mouth of a Tidally-Mixed Estuary (Cook Inlet, Alaska). Final Rep. to Minerals Management Service, OCS Study MMS 93-0072.
- _____. (ed.). 2003. Response of seabirds to fluctuations in forage fish density. Final Report to *Exxon Valdez* Oil Spill Trustee Council (Restoration Project 00163M) and Minerals Management Service (Alaska OCS Report 2002-068). Alaska Science Center, U.S. Geological Survey, Anchorage, Alaska.
- _____, and D. E. Dragoo. 2005. Seabird, fisheries, marine mammal, and oceanography coordinated investigations (SMMOCI) in Sitka Sound, Alaska, July 2000. U. S. Fish and Wildl. Serv. Report AMNWR 04/01.
- _____, J. L. Wells, A. MacCharles, and B. Fadely. 1990. The distribution of seabirds and their prey in relation to ocean currents in the southeastern Chukchi Sea. *Canadian Wildlife Service Occasional Papers* 68:21-31.
- R Development Core Team. 2006. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.
- Ribeiro, Jr., P. J. and Diggle, P. J. 2001. geoR: A package for geostatistical analysis. *R-NEWS* Vol. 1, No 2. ISSN 1609-3631.
- Robards, M., G. Drew, J. Piatt, J. M. Anson, A. Abookire, J. Bodkin, P. Hooge and S. Speckman. 2003. Ecology of selected marine communities in Glacier Bay: Zooplankton, forage fish, seabirds and marine mammals. Final Rep. for Glacier Bay National Park (Gustavus, AK). Alaska Science Center, USGS, Anchorage, Alaska.
- Schlitzer, R. 2006. Ocean Data View, <http://www.awi-bremerhaven.de/GEO/ODV>.

Table 1. Locations, dates and times of surveys used for bird and marine mammal observations, and hydroacoustics surveys in the central Aleutian Islands, Alaska in 2003.

Transect	Start Latitude ^a (°N)	Start Longitude ^a (°W)	Stop Latitude ^a (°N)	Stop Longitude ^a (°W)	Date	Start Time ^b	Stop Time ^b
1	52.1722°	176.0015°	52.0413°	175.9404°	8/01	17:46	18:45
2	52.1713°	175.8338°	52.1720°	176.0010°	8/01	17:03	17:39
3	52.0130°	175.8357°	52.1747°	175.8310°	8/03	16:09	17:04
4	51.9855°	175.7527°	52.0120°	175.8353°	8/03	15:40	15:59
5	51.9870°	175.6692°	51.9861°	175.7507°	8/03	15:17	15:34
6	52.1955°	175.6543°	51.9850°	175.6638°	7/31	17:28	18:48
7	52.2267°	175.4988°	52.1922°	175.6646°	7/31	16:35	17:12
8	52.1968°	175.5057°	52.2255°	175.4995°	7/31	16:19	16:28
9	52.0070°	175.5027°	52.1503°	175.5003°	7/31	13:07	14:01
10	51.9957°	175.3782°	52.0085°	175.5037°	7/31	12:32	13:00
11	52.0442°	175.3387°	51.9982°	175.3814°	7/31	12:05	12:20
12	52.2485°	175.3402°	52.0454°	175.3358°	7/31	09:58	11:52
13	52.2572°	175.2080°	52.2495°	175.3322°	7/31	08:59	09:41
14	52.0785°	175.1660°	52.2824°	175.1668°	7/30	14:42	15:55
15	52.1188°	174.9994°	52.0799°	175.1595°	7/30	13:59	14:36
16	52.3148°	174.9942°	52.1193°	175.0003°	7/30	12:42	13:51
17	52.0235°	175.8985°	52.0239°	175.9012°	8/04	14:00	14:51
18	51.9217°	175.7400°	52.1800°	175.7505°	8/01	14:48	16:26
19	52.1990°	175.5818°	51.9220°	175.7382°	8/01	12:28	14:43
20	52.1547°	175.5006°	52.1497°	175.4820°	7/31	14:12	15:16
21	52.0013°	175.4180°	52.2504°	175.4161°	8/02	17:00	18:28
22	52.2623°	175.2490°	52.0726°	175.2504°	8/02	19:11	20:23
23	52.2708°	175.1610°	52.2420°	175.1475°	7/30	16:12	17:01
24	52.1842°	175.7520°	52.1722°	175.8320°	8/01	16:35	16:53
25	52.0957°	175.3043°	51.9868°	175.6662°	8/03	13:18	15:11
26	52.0198°	175.9095°	52.1722°	175.9172°	8/04	15:07	15:52

^aDecimal degrees.

^bAll times are Aleutian Daylight (Universal Coordinated Time minus 9 hours).

Table 2. Species composition and numbers of seabirds and marine mammals observed on 26 transects in the central Aleutian Islands, Alaska in 2003.

Species	Scientific Name	No. Observed	Density ^a	% Total
All Bird Species Total		15,372	118.25	100.00
Laysan albatross	<i>Phoebastria immutabilis</i>	23	0.18	0.15
Black-footed albatross	<i>Phoebastria nigripes</i>	10	0.08	0.07
Northern fulmar	<i>Fulmarus glacialis</i>	2001	15.39	13.02
Mottled petrel	<i>Pterodroma inexpectata</i>	5	0.04	0.03
Sooty shearwater	<i>Puffinus griseus</i>	3	0.02	0.02
Short-tailed shearwater	<i>Puffinus tenuirostris</i>	180	1.38	1.17
Unidentified shearwater	<i>Puffinus</i> sp.	189	1.45	1.23
Fork-tailed storm-petrel	<i>Oceanodroma furcata</i>	11	0.08	0.07
Leach's storm-petrel	<i>Oceanodroma leucorhoa</i>	1	0.01	0.01
Red-faced cormorant	<i>Phalacrocorax urile</i>	4	0.03	0.03
Pelagic cormorant	<i>Phalacrocorax pelagicus</i>	10	0.08	0.07
Unidentified cormorant	<i>Phalacrocorax</i> sp.	4	0.03	0.03
Red phalarope	<i>Phalaropus lobatus</i>	221	1.70	1.44
Unidentified phalarope	<i>Phalaropus</i> sp.	12	0.09	0.08
Peregrine falcon	<i>Falco peregrinus</i>	16	0.12	0.10
Glaucous-winged gull	<i>Larus glaucescens</i>	190	1.46	1.24
Black-legged kittiwake	<i>Rissa tridactyla</i>	13	0.10	0.08
Common murre	<i>Uria aalge</i>	13	0.10	0.08
Thick-billed murre	<i>Uria lomvia</i>	276	2.12	1.80
Unidentified murre	<i>Uria</i> sp.	41	0.32	0.27
Pigeon guillemot	<i>Cephus columba</i>	25	0.19	0.16
Ancient murrelet	<i>Synthliboramphus antiquus</i>	6	0.05	0.04
Cassin's auklet	<i>Ptychoramphus aleuticus</i>	630	4.85	4.10
Parakeet auklet	<i>Aethia psittacula</i>	239	1.84	1.55
Least auklet	<i>Aethia pusilla</i>	3041	23.39	19.78
Whiskered auklet	<i>Aethia pygmaea</i>	4492	34.55	29.22
Crested auklet	<i>Aethia cristatella</i>	1767	13.59	11.49
Unid. small dark alcid	<i>Alcidae</i> sp.	18	0.14	0.12
Horned puffin	<i>Fratercula corniculata</i>	84	0.65	0.55
Tufted puffin	<i>Fratercula cirrhata</i>	1847	14.21	12.01
Minke whale	<i>Balaenoptera acutorostrata</i>	3	0.02	7.32
Sperm whale	<i>Physeter macrocephalus</i>	1	0.01	2.44
Dall's porpoise	<i>Phocoenoides dalli</i>	37	0.28	90.24

^aIndividuals/km². A total of 130 km² was surveyed.

Table 3. Locations (decimal degrees), times and depths of fishing efforts in the central Aleutian Islands, Alaska in 2003.

Tow ^a	Date	Start Latitude (N)	Start Longitude (W)	Time ^b at Depth	Depth Range (m)
MW01	7/30	52.2213°	175.1042°	20:00	20-27
MW02	7/31	52.2413°	175.1518°	07:28	70-112
MW03	7/31	52.0199°	175.5491°	20:10	0-38
MW04	7/31	52.0014°	175.5411°	21:12	16-47
MW05	08/02	52.1146°	175.9065°	06:18	78-80
MW06	08/03	52.2239°	175.1590°	05:19	85-114
MW07	08/03	52.2562°	175.2089°	06:37	11-15
MW08	08/03	52.1959°	175.9370°	20:50	8-14
MW09	08/04	52.1721°	175.9880°	05:21	6-25
MW10	08/04	52.1953°	176.0076°	06:03	63-83
BT01	07/30	52.2152°	175.1412°	22:08	29-34
BT02	07/30	52.2103°	175.1433°	22:59	102-102
BT03	07/31	52.2147°	175.1222°	00:18	24-26
BT04	07/31	52.1358°	175.4765°	23:08	52-64
BT05	08/01	52.1505°	175.5498°	03:31	107-150
BT06	08/01	52.0733°	175.8844°	19:45	100-100
BT07	08/01	52.0561°	175.9417°	20:31	77-80
BT08	08/01	52.0468°	175.9793°	22:56	19-26
BT09	08/02	52.1497°	175.4930°	22:28	19-21
BT10	08/02	52.1375°	175.5013°	23:18	40-49
BT11	08/03	52.1967°	175.1522°	01:25	151-153
BT12	08/03	52.1975°	175.1262°	02:11	131-132
LL01	08/01	52.1807°	175.5333°	08:00	46-59
LL02	08/02	52.0307°	175.9353°	09:00	46-75
LL03	08/03	52.2072°	175.1083°	08:00	69-75
NU01	07/30	52.2528°	175.1432°	17:49	0-0.5
NU02	08/02	52.1850°	175.9065°	13:10	0-0.5
VT01	07/30	52.2473°	175.1440°	17:20	0-50
VT02	07/31	52.0109°	175.5553°	19:33	0-50
VT03	08/02	52.1588°	175.9637°	07:15	0-50

^aMW = Mid-water trawl, BT = Bottom trawl, VT = Vertical plankton tow, NT = Neuston tow, LL = Long-line set.

^b All times are Alaska Daylight (Universal Coordinated Time minus 8 hours).

Table 4. Species composition and numbers of invertebrates captured with mid-water trawls during SMMOCI sampling in the central Aleutian Islands, Alaska in 2003.

Common name	Scientific name	01	02	03	04	05	06	07	08	09	10	Total
Jellyfishes	<i>Aequorea</i> sp.	41	18	19	3	3	5	19	5	4	13	130
	<i>Calycopsis nematophora</i>	--	--	1	--	10	--	--	--	13	5	29
North Pacific sea nettle	<i>Chrysaora melanaster</i>	--	--	--	2	2	--	--	--	--	--	4
Lions mane jellyfish	<i>Cyanea capillata</i>	3	4	--	--	--	--	5	2	--	3	17
	Leptomedusae, unid	--	--	1	--	--	--	3	--	--	--	4
	<i>Leuckartiara</i> sp.	--	1	--	--	--	--	--	--	--	--	1
Eggyolk jelly	<i>Phacelophora camtschatica</i>	--	--	--	--	--	--	1	--	--	--	1
	<i>Sarsia</i> sp.	1	24	1	--	8	54	56	--	41	--	185
	Scyphomedusae, unid.	4	--	--	--	--	--	--	--	--	--	4
	Beroidae, unid.	--	1	--	--	--	--	--	--	--	--	1
Molluscs												
Squid	Teuthoidea, unid.	13	1	5	--	1	--	1	--	7	19	47
Copepods	<i>Calanus marschallae</i>	--	--	14	--	--	--	--	--	--	--	14
Fish louse	Copepod, unid. (parasitic)	10	--	--	15	1	--	--	--	--	--	26
	<i>Eucalanus bungii</i>	--	1	6	--	3	--	--	--	--	--	10
	<i>Neocalanus cristatus</i>	--	1	34	--	--	--	--	--	--	--	35
	<i>Neocalanus plumchrus</i>	--	--	10	--	--	--	--	--	--	--	10
Crabs	Cheiragonidae (unid. megalops)	--	1	--	--	--	--	--	--	--	--	
Hermit crab	Paguridae (unid. zoea)	--	--	2	--	--	--	--	--	--	--	2
Krill	<i>Euphausia pacifica</i>	--	358	--	--	2	17	--	--	--	--	377
	Euphausiacea, unid.	--	--	--	--	--	--	--	--	--	100	100
	<i>Thysanoessa inermis</i>	--	260	--	--	16	13	--	--	--	--	289
	<i>Thysanoessa longipes</i>	--	4	--	--	--	--	--	--	--	--	4
	<i>Thysanoessa spinifera</i>	--	136	18	--	6	7	--	--	--	--	167
Amphipods	Amphipoda, unid.	--	--	--	--	--	--	--	--	--	1	1
	Hyperiididae	--	--	--	--	--	--	--	--	1	--	1
	<i>Parathemisto</i> sp.	--	--	--	--	--	--	--	--	--	1	1
Debris												
Moss animal	Bryozoa, unid	--	--	1	--	--	--	--	--	--	--	1
Bull kelp	<i>Nereocystis</i> sp.	--	--	1	--	--	--	--	--	--	--	1

Table 5. Species composition and numbers of fishes captured with mid-water trawls during SMMOCI sampling in the central Aleutian Islands, Alaska in 2003. No fish were caught during tow number 8.

Common Name	Scientific Name	Tow Number										Total
		01	02	03	04	05	06	07	08	09	10	
Fish egg mass	Teleost egg mass	--	--	--	2	--	--	--	--	--	--	2
Northern smoothtongue	<i>Leuroglossus schmidti</i>	--	1	--	--	--	--	--	--	--	7	8
Northern lampfish	<i>Stenobranchius leucopsarus</i>	--	--	--	--	--	--	--	--	1	60	61
Garnet lampfish	<i>Stenobranchius nannochir</i>	--	--	--	--	--	--	--	--	--	1	1
Pacific cod	<i>Gadus macrocephalus</i>	--	--	--	--	--	1	--	--	--	--	1
Walleye pollock	<i>Theragra chalcogramma</i>	4	6	--	--	2	20	12	--	--	4	48
Atka mackerel	<i>Pleurogrammus monopterygius</i>	2	--	--	64	--	--	8	--	20	2	96
Sculpin post-larva	Cottidae	--	--	--	--	--	1	--	--	--	--	1
Antlered sculpin	<i>Enophrys diceraus</i>	--	--	--	--	--	1	--	--	--	--	1
Longfin Irish lord	<i>Hemilepidotus zapus</i>	1	--	--	--	--	--	--	--	--	--	1
Alligatorfish	<i>Aspidophoroides monopterygius</i>	1	--	--	--	--	--	--	--	1	--	2
Smooth lumpsucker	<i>Aptocyclus ventricosus</i>	--	--	--	--	--	2	--	--	--	--	2
Pacific spiny lumpsucker	<i>Eumicrotremus orbis</i>	--	--	2	--	--	--	--	--	--	--	2
Prowfish	<i>Zaprora silenus</i>	--	--	--	--	--	--	--	--	1	--	1
Pacific sand lance	<i>Ammodytes hexapterus</i>	1	--	--	--	--	1	--	--	--	--	2
Arrowtooth flounder	<i>Atheresthes stomias</i>	8	1	--	--	--	1	--	--	5	2	17
Flathead sole	<i>Hippoglossoides elassodon</i>	5	--	--	--	--	--	--	--	--	--	5
Northern rock sole	<i>Lepidopsetta polyxystra</i>	--	4	--	--	--	--	--	--	--	--	4

Table 6. Total lengths (mm) of species captured with mid-water trawls during SMMOCI sampling in the central Aleutian Islands, Alaska in 2003.

Species	Mean	SD ^a	Range	n ^a
Northern smoothtongue	62.0	42.8	39-167	8
Northern lampfish	55.1	12.6	30-84	61
Garnet lampfish	111.0	--	--	1
Pacific cod	45.0	--	--	1
Walleye pollock	240.3	217.2	25-511	48
Atka mackerel	320.0	48.3	141-451	96
Antlered sculpin	24.0	--	--	1
Longfin Irish lord	30.0	--	--	1
Alligatorfish	33.0	11.3	25-41	2
Smooth lumpsucker	14.5	0.7	14-15	2
Pacific spiny lumpsucker	39.5	17.7	27-52	2
Prowfish	53.0	--	--	1
Pacific sand lance	66.5	6.4	62-71	2
Arrowtooth flounder	36.2	7.5	25-45	17
Flathead sole	19.2	1.5	17-21	5
Northern rock sole	20.3	2.5	17-23	4

^aSD = Standard deviation, n = Sample size.

Table 7. Species composition and numbers of invertebrates captured with bottom trawls during SMMOCI sampling in the central Aleutian Islands, Alaska in 2003.

Common name	Scientific name	Tow Number												Total
		01 ^a	02	03	04	05	06	07	08	09	10	11	12	
Sponges														
Rough scallop sponge	<i>Myxilla incrustans</i> on <i>Chlamys</i> sp.	--	--	--	6	--	--	--	--	--	--	--	--	6
	<i>Polymastia</i> sp.	--	--	--	1	--	--	--	--	--	--	--	--	1
	Porifera, unid.	--	--	--	2	--	3	4	--	--	--	--	--	9
Purse sponge	<i>Scypha ciliata</i>	--	--	--	2	--	--	--	--	--	--	--	--	2
Hermit crab sponge	<i>Suberites ficus</i> with hermit crab	--	--	--	--	1	--	--	--	--	--	--	--	1
Hermit crab sponge	<i>Suberites ficus</i> without hermit crab	--	--	--	3	--	--	1	--	--	--	--	--	4
Polychaete worms														
Depressed scale worm	<i>Eunoe depressa</i>	--	--	--	25	--	--	8	--	--	--	--	--	33
	Nereidae	--	--	--	33	--	2	2	--	--	--	--	--	37
	Polychaeta, unid. fragment	--	--	1	--	--	--	--	--	--	--	--	--	1
Misc. Cnidarians														
Sea raspberry	<i>Gersemia</i> sp.	--	--	--	1	--	--	--	--	--	--	--	--	1
Sea pen	<i>Ptilosarcus gurneyi</i>	--	--	--	1	--	--	--	--	--	--	--	--	1
Bivalves														
Pacific pink scallop	<i>Chlamys rubida</i>	--	--	--	1	--	--	--	--	--	--	--	--	1
	<i>Chlamys</i> sp.	--	--	--	12	--	6	70	--	--	--	--	--	88
	Mactridae, unid.	--	--	6	--	--	--	--	--	--	--	--	--	6
Northern horse mussel	<i>Modiolus modiolus</i>	--	--	--	--	--	4	12	--	--	--	--	--	16
	<i>Mya</i> sp.	--	--	--	--	--	--	--	--	13	--	--	--	13
Alaska jingle	<i>Pododesmus macroschisma</i>	--	--	--	45	--	3	50	--	--	--	--	--	98
Gastropods														
	<i>Boreotrophon</i> sp.	--	--	--	--	--	--	1	--	--	--	--	--	1
	<i>Buccinum</i> sp.	--	--	--	6	--	--	--	--	--	--	--	--	6
	<i>Colus</i> sp.	--	--	--	9	--	--	3	--	--	--	--	--	12
Rusty moon snail	<i>Cryptonatica russa</i>	--	--	--	--	--	--	--	--	1	--	--	--	1
Oregon triton	<i>Fusitriton oregonensis</i>	--	--	--	16	--	6	145	--	--	--	--	--	167
Oregon triton egg mass	<i>Fusitriton oregonensis</i> egg mass	--	--	--	--	--	--	3	--	--	--	--	--	3
	Gastropod egg mass	--	--	--	--	--	1	--	--	--	--	--	--	1
Pribilof whelk	<i>Neptunea pribiloffensis</i>	--	--	--	--	--	--	1	--	--	--	--	--	1

Table 7. Species composition and numbers of invertebrates captured with bottom trawls during SMMOCI sampling in the central Aleutian Islands, Alaska in 2003 (continued).

Common name	Scientific name	Tow Number												Total
		01 ^a	02	03	04	05	06	07	08	09	10	11	12	
	<i>Neptunea</i> sp.	--	--	--	7	--	--	--	--	--	--	--	--	7
	<i>Trophonopsis</i> sp.	--	--	--	--	--	--	4	--	--	--	--	--	4
	<i>Velutina</i> sp.	--	--	--	--	--	--	4	--	--	--	--	--	4
Misc. Molluscs														
	Nudibranchia, unid.	--	--	--	11	2	2	7	--	--	--	--	--	22
	Octopoda, unid.	--	--	--	1	--	--	1	--	--	--	--	--	2
Red veiled chiton	<i>Placiphorella rufa</i>	--	--	--	1	--	--	--	--	--	--	--	--	1
	Polyplacophora, unid.	--	--	--	--	--	--	1	--	--	--	--	--	1
Rosy tritonia	<i>Tritonia diomedea</i>	--	--	--	4	--	--	--	--	--	--	--	--	4
Copepods														
Fish louse	Copepoda, unid. (parasitic)	--	--	1	--	--	--	--	--	--	--	--	--	1
	<i>Neocalanus cristatus</i>	--	--	--	--	--	--	--	--	--	--	20	--	20
Crabs														
Pacific red hermit crab	<i>Elassochirus gilli</i>	--	2	--	--	--	--	--	--	--	--	--	--	2
Pacific lyre crab	<i>Hyas lyratus</i>	--	--	--	4	--	--	32	--	--	--	--	--	36
Graceful decorator crab	<i>Oregonia gracilis</i>	--	1	--	27	--	1	22	--	--	--	--	1	52
Alaskan hermit crab	<i>Pagurus ochotensis</i>	--	1	--	--	--	--	--	--	--	--	--	--	1
	<i>Pagurus</i> sp.	--	--	23	73	3	4	71	--	--	1	--	--	175
Hermit crab in sponge	<i>Pagurus</i> sp. with <i>Suberites ficus</i>	--	--	--	3	--	9	--	--	--	--	--	--	12
Red king crab	<i>Paralithodes camtschatica</i>	--	--	--	1	--	--	--	--	--	--	--	--	1
Crangonid shrimps														
Common argid	<i>Argis alaskensis</i>	--	--	--	--	--	--	--	1	--	--	--	--	1
Rough argid	<i>Argis crassa</i>	--	5	--	174	20	5	5	--	--	--	--	--	209
Northern argid	<i>Argis lar</i>	--	--	--	66	26	--	--	--	--	--	--	--	92
Northern crangon	<i>Crangon alaskensis</i>	--	--	--	--	--	--	--	18	--	--	--	--	18
Deepsea spinyhead	<i>Metacrangon variabilis</i>	--	--	--	--	--	--	--	--	--	--	--	1	1
Horned shrimp	<i>Paracrangon echinata</i>	--	--	--	--	--	7	33	--	--	--	--	--	40
Saddleback shrimp	<i>Rhynocrangon alata</i>	--	--	--	--	--	5	23	--	--	7	--	--	35
Hippolytid shrimps														
Townsend eualid	<i>Eualus townsendi</i>	--	--	--	--	--	6	--	--	--	--	--	--	6
Alaska coastal shrimp	<i>Heptacarpus moseri</i>	--	--	--	--	--	--	--	--	--	--	--	46	46

Table 7. Species composition and numbers of invertebrates captured with bottom trawls during SMMOCI sampling in the central Aleutian Islands, Alaska in 2003 (continued).

Common name	Scientific name	Tow Number												Total
		01 ^a	02	03	04	05	06	07	08	09	10	11	12	
Spiny lebbeid	<i>Lebbeus groenlandicus</i>	--	--	--	--	--	--	5	--	--	--	--	15	20
Rathbun blade shrimp	<i>Spirontocaris arcuata</i>	--	--	--	42	15	8	37	--	--	--	--	18	120
Pandalid shrimps	Pandalidae (unid. juvenile)	--	--	2	--	--	--	--	--	--	--	--	--	2
Yellowleg pandalid	<i>Pandalus tridens</i>	--	2	--	546	47	95	658	--	--	--	--	88	1436
Krill	<i>Euphausia pacifica</i>	--	--	4	--	--	--	--	--	--	--	--	--	4
	<i>Thysanoessa inermis</i>	--	2	2	--	--	--	--	--	--	--	--	--	4
	<i>Thysanoessa inspinata</i>	--	--	2	--	--	--	--	--	--	--	--	--	2
	<i>Thysanoessa longipes</i>	--	--	--	--	--	--	--	--	1	--	--	--	1
	<i>Thysanoessa spinifera</i>	--	--	3	--	--	--	--	--	--	--	--	--	3
Mysids	<i>Exacanthomysis alaskensis</i>	--	--	--	--	--	--	48	--	--	--	--	--	48
	<i>Neomysis rayii</i>	--	--	2	--	--	--	--	--	--	--	--	--	2
Isopods	<i>Arcturus longispinus</i>	--	--	--	1	--	--	--	--	--	--	--	--	1
	<i>Rocinela belliceps</i>	--	--	--	1	--	--	--	--	--	--	--	--	1
Amphipods	Amphipoda, unid.	--	--	--	--	--	--	--	--	--	1	--	--	1
	<i>Ampithoe</i> sp.	--	--	6	--	--	--	--	--	4	--	--	--	10
	<i>Anonyx</i> sp.	--	5	--	156	5	--	--	--	--	--	--	1	167
	<i>Atylus collingi</i>	--	--	--	--	1	--	--	--	--	--	--	--	1
	<i>Boeckosimus</i> sp.	--	--	--	--	--	--	1	--	--	--	--	--	1
	Caprellidae, unid.	--	--	--	--	--	--	--	--	--	1	--	--	1
	<i>Gammaracanthus loricatus</i>	--	--	--	1	1	--	--	--	--	--	--	--	2
	Gammaridea, unid.	--	17	--	--	--	--	--	--	8	--	--	--	25
	<i>Ischyrocerus</i> sp.	--	--	--	--	--	--	3	--	6	1	--	--	10
	<i>Monoculodes crassirostrus</i>	--	33	90	--	10	--	--	--	--	--	--	--	133
	<i>Monoculopsis longicornis</i>	--	--	--	1	1	--	2	--	--	--	--	--	4
	<i>Pleustes</i> sp.	--	--	--	1	--	--	--	--	--	--	--	--	1
	<i>Rhachotropis oculata</i>	--	8	--	--	--	--	--	--	--	--	--	--	8

Table 7. Species composition and numbers of invertebrates captured with bottom trawls during SMMOCI sampling in the central Aleutian Islands, Alaska in 2003 (continued).

Common name	Scientific name	Tow Number												Total
		01 ^a	02	03	04	05	06	07	08	09	10	11	12	
Sea stars														
Flatbottom sea star	<i>Asterias amurensis</i>	--	--	--	--	--	--	1	--	--	--	--	--	1
Orange bat sea star	<i>Ceremaster patagonicus</i>	--	1	--	--	--	1	1	--	--	--	--	--	3
Grooved sea star	<i>Crossaster borealis</i>	--	--	--	1	--	--	--	--	--	--	--	--	1
	<i>Crossaster</i> sp.	--	--	--	16	--	1	9	--	--	--	--	--	26
Pincushion sea star	<i>Diplopteraster multipes</i>	--	--	--	--	--	--	--	--	--	--	--	1	1
Northern sea star	<i>Dipsacaster borealis</i>	--	--	--	--	--	--	5	--	--	--	--	--	5
	<i>Henricia</i> sp.	--	--	--	25	--	1	14	--	--	--	--	--	40
Tumid sea star	<i>Henricia tumida</i>	--	--	--	20	--	--	--	--	1	--	--	--	21
Blackspined sea star	<i>Lethasterias nanimensis</i>	--	--	--	--	--	--	5	--	--	--	--	--	5
Notched brittle star	<i>Ophiura sarsi</i>	--	--	--	--	2	--	--	--	--	--	--	--	2
Obscure sea star	<i>Pteraster obscurus</i>	--	--	--	1	--	--	--	--	--	--	--	--	1
	<i>Pteraster</i> sp.	--	--	--	1	--	--	6	--	--	--	--	--	7
Brittle stars														
Ubiquitous brittle star	<i>Ophiopholis aculeata</i>	--	--	--	3	--	8	335	4	--	--	--	--	350
Notched brittle star	<i>Ophiura sarsi</i>	--	--	1	2	--	12	16	--	--	--	--	--	31
Other Echinoderms														
Slender sea cucumber	<i>Bathyploetes</i> sp.	--	--	--	--	--	1	2	--	--	--	--	--	3
Crescent sea cucumber	<i>Pentamera lissoplaca</i>	--	--	--	--	--	--	2	--	--	--	--	--	2
Green urchin	<i>Strongylocentrotus droebachiensis</i>	--	13	2	221	25	13	124	--	57	--	--	--	455
Moss animals														
	Bryozoa, unid.	--	--	--	2	3	4	3	--	--	--	--	--	12
	<i>Flustra carbasea</i>	--	--	--	1	--	--	--	--	--	--	--	--	1
Urochordates														
Sea onion	<i>Boltenia ovifera</i>	--	--	--	--	--	--	5	--	--	--	--	--	5
Sea peach	<i>Halocynthia aurantium</i>	--	--	--	2	--	--	2	--	--	--	--	--	4
Salp	Salpida, unid.	--	--	--	1	--	--	--	--	--	--	--	--	1
Tunicate	Tunicata, unid.	--	--	--	10	1	1	8	--	--	--	--	--	20
Other Invertebrates														
Lamp shell	Brachiopoda, unid.	--	--	--	--	--	--	8	--	--	--	--	--	8
Arrow worm	<i>Eukrohnia hamata</i>	--	--	1	--	--	--	--	--	--	--	--	--	1

^aBOTR-01 was not quantified for invertebrates or fishes

Table 8. Species composition and numbers of fishes captured with bottom trawls during SMMOCI sampling in the central Aleutian Islands, Alaska in 2003.

Common Name	Scientific Name	Tow Number												Total
		01	02	03	04	05	06	07	08	09	10	11	12	
Fish egg mass		--	--	--	2	--	--	--	--	--	--	--	--	2
Pacific cod	<i>Gadus macrocephalus</i>	--	--	--	--	--	--	--	1	--	--	--	--	1
Walleye pollock	<i>Theragra chalcogramma</i>	--	--	1	--	--	--	--	--	--	--	--	--	1
Sharpchin rockfish	<i>Sebastes zacentrus</i>	--	--	--	--	--	2	--	--	--	--	--	--	2
Unid. rockfish	<i>Sebastes</i> sp.	--	--	--	--	--	--	1	--	--	--	--	--	1
	<i>Hexagrammos</i>													
Kelp greenling	<i>decagrammus</i>	--	--	--	--	--	--	--	--	1	--	--	--	1
	<i>Hexagrammos</i>													
Rock greenling	<i>lagocephalus</i>	--	--	--	--	--	--	--	--	3	--	--	--	3
	<i>Pleurogrammus</i>													
Atka mackerel	<i>monopterygius</i>	--	--	--	--	--	--	--	--	1	--	--	--	1
Sculpin post-larva	Cottidae	--	--	--	--	--	--	--	--	--	--	1	--	1
Armorhead sculpin	<i>Gymnocanthus galeatus</i>	--	--	--	1	--	--	--	--	--	--	--	--	1
Yellow Irish lord	<i>Hemilepidotus jordani</i>	--	--	--	--	2	--	--	--	--	3	--	--	5
Unid. sculpin	<i>Hemilepidotus</i> sp.	1	--	--	85	--	--	--	--	--	--	--	--	86
Northern sculpin	<i>Icelinus borealis</i>	--	1	14	--	6	2	19	4	--	--	--	--	46
Unid. sculpin	<i>Icelinus cf. borealis</i>	--	--	--	9	--	--	--	--	--	--	--	--	9
Antlered sculpin	<i>Enophrys diceraus</i>	--	--	--	2	--	--	--	--	--	--	--	--	2
	<i>Myoxocephalus</i>													
Great sculpin	<i>polyacanthocephalus</i>	--	--	--	6	--	--	1	--	--	--	--	--	7
Eyeshade sculpin	<i>Nautichthys pribilovius</i>	--	--	--	3	--	--	1	--	--	--	--	--	4
Roughskin sculpin	<i>Rastrinus scutiger</i>	--	--	--	--	1	--	--	--	--	--	--	--	1
Unid. sculpin	<i>Triglops</i> sp.	--	--	--	83	--	--	--	--	--	--	--	1	84
Highbrow sculpin	<i>Triglops metopias</i>	--	--	--	--	--	--	--	1	--	--	--	--	1
Scissortail sculpin	<i>Triglops forficatus</i>	--	--	--	5	--	--	--	--	--	--	--	--	5
Roughspine sculpin	<i>Triglops macellus</i>	--	2	--	--	--	--	--	--	--	--	--	--	2

Table 8. Species composition and numbers of fishes captured with bottom trawls during SMMOCI sampling in the central Aleutian Islands, Alaska in 2003 (continued).

Common Name	Scientific Name	Tow Number												Total
		01	02	03	04	05	06	07	08	09	10	11	12	
Ribbed sculpin	<i>Triglops pingelii</i>	--	--	--	--	1	--	--	--	--	23	--	--	24
Spectacled sculpin	<i>Triglops szepticus</i>	--	--	--	--	5	--	--	--	--	--	--	1	6
Scalybreasted sculpin	<i>Triglops xenostethus</i>	--	--	--	10	--	--	--	--	--	--	--	--	10
Smooth alligatorfish	<i>Anoplagonus inermis</i>	--	--	--	2	1	--	--	--	--	--	--	--	3
Alligatorfish	<i>Aspidophoroides monopterygius</i>	--	--	--	--	1	--	--	--	--	--	--	--	1
Fourhorn poacher	<i>Hypsagonus quadricornis</i>	--	--	--	1	--	3	30	--	--	--	--	--	34
Longnose poacher	<i>Sarritor leptorhynchus</i>	--	--	--	2	--	--	--	--	--	--	--	--	2
Pacific spiny lumpsucker	<i>Eumicrotremus orbis</i>	--	--	--	--	--	--	1	--	--	--	--	--	1
Docked snailfish	<i>Lethotremus muticus</i>	--	--	--	7	--	--	1	--	--	--	--	--	8
Unid. snailfishes	<i>Careproctus</i> spp.	--	--	--	5	--	--	3	--	--	--	--	--	8
Blotched snailfish	<i>Crystallichthys cyclospilus</i>	--	--	--	5	2	--	--	--	--	1	--	--	8
Snailfish: Liparis sp.	<i>Liparis</i> sp.	--	--	--	57	27	--	--	--	--	--	--	1	85
Lobefin snailfish	<i>Liparis greeni</i>	--	--	--	--	--	--	--	--	2	--	--	--	2
Unid. ronquil	<i>Bathymaster</i> sp.	--	--	--	2	--	--	--	--	--	1	--	--	3
Searcher	<i>Bathymaster signatus</i>	--	--	--	1	--	1	2	--	--	--	--	--	4
Nutcracker														
prickleback	<i>Bryozoichthys lysimus</i>	--	--	--	--	--	--	1	--	--	--	--	--	1
Pacific sand lance	<i>Ammodytes hexapterus</i>	--	--	9	--	--	--	--	--	--	--	--	--	9
Arrowtooth flounder	<i>Atheresthes stomias</i>	--	--	1	--	1	--	1	--	--	--	--	--	3
Flathead sole	<i>Hippoglossoides elassodon</i>	--	--	1	--	--	--	--	--	--	--	--	--	1
Pacific halibut	<i>Hippoglossus stenolepis</i>	--	--	--	--	--	--	--	3	--	--	--	--	3
Northern rock sole	<i>Lepidopsetta polyxystra</i>	--	7	69	12	--	--	--	23	--	--	--	1	112

Table 9. Total lengths (mm) of species captured with bottom trawls during SMMOCI sampling in the central Aleutian Islands, Alaska in 2003.

Species	Mean	SD ^a	Range	n ^a
Pacific cod	48.0	--	--	1
Walleye pollock	65.0	--	--	1
Sharpchin rockfish	89.0	8.5	83-95	2
Kelp greenling	85.0	--	--	1
Rock greenling	389.7	18.0	369-402	3
Atka mackerel	403.0	--	--	1
Antlered sculpin	23.5	2.1	22-25	2
Armorhead sculpin	119.0	--	--	1
Yellow Irish lord	53.6	5.4	45-59	5
Northern sculpin	46.7	17.4	17-72	46
Great sculpin	83.0	146.4	23-415	7
Roughskin sculpin	57.0	--	--	1
Scissortail sculpin	164.4	8.4	153-175	5
Roughspine sculpin	183.5	43.1	153-214	2
Highbrow sculpin	72.0	--	--	1
Ribbed sculpin	73.0	6.8	60-87	24
Spectacled sculpin	82.8	8.9	71-95	6
Scalybreasted sculpin	84.6	6.7	78-97	10
Eyeshade sculpin	46.5	31.8	28-94	4
Smooth alligatorfish	63.0	31.4	27-85	3
Alligatorfish	82.0	--	--	1
Fourhorn poacher	46.0	9.4	31-74	34
Longnose poacher	89.5	9.2	83-96	2
Pacific spiny lumpsucker	65.0	--	--	1
Docked snailfish	25.9	6.6	17-40	8
Blotched snailfish	42.5	10.1	33-65	8
Lobefin snailfish	114.2	166.1	17.5-306	3
Searcher	148.0	71.3	70-243	4
Nutcracker prickleback	120.0	--	--	1
Pacific sand lance	62.7	7.2	50-73	9
Arrowtooth flounder	187.3	126.8	42-275	3
Flathead sole	32.0	--	--	1
Pacific halibut	30.7	8.5	22-39	3
Northern rock sole	74.2	103.3	17-413	112

^aSD = Standard deviation, n = Sample size.

Table 10. Species composition and numbers of fishes captured with long-line gear during SMMOCI sampling in the central Aleutian Islands, Alaska in 2003.

Common Name	Scientific Name	Set Number			Total
		01 (46-59) ^a	02 (46-75)	03 (69-75)	
Alaska skate	<i>Bathyraja parmifera</i>		6		6
Pacific cod	<i>Gadus macrocephalus</i>	12	25	37	74
Dusky rockfish	<i>Sebastes ciliatus</i>	1		1	2
Yellow Irish lord	<i>Hemilepidotus jordani</i>		3		3
Pacific halibut	<i>Hippoglossus stenolepis</i>		10	2	12

^aNumbers in parentheses represent gear depth in meters.

Table 11. Total lengths and weights of species captured with long-line gear during SMMOCI sampling in the central Aleutian Islands, Alaska in 2003.

Species	Sex	Length (mm)				Weight (grams)			
		Mean	SD ^a	Range	n ^a	Mean	SD ^a	Range	n ^a
Alaska skate	All	908.2	145.9	665-1060	6				
	Male	755.0	127.3	665-845	2				
	Female	984.8	81.2	914-1060	4				
Pacific cod	All	749.3	113.4	500-980	74	5500.0	2511.6	1000-11,000	74
	Male	715.5	120.1	500-900	27	4870.4	2662.4	1000-10,500	27
	Female	768.7	105.8	526-980	47	5861.7	2374.5	1500-11,000	47
Dusky rockfish	All	468.5	30.4	447-490	2				
Yellow Irish lord	All	433.3	68.2	390-512	3				
Pacific halibut	All	820.5	127.2	629-990	12	6708.3	2872.0	2500-10,000	12
	Male	816.8	138.8	629-990	5	6700.0	3271.1	2500-10,000	5
	Female	823.1	129.6	634-970	7	6714.3	2826.3	3000-10,000	7

^a SD = Standard deviation, n = Sample size.

Table 12. Prey composition of stomach samples taken from Pacific halibut caught during long-line sets in the central Aleutian Islands, Alaska in 2003 ($n = 6$ non-empty stomachs).

Prey Name	%FO ^a	%WT ^a
Polychaeta (worm)	16.67	19.68
Bivalvia (clam)	16.67	1.05
Gammaridea (amphipod)	16.67	3.47
Paguridae (hermit crab)	16.67	14.69
<i>Chionoecetes</i> sp. (snow and Tanner crabs)	16.67	3.01
Osteichthyes Teleostei (fish)	16.67	0.14
Non-gadoid fish remains	16.67	3.91
<i>Theragra chalcogramma</i> (walleye pollock)	16.67	54.04

^a%FO = Percent frequency of occurrence, %WT = Percent total weight.

Table 13. Prey composition of stomach samples taken from Pacific cod caught during long-line sets in the central Aleutian Islands, Alaska in 2003 ($n = 67$ non-empty stomachs).

Prey Name	%FO ^a	%WT ^a
Hydrozoa Hydroida (hydroid)	1.49	0.03
Polychaeta (worm)	5.97	0.05
Nephtyidae (polychaete)	2.99	0.82
Gastropoda (snail)	2.99	0.01
<i>Natica</i> sp. (moon snail)	1.49	0.01
Bivalvia (clam)	2.99	0.03
Octopoda (octopus)	5.97	0.8
Isopoda (isopod)	4.48	0.15
Gammaridea (amphipod)	13.43	0.14
Caridea (shrimp)	1.49	0.01
Hippolytidae (shrimp)	16.42	0.68
Pandalidae (shrimp)	23.88	0.97
<i>Pandalus</i> sp. (shrimp)	2.99	0.4
<i>Pandalus stenolepis</i> (shrimp)	23.88	2.23
Crangonidae (shrimp)	1.49	0.03
Paguridae (hermit crab)	7.46	0.46
<i>Paralithodes camtschatica</i> (red king crab)	1.49	0.19
<i>Oregonia gracilis</i> (decorator crab)	2.99	0.2
<i>Telmessus cheiragonus</i> (hair crab)	1.49	1.05
Ophiuroidea Ophiurida (brittle star)	2.99	0.27
Echinoidea (sea urchin and sand dollar)	2.99	1.95
Osteichthyes Teleostei (fish)	2.99	0.11
Non-gadoid fish remains	13.43	10.19
Gadidae (gadid fish)	5.97	2.05
<i>Gadus macrocephalus</i> (Pacific cod)	1.49	2.94
<i>Theragra chalcogramma</i> (walleye pollock)	14.93	28.1
<i>Sebastes</i> sp. (rockfish)	5.97	7.61
<i>Sebastes alutus</i> (Pacific ocean perch)	4.48	25.52
<i>Sebastes zacentrus</i> (sharpchin rockfish)	1.49	0.89
<i>Pleurogrammus monopterygius</i> (Atka mackerel)	4.48	10.87
Cottoidei (sculpin)	11.94	1.16
Pleuronectidae (flatfish)	2.99	0.07

^a%FO = Percent frequency of occurrence, %WT = Percent total weight.

Table 14. Counts of individuals captured with plankton tows during SMMOCI sampling in the central Aleutian Islands in 2003.

	Haul ^a	NU-1		NU-2		VT-1		VT-2 ^b		VT-3	
	Split (%)	12.5	100	12.5	100	1.6	100	1.6	1.6	100	
Phylum Cnidaria, Class Hydrozoa (jellyfishes)											
Subclass Siphonophorae (bract)	P ^c	--	--	P	--	--	--	--	--	--	--
Phylum Mollusca, Class Gastropoda (snails, pteropods, etc.)											
Gastropod (juvenile)		--	--	--	1	--	--	--	--	--	--
<i>Limacina helicina</i>		--	--	--	--	1	--	1	1	1	
Phylum Annelida, Class Polychaeta (bristleworms)											
<i>Autolytis</i> sp.		--	--	1	1	--	--	--	--	--	
Phylum Arthropoda, Class Insecta											
Class Insecta		--	--	2	--	--	--	--	--	--	
Order Diptera		--	--	--	--	--	1	--	--	--	
Phylum Arthropoda, Subphylum Crustacea											
Class Cirripedia (barnacles)											
Cirripedia (nauplius)		--	--	--	--	1	--	--	--	--	
Class Copepoda (copepods)											
Order Calanoida											
<i>Acartia longiremus</i>		9	--	124	--	1	--	1	--	--	
<i>Acartia tumida</i>		3	--	12	--	--	--	--	--	--	
<i>Centropages abdominalis</i>		3	--	3	--	--	--	--	--	--	
<i>Eucalanus bungii</i>		39	--	3	2	111	6	75	67	4	
<i>Metridia pacifica</i>		--	--	--	--	--	--	2	--	--	
<i>Neocalanus flemengeri</i>		--	--	--	--	2	--	5	1	--	
<i>Neocalanus plumchrus</i>		5	--	6	--	5	--	3	2	--	

Table 14. Counts of individuals captured with plankton tows during SMMOCI sampling in the central Aleutian Islands in 2003 (continued).

	Haul ^a	NU-1		NU-2		VT-1		VT-2 ^b		VT-3	
	Split (%)	12.5	100	12.5	100	1.6	100	1.6	1.6	1.6	100
Class Copepoda (copepods)											
Order Calanoida (continued)											
<i>Neocalanus</i> spp.	100	--	--	--	--	14	--	15	8	--	--
<i>Pseudocalanus</i> sp.	--	--	--	--	--	1	--	3	1	--	--
Order Harpacticoida											
<i>Harpacticus</i> sp.	--	--	1	--	--	--	--	--	--	--	--
Class Malacostraca, Order Amphipoda											
Order Amphipoda											
<i>Hyperia medusarum</i>	--	--	--	1	--	--	--	--	1	--	--
<i>Hyperia</i> sp. (juvenile)	--	--	--	--	--	--	2	--	--	--	--
<i>Mimonectes</i> sp.	--	--	1	--	--	--	--	--	--	--	--
<i>Parathemisto pacifica</i>	--	--	--	--	--	--	--	--	--	--	1
Suborder Hyperiididae (juvenile)	--	--	--	--	--	5	--	1	--	--	--
Class Malacostraca, Order Decapoda (crabs, shrimps)											
Infraorder Caridea (juvenile)	--	--	--	--	--	--	--	2	--	--	--
Family Atelecyclidae (megalops)	--	2	--	1	--	--	--	--	--	--	--
Class Malacostraca, Order Euphausiacea (krill / euphausiids)											
<i>Thysanoessa longipes</i>	--	--	--	1	--	--	--	--	--	--	--
<i>Thysanoessa raschii</i>	--	--	--	--	--	--	2	--	--	--	--
<i>Thysanoessa raschii</i> (juvenile)	--	--	--	--	--	2	--	4	--	2	--

Table 14. Counts of individuals captured with plankton tows during SMMOCI sampling in the central Aleutian Islands in 2003 (continued).

		Haul ^a		NU-1		NU-2		VT-1		VT-2 ^b		VT-3	
		Split (%)		12.5	100	12.5	100	1.6	100	1.6	1.6	1.6	100
Class Malacostraca, Order Euphausiacea (krill / euphausiids) (continued)													
	<i>Thysanoessa spinifera</i>	--	--	--	1	--	--	--	--	--	--	--	--
	Order Euphausiacea (calytopsis)	--	--	--	--	3	--	2	1	--	--	--	--
	Order Euphausiacea (furcilia)	--	--	--	--	--	--	--	--	2	--	--	--
	Order Euphausiacea (juvenile)	--	--	--	--	--	--	1	--	--	--	--	--
Phylum Chaetognatha (arrowworms)													
	<i>Eukhronia hamata</i>	15	--	2	1	--	--	--	10	1	--	--	--
	<i>Sagitta elegans</i>	1	--	2	--	3	--	1	--	--	--	--	--
Phylum Chordata, Subphylum Urochordata (tunicates)													
	<i>Oikopleura</i> sp.	--	--	--	--	8	--	16	24	--	--	--	--
Phylum Chordata, Subphylum Vertebrata													
Fish eggs	Fish egg <1 mm	1	--	--	--	--	--	--	--	--	--	--	--
	Fish egg 2-3 mm	--	--	18	--	--	--	--	--	--	--	--	--
	Fish egg 2-3 mm (rotten)	--	--	41	--	1	1	--	--	--	--	--	--
Fishes	<i>Anoplopoma fimbria</i> , Sablefish	--	--	--	1	--	--	--	--	--	--	--	--
	Family Stichaeidae, Prickleback	--	1	--	--	--	--	--	--	--	--	--	--
	Teleostei (larva)	--	--	--	--	--	--	--	--	--	--	2	--
Plants													
	Filamentous algae clumps	1	--	--	--	--	--	--	--	--	--	--	--

^aNU = neuston tow, VT = vertical (bongo) tow.

^bNo animals were noticeably uncommon in VT-2.

^cP = present but not enumerated.

Table 15. Locations (decimal degrees), times and dates of CTD casts made in the central Aleutian Islands, Alaska in 2003.

Cast	Latitude (N)	Longitude (W)	Date	Time ^a	Depth ^b (m)	Notes ^c
000	52.2447°	175.1439°	30 July	15:12	86 (>250)	VERT 01, NEUS 01
001	52.2426°	175.1293°	30 July	20:41	77 (274)	MWTR 01 (end)
002	52.2165°	175.1426°	30 July	21:51	19 (29)	BOTR 01 (start)
003	52.2097°	175.1349°	30 July	22:32	54 (58)	BOTR 02 (start)
004	52.2075°	175.1450°	30 July	23:18	79 (117)	BOTR 02 (end)
005	52.2170°	175.1219°	31 July	00:07	26 (32)	BOTR 03 (start)
007	52.2490°	175.3403°	31 July	09:45	78 (>250)	TX 12, Sta. 1
009	52.2156°	175.3341°	31 July	10:09	80 (>250)	TX 12, Sta. 2
011	52.1446°	175.3331°	31 July	10:51	80 (181)	TX 12, Sta. 3
012	52.1130°	175.3351°	31 July	11:11	79 (128)	TX 12, Sta. 4
013	52.0793°	175.3321°	31 July	11:31	80 (104)	TX 12, Sta. 5
016	52.0445°	175.3358°	31 July	11:54	48 (68)	TX 12, Sta. 6
017	52.0246°	175.5577°	31 July	19:51	82 (103)	MWTR 03 (start) VERT 02 (end)
018	52.0278°	175.5356°	31 July	21:56	79 (90)	MWTR 04 (end)
019	52.1250°	175.4703°	31 July	22:51	69 (75)	BOTR 04 (start)
020	52.1398°	175.5419°	01 Aug.	03:15	79 (98)	BOTR 05 (start)
021	52.1507°	175.4975°	01 Aug.	08:54	10 (20)	TX 09, Sta. 1
022	52.1165°	175.4993°	01 Aug.	09:11	39 (54)	TX 09, Sta. 2
023	52.0825°	175.5002°	01 Aug.	09:30	49 (65)	TX 09, Sta. 3
024	52.0726°	175.8860°	01 Aug.	20:02	80 (100)	BOTR 06 (end)
025	52.0667°	175.9464°	01 Aug.	20:49	80 (108)	BOTR 07 (end)
026	52.0458°	175.9878°	01 Aug.	22:12	16 (17)	BOTR 08 (end)
027	52.1207°	175.8874°	02 Aug.	06:47	43 (90)	MWTR 05 (end)
028	52.1588°	175.8803°	02 Aug.	07:26	79 (318)	VERT 03
029	52.0329°	175.9174°	02 Aug.	09:23	20 (32)	TX 26, Sta. 1
030	52.0504°	175.9227°	02 Aug.	09:36	79 (125)	TX 26, Sta. 2
031	52.0837°	175.9196°	02 Aug.	09:58	78 (95)	TX 26, Sta. 3
032	52.1172°	175.9173°	02 Aug.	10:20	79 (90)	TX 26, Sta. 4
033	52.1489°	175.9158°	02 Aug.	12:36	72 (88)	TX 26, Sta. 5
034	52.1850°	175.9151°	02 Aug.	13:02	80 (894)	TX 26, Sta. 6
035	52.0082°	175.5001°	02 Aug.	15:30	59 (65)	TX 09, Sta.4
036	52.0414°	175.5004°	02 Aug.	15:52	79 (85)	TX 09, Sta. 5
037	52.0728°	175.5001°	02 Aug.	16:12	61 (64)	TX 09, Sta. 6
100	52.1507°	175.5035°	02 Aug.	22:40	18 (21)	BOTR 09 (end)
101	52.1355°	175.5132°	02 Aug.	23:40	45 (47)	BOTR 10 (end)

Table 15. Locations (decimal degrees), times and dates of CTD casts made in the central Aleutian Islands, Alaska in 2003 (continued).

Cast	Latitude (N)	Longitude (W)	Date	Time ^a	Depth ^b (m)	Notes ^c
102	52.1952°	175.1460°	03 Aug.	02:33	84 (143)	BOTR 12 (end)
103	52.2373°	175.1664°	03 Aug.	05:57	83 (389)	MWTR 06 (end)
104	52.2562°	175.2285°	03 Aug.	07:01	79 (1200)	MWTR 07 (end)
105	52.3084°	174.9990°	03 Aug.	09:17	49 (1737)	TX 16, Sta. 1
107	52.2397°	175.0023°	03 Aug.	10:04	58 (1117)	TX 16, Sta. 2

^aAll times are Aleutian Daylight (Universal Coordinated Time minus 9 hours).

^bDepth of cast. Values in parentheses are bottom depth at cast location.

^cTX = Transect, MWTR = Mid-water Trawl, BOTR = Bottom Trawl, VERT = Vertical Plankton Tow, NEUS = Neuston (surface) Tow.

Table 16. Estimates of at-sea densities of seabirds near colonies at several Alaskan sites. Data are from cruises similar to the 2003 cruise discussed here and were gathered using similar procedures.

Colony Area	# birds/km ²	Reference
Cape Thompson / Chukchi Sea	54	Piatt et al. 1990
Norton Sound / Northeastern Bering Sea	13	Dragoo 2006 <i>b</i>
Pribilof Islands / Southeast Bering Sea (1997)	51	Dragoo and Byrd 1998
Pribilof Islands / Southeast Bering Sea (2005)	65 ^a	D. Dragoo Unpubl. Data
Buldir Island / Western Aleutians	145	Dragoo and Byrd 1999
Kasatochi Island / Central Aleutians (1996)	110	Drew et al. 2003
Kasatochi Island / Central Aleutians (2003)	118	This Study
Aiktak Island / Unimak Pass, Eastern Aleutians	38	Byrd et al. 1997
Semidi Islands / Northern Gulf of Alaska (2001)	93 ^b	Dragoo 2006 <i>a</i>
Semidi Islands / Northern Gulf of Alaska (2004)	68	Dragoo 2006 <i>a</i>
Barren Islands / Lower Cook Inlet (1992)	174	Piatt 1994
Barren Islands / Lower Cook Inlet (1996)	126	Piatt 2003
Glacier Bay/ Southeast Alaska	21	Robards et al. 2003
St. Lazaria/ Sitka Sound, Southeast Alaska	18	Piatt and Dragoo 2005

^aDoes not include the circumnavigation of St. George Island. Bird density including St. George Island circumnavigation was 99 birds/km².

^bDoes not include a flock of approximately 50,000 shearwaters observed on transect. Bird density including this large flock of shearwaters was 476 birds/km².

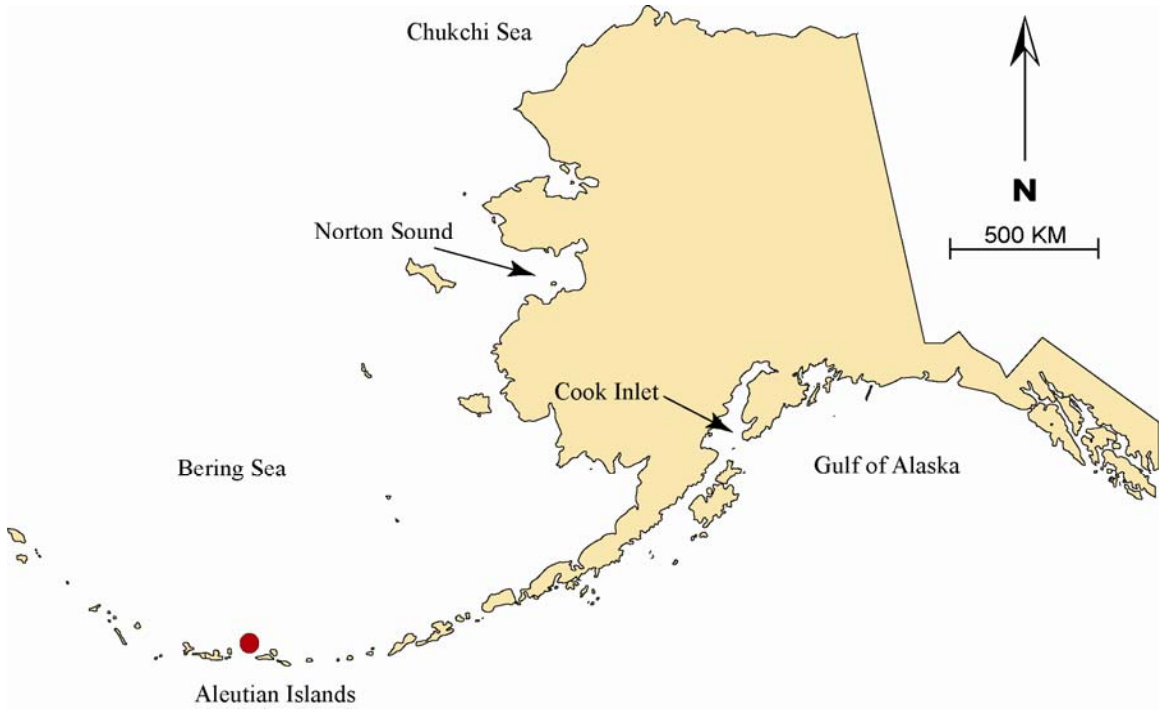


Figure 1. Map of Alaska showing the location of the central Aleutian Islands study area (red dot).

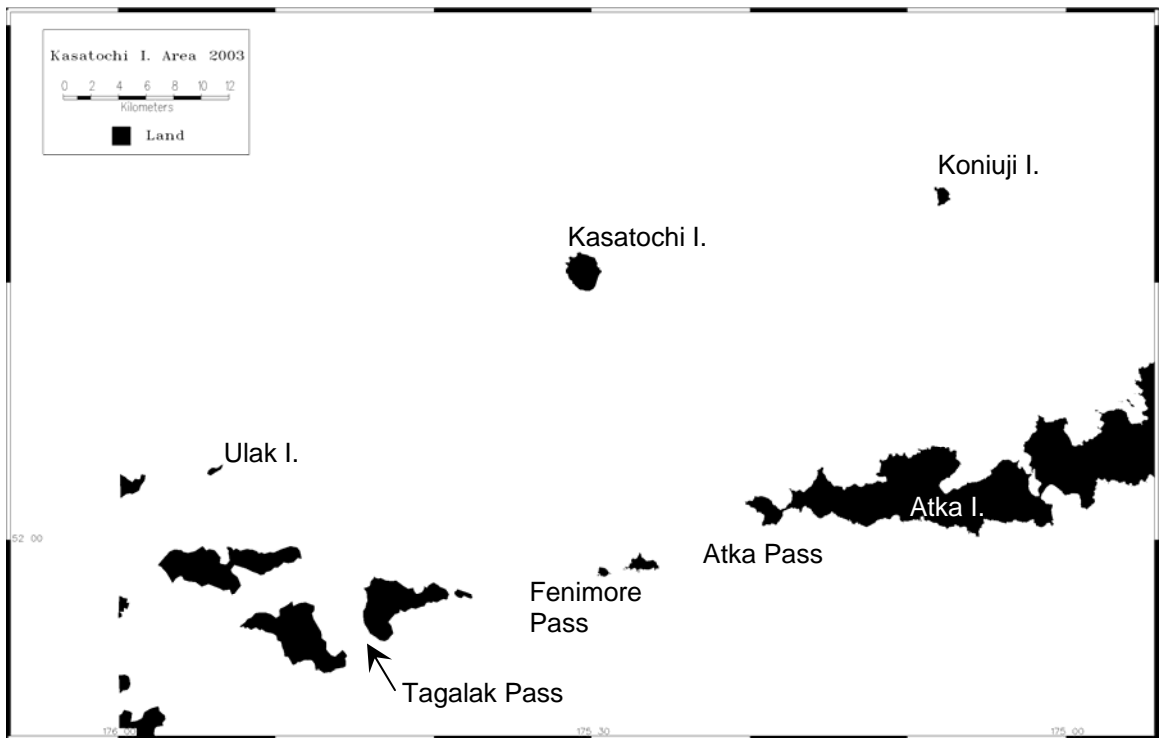


Figure 2. Map of central Aleutian Islands study area.

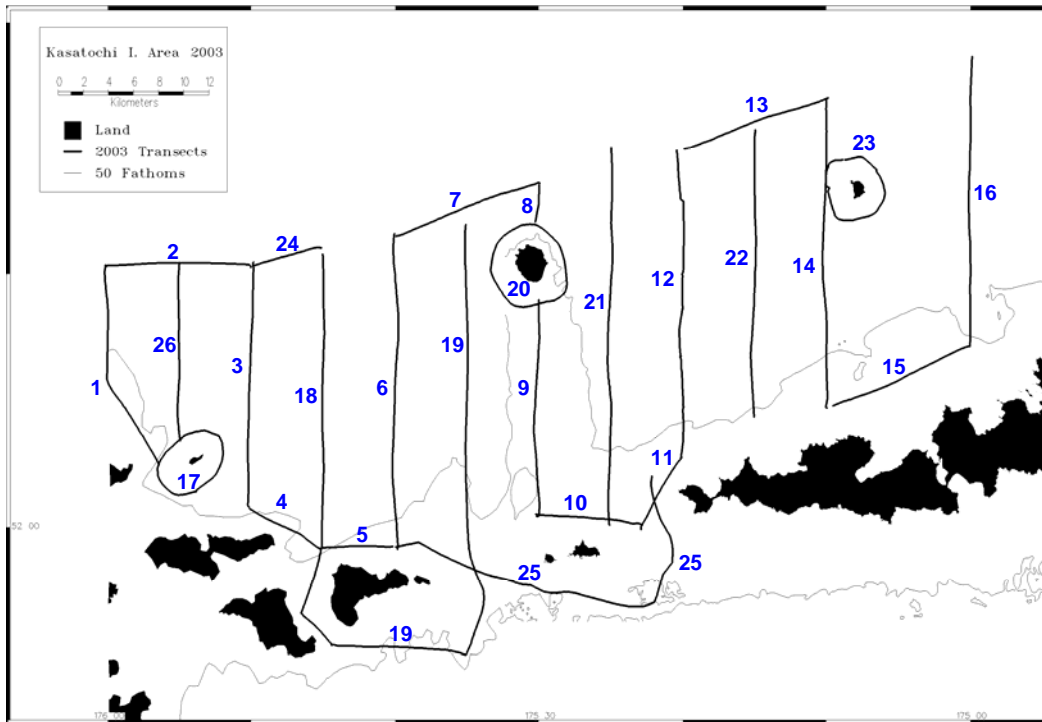


Figure 3. Map of transects surveyed near Ulak, Kasatochi and Koniuji islands, Alaska in 2003. Transects shown were derived from GPS positions recorded during surveys.

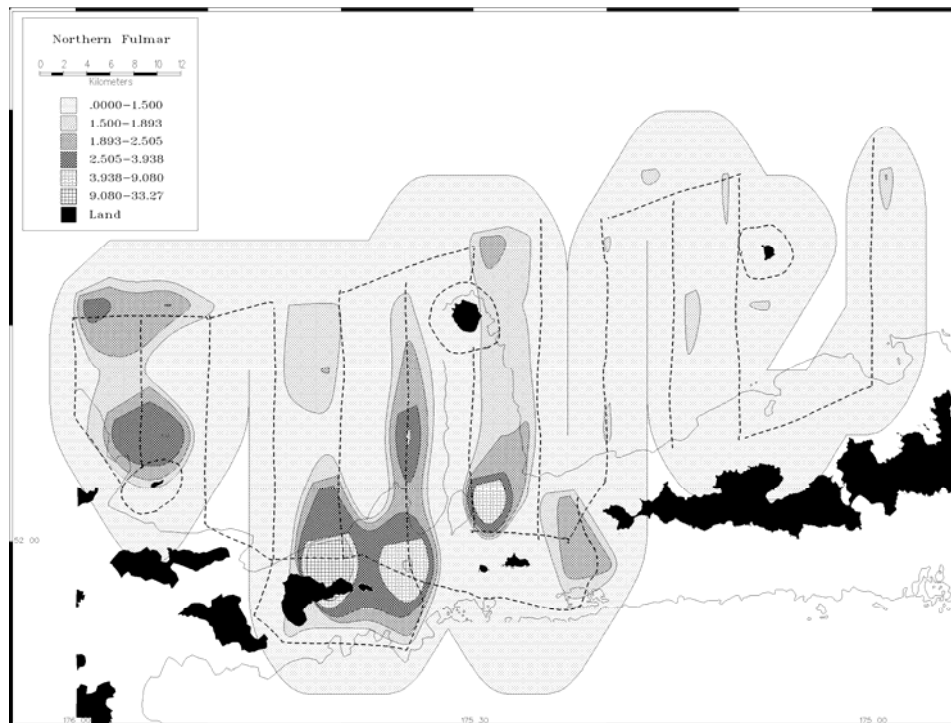


Figure 4. Distribution of northern fulmars on transects surveyed in the central Aleutian Islands, Alaska in 2003. Includes birds on water and flying.

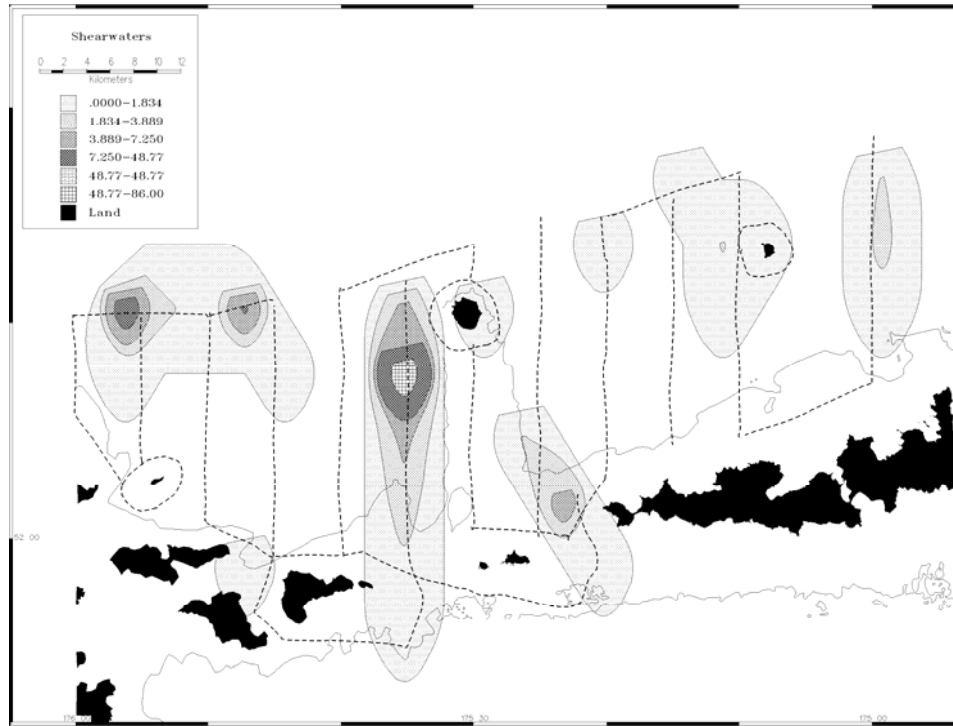


Figure 5. Distribution of shearwaters (species combined) on transects surveyed in the central Aleutian Islands, Alaska in 2003. Includes birds on water and flying.

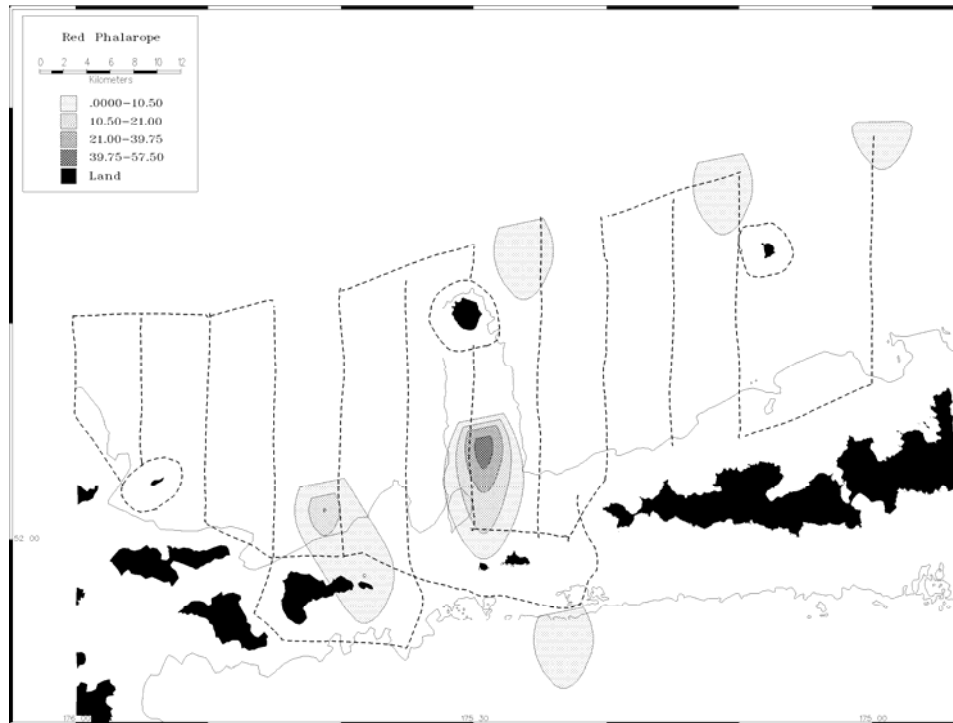


Figure 6. Distribution of red phalaropes on transects surveyed in the central Aleutian Islands, Alaska in 2003. Includes birds on water and flying.

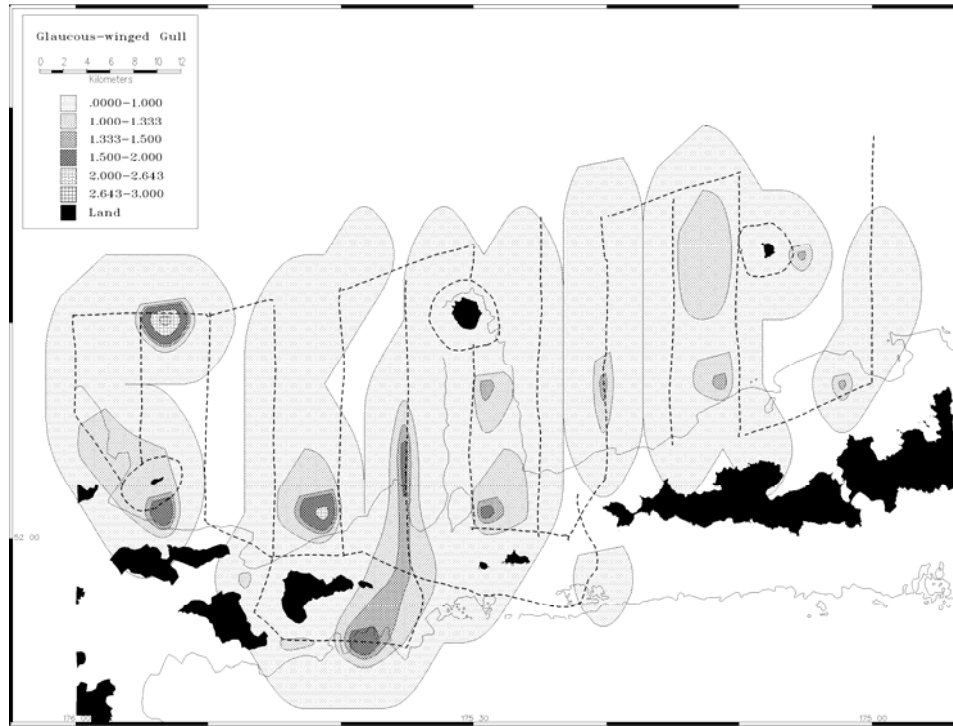


Figure 7. Distribution of glaucous-winged gulls on transects surveyed in the central Aleutian Islands, Alaska in 2003. Includes birds on water and flying.

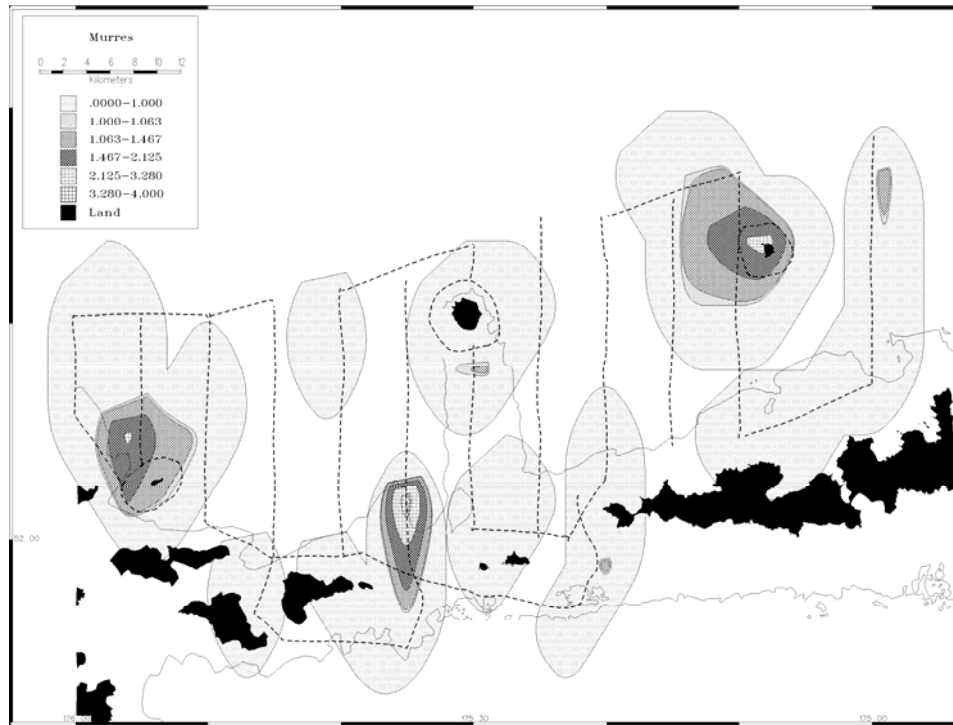


Figure 8. Distribution of murres (species combined) on transects surveyed in the central Aleutian Islands, Alaska in 2003. Includes birds on water and flying.

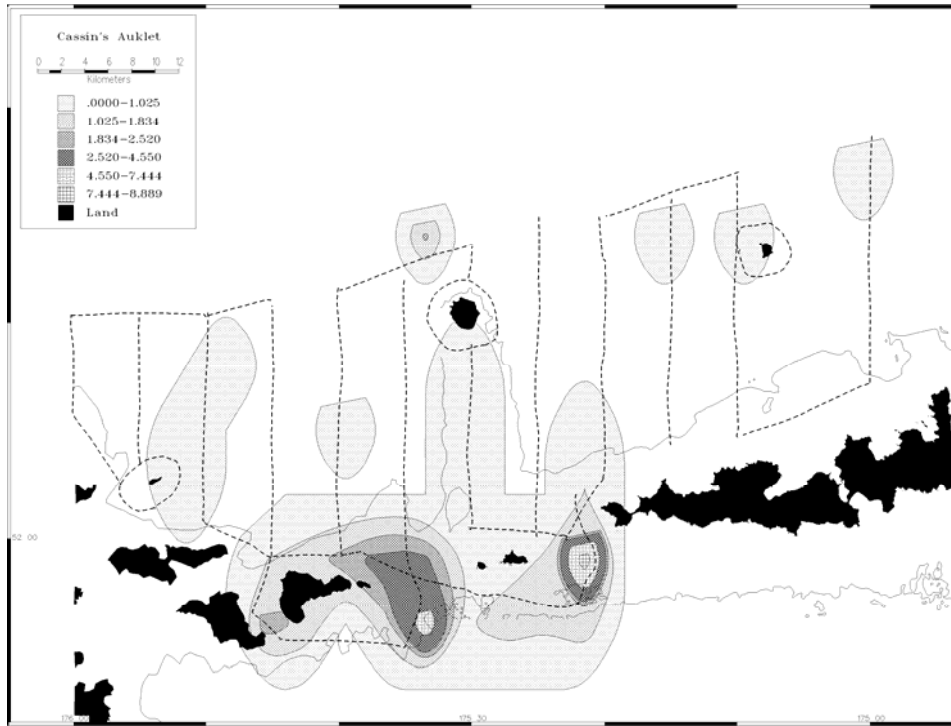


Figure 9. Distribution of Cassin's auklets on transects surveyed in the central Aleutian Islands, Alaska in 2003. Includes birds on water and flying.

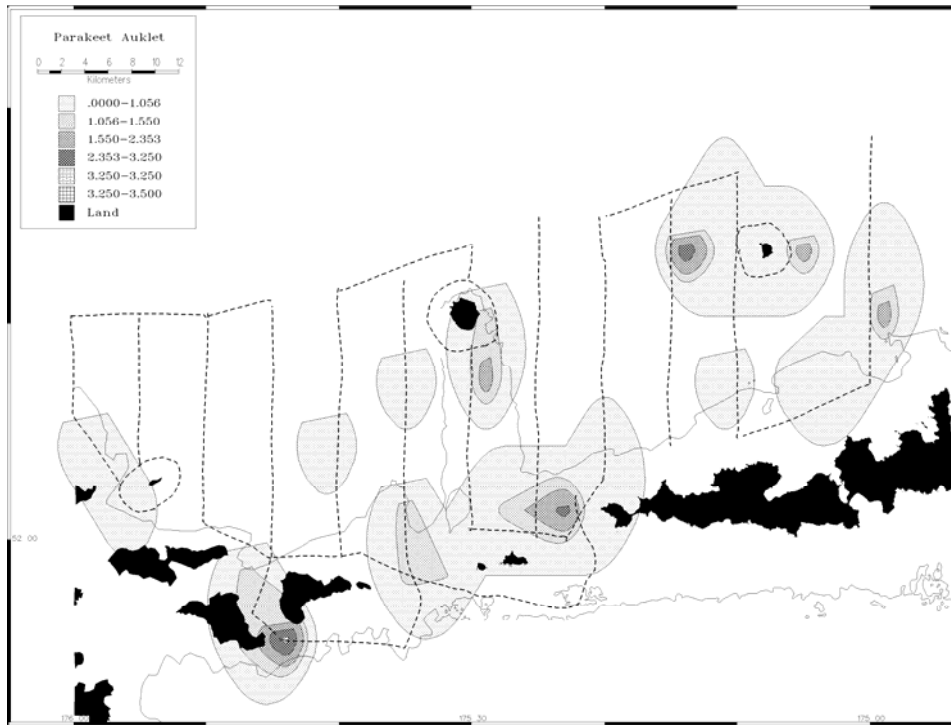


Figure 10. Distribution of parakeet auklets on transects surveyed in the central Aleutian Islands, Alaska in 2003. Includes birds on water and flying.

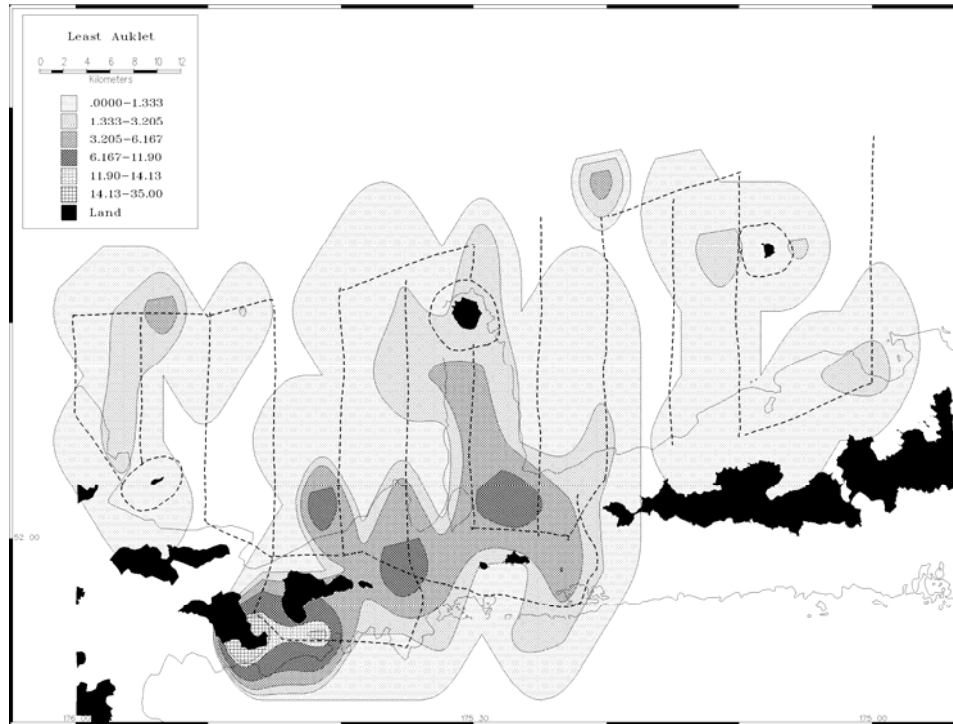


Figure11. Distribution of least auklets on transects surveyed in the central Aleutian Islands, Alaska in 2003. Includes birds on water and flying.

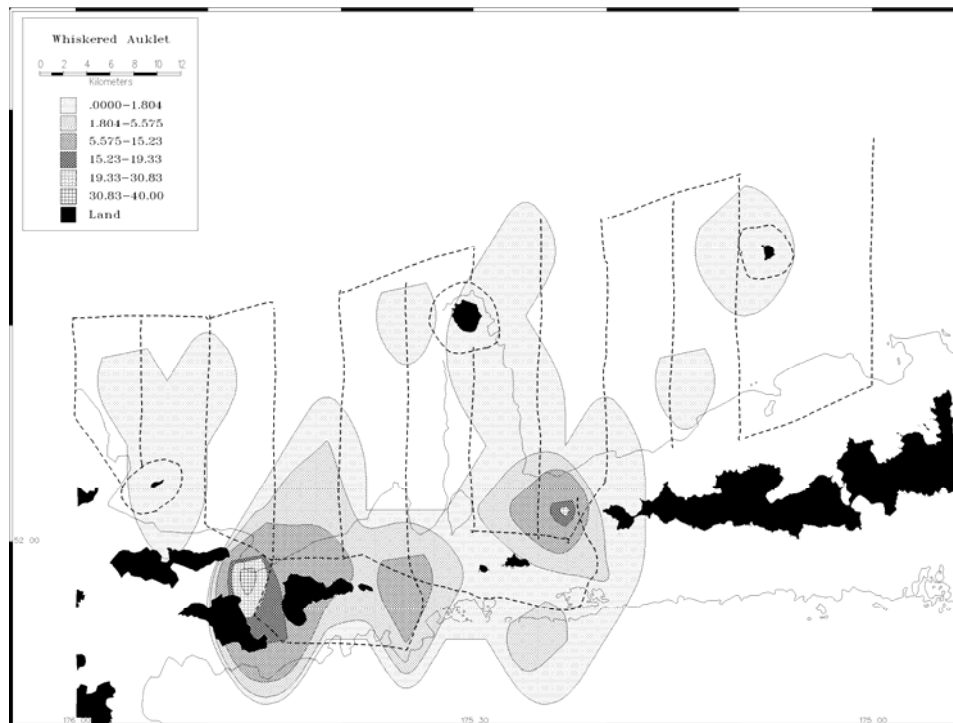


Figure12. Distribution of whiskered auklets on transects surveyed in the central Aleutian Islands, Alaska in 2003. Includes birds on water and flying.

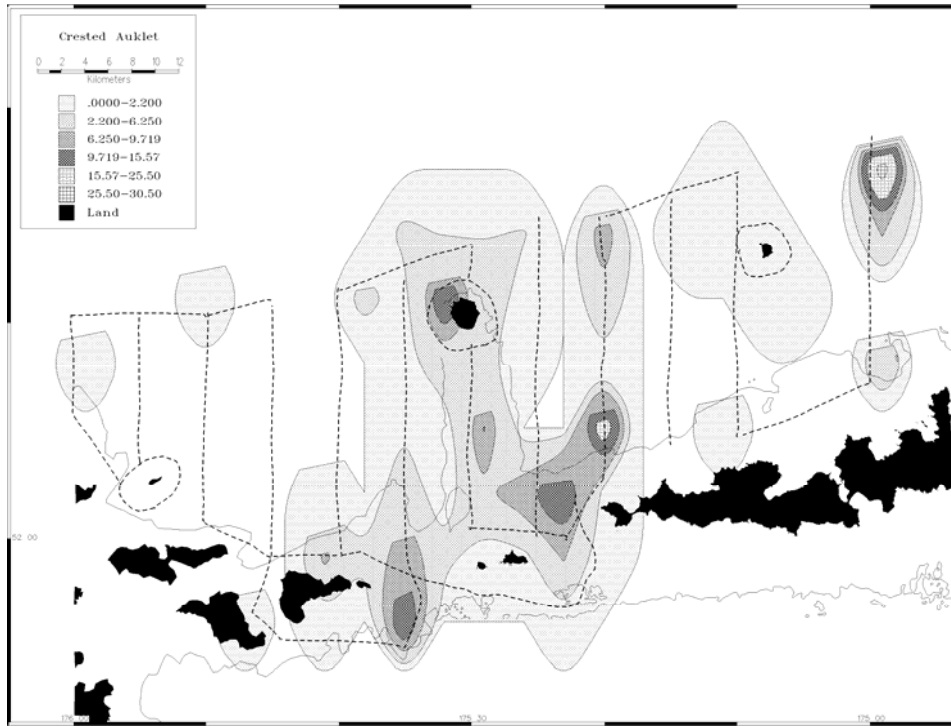


Figure 13. Distribution of crested auklets on transects surveyed in the central Aleutian Islands, Alaska in 2003. Includes birds on water and flying.

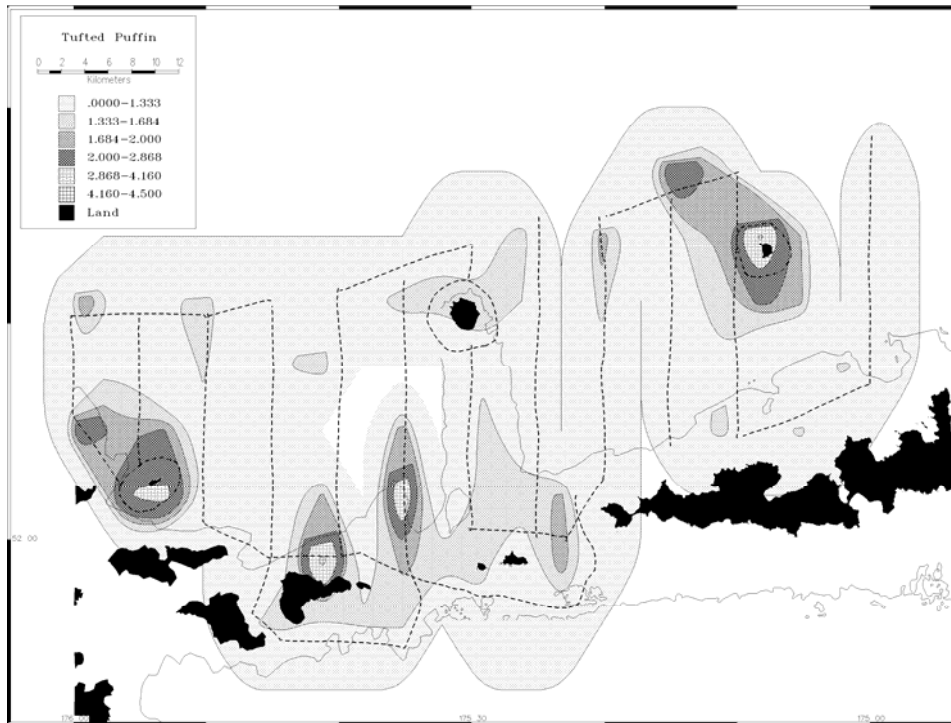


Figure 14. Distribution of tufted puffins on transects surveyed in the central Aleutian Islands, Alaska in 2003. Includes birds on water and flying.

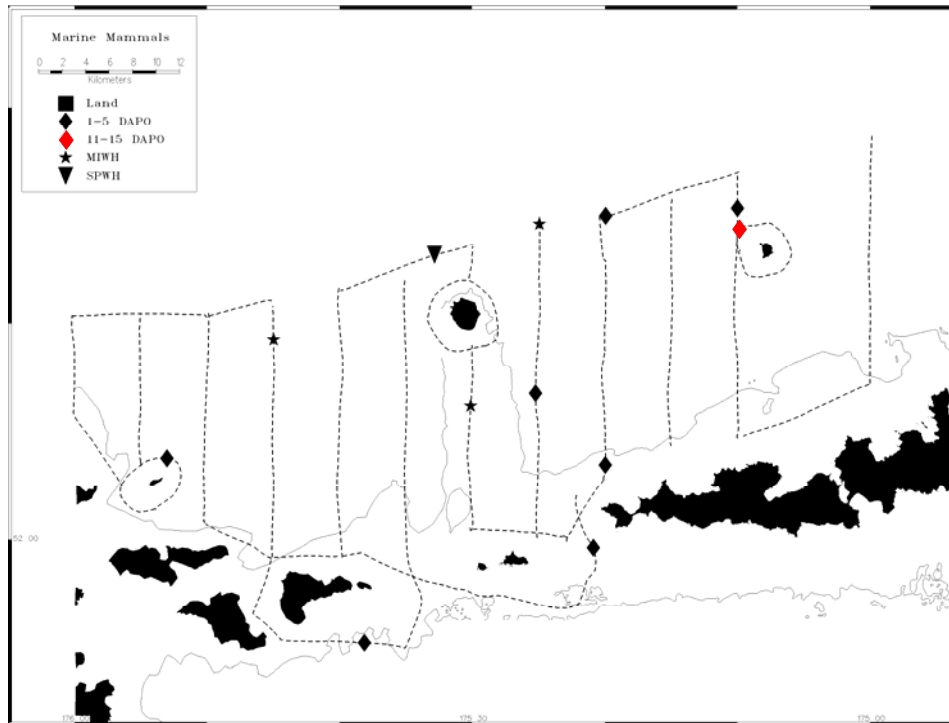


Figure 15. Distribution of marine mammals on transects surveyed in the central Aleutian Islands, Alaska in 2003. DAPO = Dall’s porpoise, MIWH = minke whale, SPWH = sperm whale.

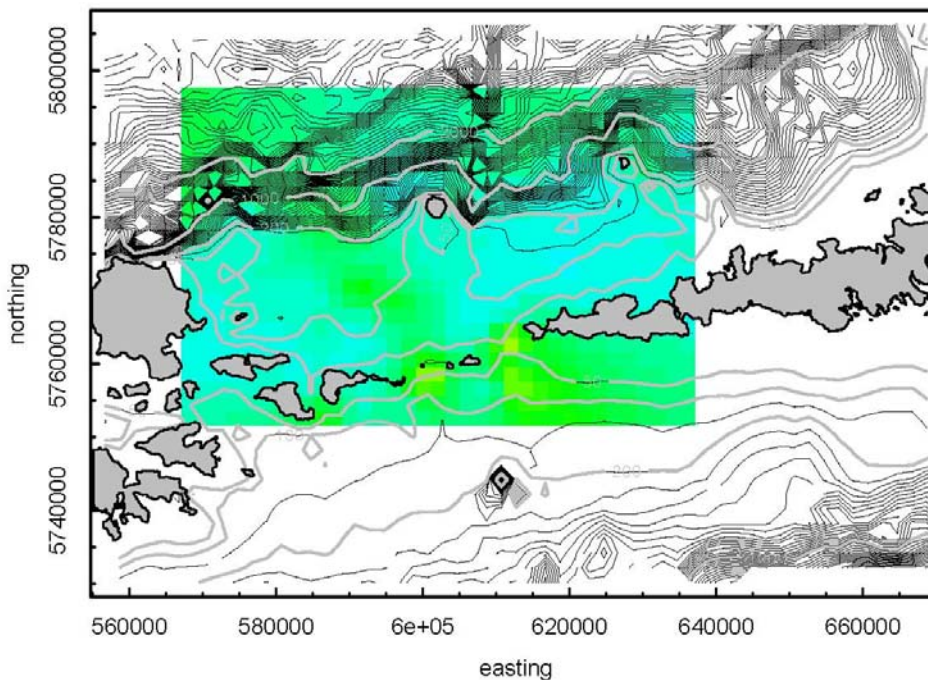


Figure 16. Distribution of prey in the water column (0-50 m) based on acoustic surveys in the central Aleutian Islands, Alaska in 2003. Map projection is UTM, zone 4. “Hotter” colors (reds-yellows) indicate relatively higher biomass.

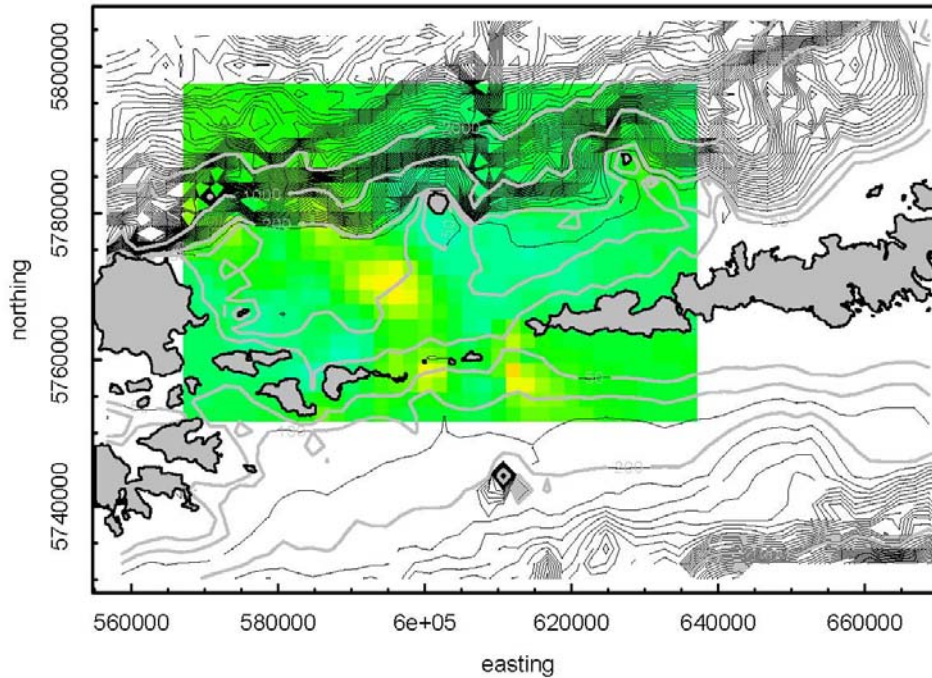


Figure 17. Distribution of prey in the water column (0-100 m) based on acoustic surveys in the central Aleutian Islands, Alaska in 2003. Map projection is UTM, zone 4. “Hotter” colors (red-yellows) indicate relatively higher biomass.

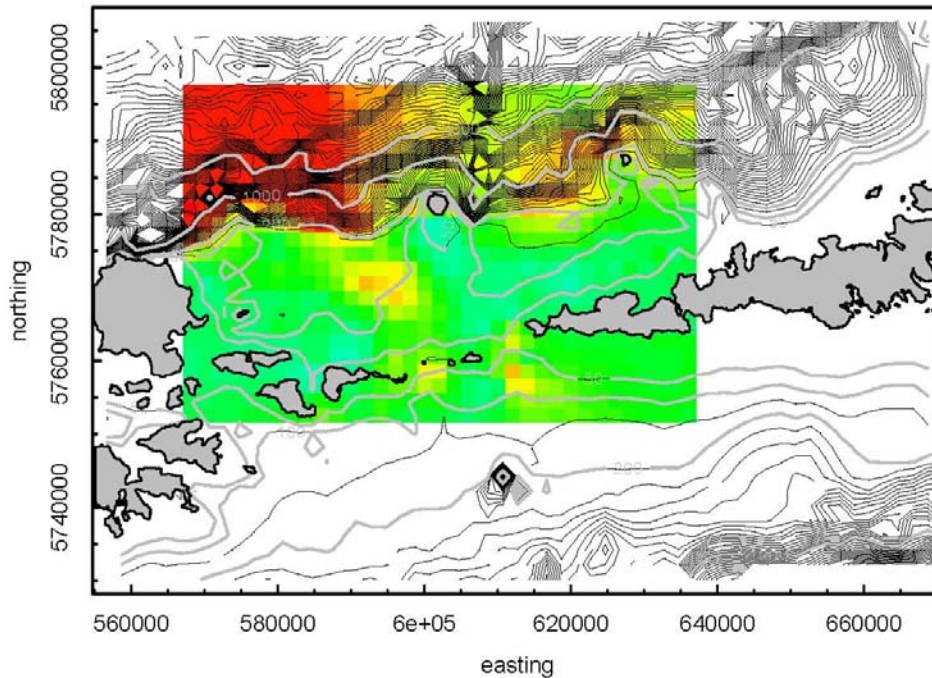


Figure 18. Distribution of prey in the water column (0-250 m) based on acoustic surveys in the central Aleutian Islands, Alaska in 2003. Map projection is UTM, zone 4. “Hotter” colors (red-yellows) indicate relatively higher biomass.

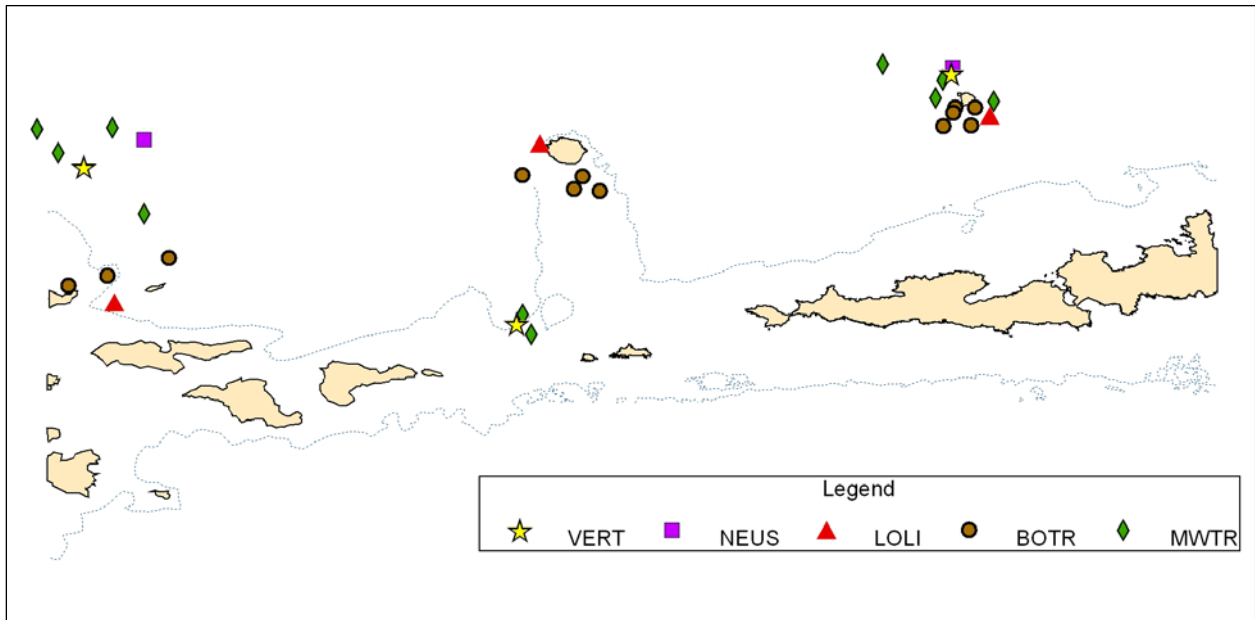


Figure 19. Locations of fishing efforts in the central Aleutian Islands, Alaska in 2003. VERT = vertical plankton tow, NEUS = neuston (surface) plankton tow, LOLI = long-line, BOTR = bottom trawl, MWTR = mid-water trawl.

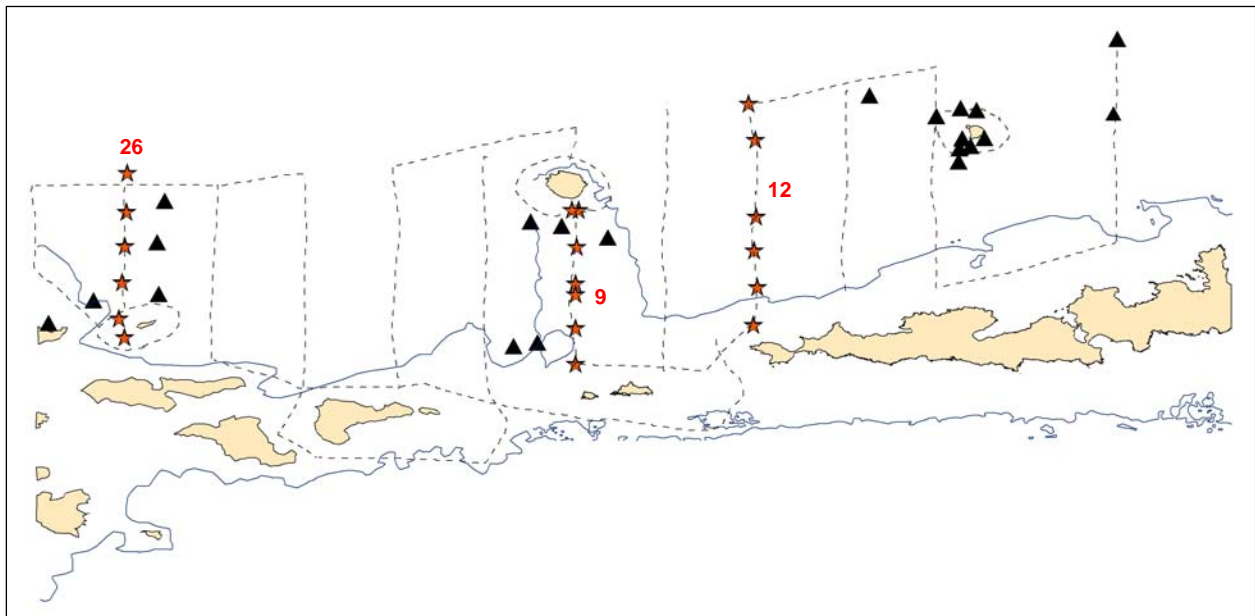


Figure 20. Locations of CTD stations sampled in the central Aleutian Islands, Alaska in 2003. Red stars represent CTD casts used to generate profiles.

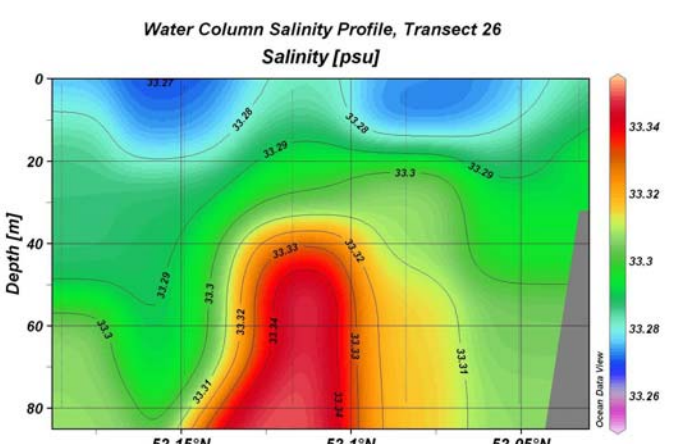
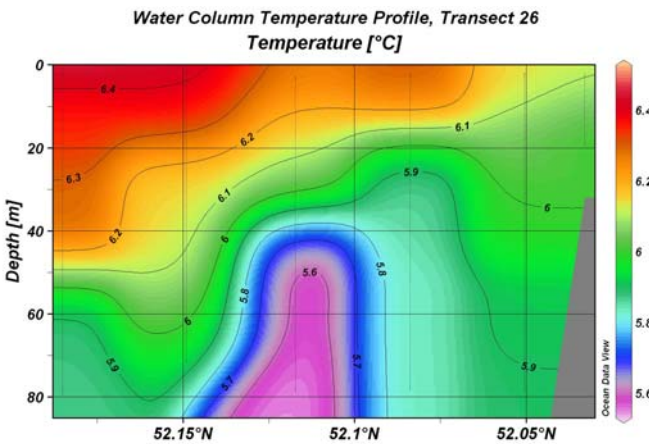
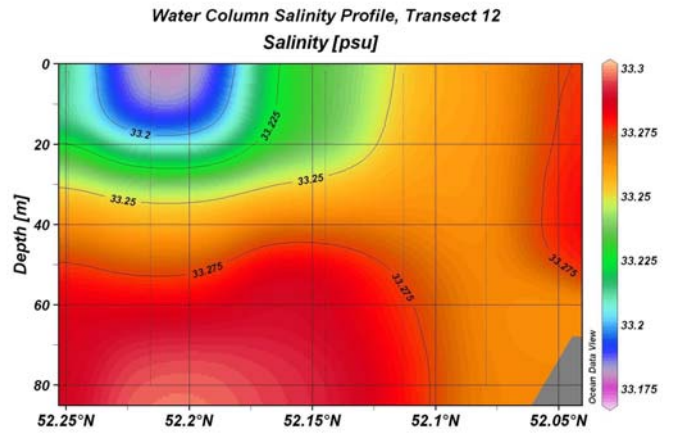
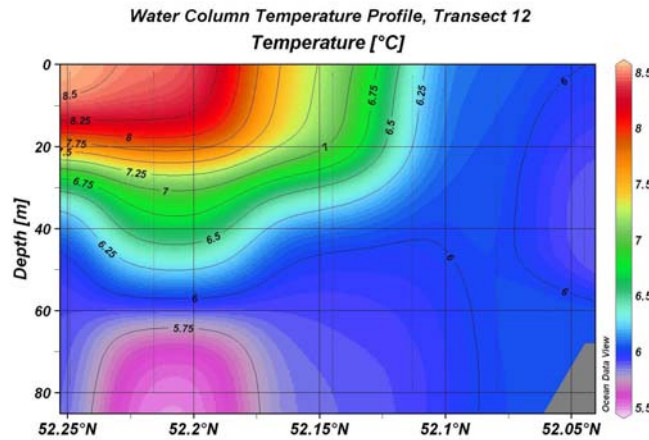
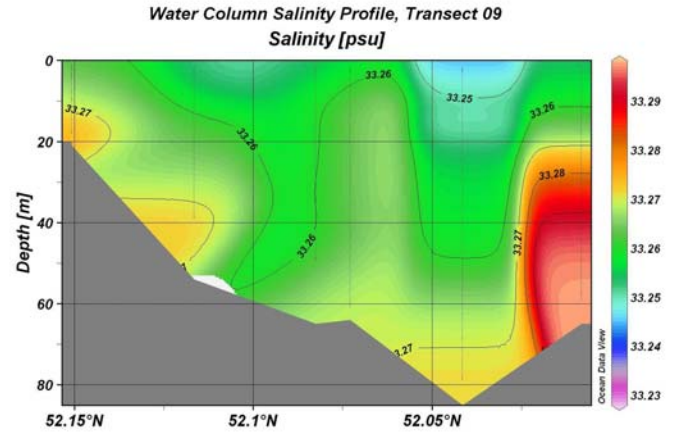
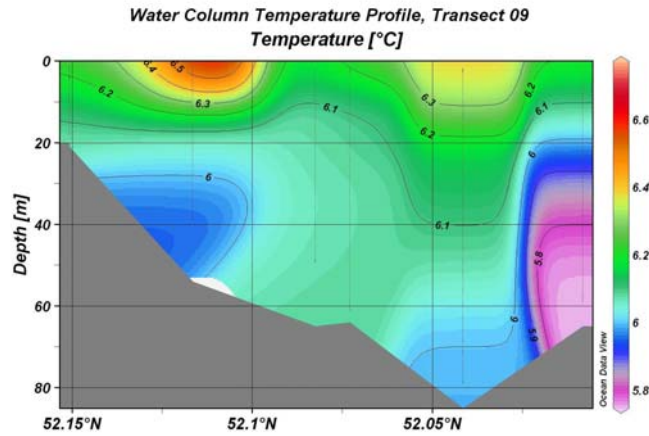


Figure 21. CTD temperature (left) and salinity (right) profiles obtained from central Aleutian Islands, Alaska transect 9 (top), transect 12 (middle) and transect 26 (bottom) in 2003.

Sea Surface Temperature (°C)

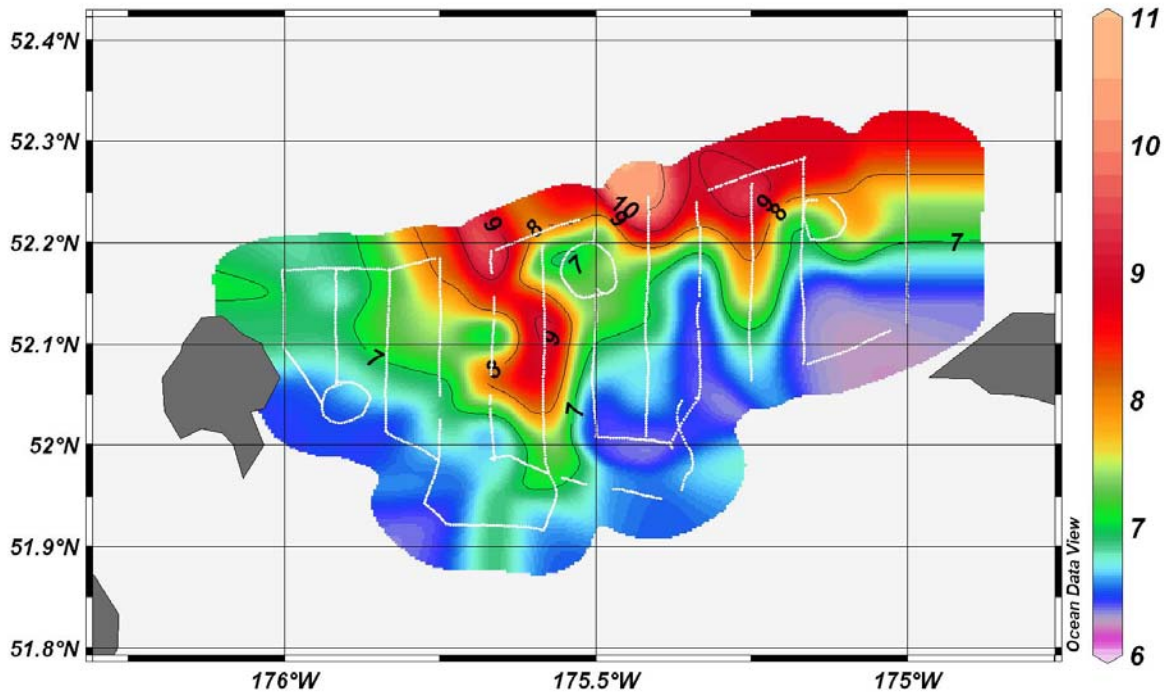


Figure 22. Sea surface temperature interpolated from thermosalinograph records on transects surveyed in the central Aleutian Islands, Alaska in 2003.

Sea Surface Salinity (PSU)

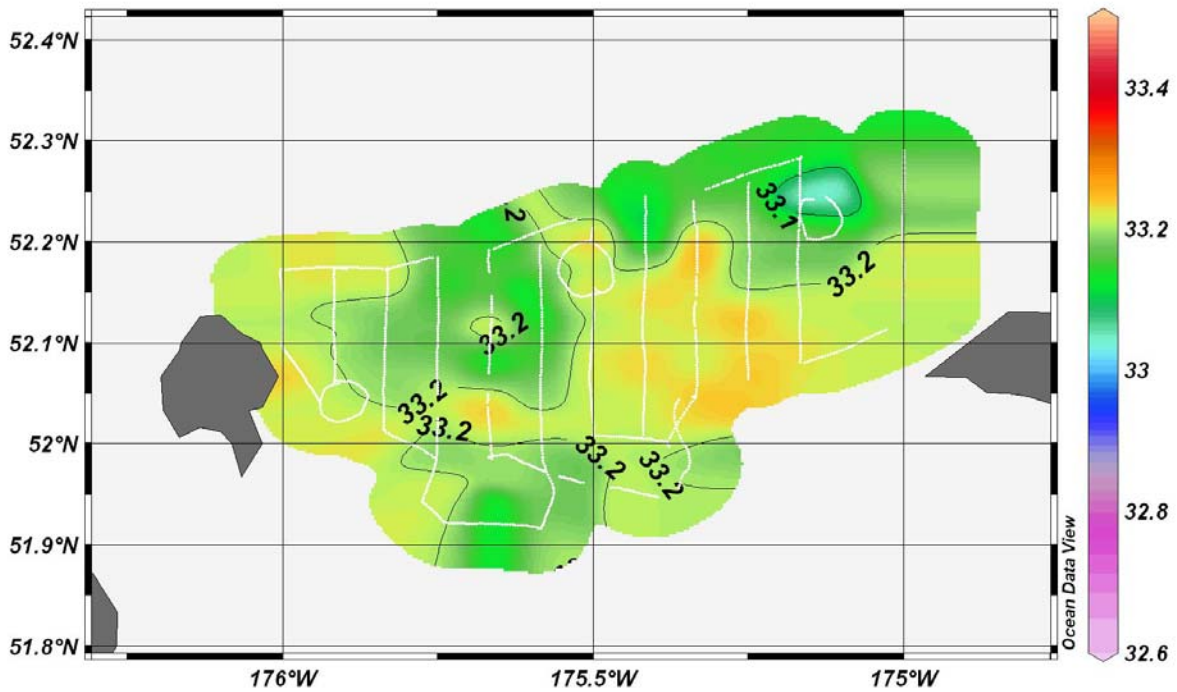


Figure 23. Sea surface salinity interpolated from thermosalinograph records on transects surveyed in the central Aleutian Islands, Alaska in 2003.

Appendix A. Numbers of seabirds and marine mammals observed on 26 transects in the central Aleutian Islands, Alaska in 2003.

Species/Transect No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Laysan albatross	--	2	1	--	--	1	--	--	--	--	--	--	2	--	--	5	--	1	1	--	4	3	--	--	--	3
Black-footed albatross	1	--	--	--	--	--	--	--	--	--	--	1	2	2	--	--	--	--	1	--	1	--	--	--	--	2
Northern fulmar	38	110	12	--	2	467	37	19	246	27	15	44	34	48	21	66	6	47	355	26	72	48	16	6	130	109
Mottled petrel	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	--	--	--	--	--	--	--
Sooty shearwater	--	2	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Short-tailed shearwater	--	7	1	--	--	--	--	--	--	--	--	--	--	2	--	11	--	1	142	1	--	--	1	--	14	--
Unidentified shearwater	--	26	--	1	--	--	--	--	--	--	--	--	2	--	--	14	--	--	4	--	2	--	--	8	--	132
Fork-tailed storm-petrel	--	7	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	3	--	--	--	--
Leach's storm-petrel	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Red-faced cormorant	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--
Pelagic cormorant	2	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	4	--	2	--	--	--	--	--	1
Unidentified cormorant	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	1	1	--	--	--	--	--	--	1
Red phalarope	--	--	--	--	--	44	--	--	135	--	--	--	1	--	3	--	4	--	--	--	3	--	--	--	--	31
Unidentified phalarope	--	--	--	--	--	--	--	--	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Peregrine falcon	--	--	--	--	--	--	1	--	2	--	--	2	1	1	--	--	--	2	1	--	1	2	2	--	--	1
Glaucous-winged gull	5	4	3	--	--	20	4	--	16	1	--	11	3	9	4	3	8	20	22	5	16	11	9	--	11	5
Black-legged kittiwake	--	1	--	--	--	--	1	--	--	--	--	1	--	--	--	2	--	1	--	--	1	2	4	--	--	--
Common murre	--	1	--	--	--	--	--	--	--	--	--	--	--	1	1	--	3	4	--	--	3	--	--	--	--	--
Thick-billed murre	10	1	2	--	1	2	1	--	8	--	1	4	8	25	11	4	29	--	5	21	4	5	117	--	7	10
Unidentified murre	--	--	--	--	--	--	--	--	--	--	--	1	4	1	2	1	--	--	--	2	1	--	1	--	1	27
Pigeon guillemot	--	--	--	--	--	--	--	--	5	3	--	--	--	--	--	--	--	11	--	--	--	1	--	--	--	5
Ancient murrelet	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	--	--	--	--	3
Cassin's auklet	--	--	3	--	14	1	2	--	5	99	100	1	--	--	--	2	--	21	86	1	2	1	2	--	290	--
Parakeet auklet	1	--	--	--	--	1	--	--	3	28	34	1	--	3	2	3	2	100	18	7	3	3	7	--	23	--
Least auklet	2	9	1	--	1	175	2	5	465	51	219	43	6	34	43	2	8	141	1062	168	261	3	19	3	314	4
Whiskered auklet	--	--	2	--	--	160	--	--	5	179	--	--	--	--	--	--	2	1448	824	7	273	2	4	--	1584	2
Crested auklet	1	1	--	--	--	13	22	25	39	192	169	114	1	1	--	79	--	1	321	331	143	2	15	--	297	--
Unid. small dark alcid	--	2	--	--	--	--	--	--	2	--	--	--	--	--	--	1	--	--	1	--	--	1	--	--	--	8
Horned puffin	2	2	--	--	--	1	1	--	1	--	--	--	--	--	3	2	5	32	7	20	2	--	1	--	5	--
Tufted puffin	53	31	26	3	2	50	4	11	42	126	28	35	34	95	27	28	275	41	147	53	55	56	339	1	162	123
Minke whale	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	1	--	--	1	--	--	--	--	--
Sperm whale	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dall's porpoise	--	--	--	--	--	--	--	--	--	--	--	5	4	1	--	--	3	--	2	--	2	--	15	--	5	--

Appendix B. Photographs of some fish species caught during the SMMOCI cruise to the central Aleutian Islands, Alaska in 2003 (all by Kitty Mecklenburg).



Pacific spiny lumpsucker



Blotched snailfish



Garnet lampfish



Rock greenling



Atka mackerel



Scissortail sculpin