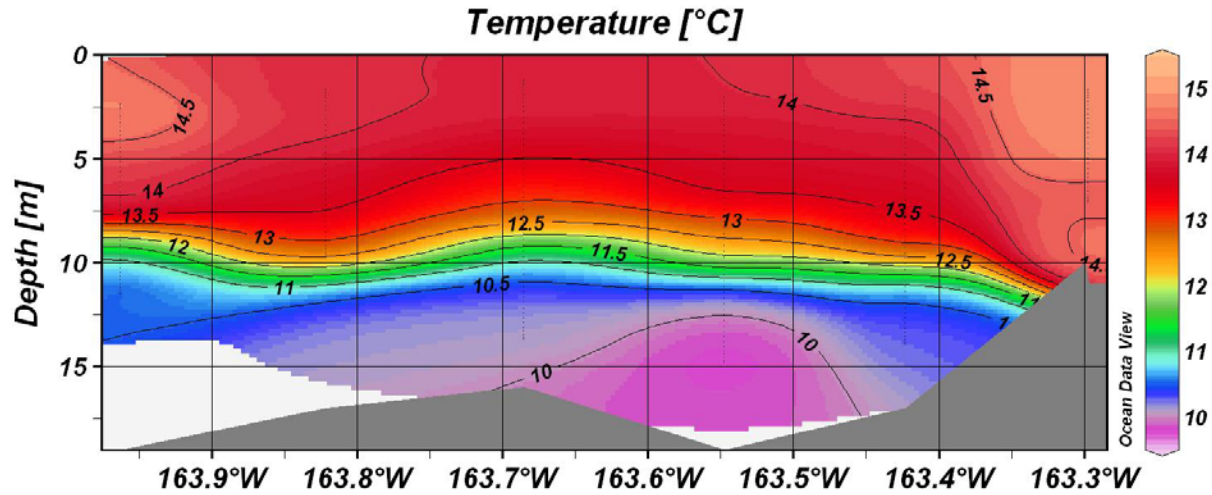


SEABIRD, FISH, MARINE MAMMAL AND OCEANOGRAPHY COORDINATED INVESTIGATIONS (SMMOCI) NEAR BLUFF, NORTON SOUND, ALASKA, JULY 2002



By
Donald E. Dragoo

Key Words: Alaska, Bluff, CTD, fishes, hydroacoustics, marine mammals, oceanography, pelagic surveys, prey, salinity, seabirds, Norton Sound, temperature, thermosalinograph

U. S. Fish and Wildlife Service
Alaska Maritime National Wildlife Refuge
95 Sterling Hwy., Suite 1
Homer, Alaska, USA 99603

May 2006

Cite as: Dragoo, D. E. 2006. 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.

EXECUTIVE SUMMARY

We conducted surveys of seabirds, fish, marine mammals and oceanographic conditions in Norton Sound, Alaska from the *M/V Tiglax* during 24-29 July 2002 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 Bluff, one of nine seabird colonies monitored annually by the Alaska Maritime National Wildlife Refuge.

In addition to surveying seabirds and marine mammals encountered on transects, we characterized local oceanography by measuring water temperature 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. 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. We used bottom trawls to describe the bottom fauna and we sampled plankton at several sites.

In 2002 we counted a total of 2937 birds on 20 transects that covered 736 linear km of surveys, resulting in a density of approximately 13 birds/km² over an area of some 221 km². Black-legged kittiwakes and common murre were the most common birds we observed on transects. Bird densities in Norton Sound in 2002 were lower than most areas where SMMOCI surveys have been conducted. We saw only two marine mammals on transects during our surveys in 2002.

In general, acoustic biomass was greatest near the middle and eastern portions of the survey, and was concentrated in the upper strata of the water column. Pacific herring and Pacific sand lance dominated mid-water trawl catches. We caught only sea stars, no fish, on the single long-line set. We captured more than 5000 tunicates in one bottom trawl. Single bottom trawl tows were dominated by numbers of several other species as well (e. g., mysid, pandalid and crangonid shrimp, yellowfin sole). Saffron cod, slender eelblenny and yellowfin sole were the most numerous fish caught in bottom trawls. Juvenile polychaete worms, copepods and echinoderm larvae were the most numerous among the wide variety of species we captured in vertical plankton tows. Copepods, insects and echinoderm larvae were the numerically dominant animals captured during neuston tows.

CTD profiles indicated a stratified water column with a complex structure. Sea surface temperature generally was higher in the eastern portion of the survey area.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	i
TABLE OF CONTENTS.....	ii
LIST OF TABLES.....	iii
LIST OF FIGURES	iii
LIST OF APPENDICES.....	iv
INTRODUCTION	1
Personnel.....	1
METHODS	1
Bird and Marine Mammal Observations.....	1
Hydroacoustic Surveys	2
Fishing.....	2
Oceanographic Data.....	3
RESULTS	3
Bird and Marine Mammal Observations.....	3
Prey	4
Oceanography	4
DISCUSSION.....	5
ACKNOWLEDGEMENTS.....	5
LITERATURE CITED.....	5

LIST OF TABLES

No.	Title	Page
1.	Locations and times of surveys near Bluff, Norton Sound, Alaska in 2002.....	7
2.	Species composition and numbers of seabirds and marine mammals observed on 20 transects near Bluff, Norton Sound, Alaska in July 2002.....	8
3.	Locations, times and depths of fishing efforts near Bluff, Norton Sound, Alaska in 2002.....	9
4.	Species composition and numbers of individuals captured with mid-water trawls during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002	11
5.	Total lengths of species captured with mid-water trawls during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002	12
6.	Species composition and numbers of individuals captured with bottom trawls during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002.....	13
7.	Total lengths of species captured with the bottom trawl during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002.....	16
8.	Species composition and numbers of individuals captured with the vertical plankton net during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002	17
9.	Species composition and numbers of individuals captured with the neuston plankton net during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002	20
10.	Locations, times and dates of CTD casts made near Bluff, Norton Sound, Alaska in July 2002	22
11.	Estimates of at sea densities of seabirds near colonies at several Alaskan sites.....	23

LIST OF FIGURES

No.	Title	Page
1.	Map of Alaska showing the location of Norton Sound.....	24
2.	Map of transects surveyed near Bluff, Norton Sound, Alaska in July 2002.....	24
3.	Distribution of pelagic cormorants on transects surveyed near Bluff, Norton Sound, Alaska in July 2002	25
4.	Distribution of large gulls on transects surveyed near Bluff, Norton Sound, Alaska in July 2002	25

LIST OF FIGURES (continued)

No.	Title	Page
5.	Distribution of black-legged kittiwakes on transects surveyed near Bluff, Norton Sound, Alaska in July 2002	26
6.	Distribution of common murrens on transects surveyed near Bluff, Norton Sound, Alaska in July 2002	26
7.	Distribution of horned puffins on transects surveyed near Bluff, Norton Sound, Alaska in July 2002	27
8.	Distribution of prey in the water column, based on acoustic surveys near Bluff, Norton Sound, Alaska in July 2002.....	27
9.	Water column relative prey densities measured during acoustic surveys on transects near Bluff, Norton Sound, Alaska in July 2002.....	28
10.	Relative density of prey by depth stratum measured during acoustic surveys on transects near Bluff, Norton Sound, Alaska in July 2002.....	28
11.	Locations of fishing efforts near Bluff, Norton Sound, Alaska in July 2002	29
12.	Locations of CTD stations sampled near Bluff, Norton Sound, Alaska in 2002.....	29
13.	CTD profiles obtained from Norton Sound, Alaska transect E in 2002	30
14.	CTD profiles obtained from Norton Sound, Alaska transect I in 2002	31
15.	CTD profiles obtained from Norton Sound, Alaska transect Q in 2002.....	32
16.	Sea surface temperatures interpolated from thermosalinograph records on transects surveyed near Bluff, Norton Sound, Alaska in 2002.....	33

LIST OF APPENDICES

No.	Title	Page
A.	Numbers of seabirds and marine mammals observed on 20 transects near Bluff, Norton Sound, Alaska in July 2002.....	34
B.	Photographs of some fish species caught during the SMMOCI cruise to Norton Sound, Alaska in 2002.....	35

INTRODUCTION

We conducted surveys of seabirds, fish, marine mammals and oceanographic conditions in Norton Sound, Alaska (Fig. 1) from the *M/V Tiġlaġ* during 24-29 July 2002 (Table 1, Fig. 2) 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 Bluff, 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 encountered on transects, we characterized local oceanography by measuring water temperature continuously at the sea surface and by taking profiles of the water column 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. We used bottom trawls to describe the bottom fauna and we sampled plankton at several sites. This report summarizes the data collected from the 2002 SMMOCI cruise to Norton Sound.

Personnel

Bird Crew: Karen Boylan, Vernon Byrd, Gary Drew, John Piatt, Deb Rudis, Barry Sampson, Jeff Williams

Fish Crew: Brenda Holladay, Kitty Mecklenburg, Mike Palmer

Hydroacoustics Crew: Don Dragoo, Doug Palmer

Tiġlaġ Crew: Kevin Bell, John Faris, Dan McNulty, 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 dLOG2 (Ver. 2.1.4, R. G. Ford Consulting, Portland, OR) which assigned all records GPS positions in real time.

We conducted surveys on 15 linear transects, which were roughly perpendicular to the shore. We also conducted five shoreline transects, which followed the coast at a set distance from shore (Table 1, Fig. 2). We counted marine mammals on the same transects as birds. We mapped bird and marine mammal distributions and estimated densities from these data.

Hydroacoustic Surveys

We collected acoustics data along the same transects and concurrently with marine bird and mammal observations, with the exception that we have acoustics data from Transect C but bird and marine mammal data are not available for this transect (Fig. 2). We determined relative prey abundance on all transects using a dual frequency (38 and 120 kHz) Simrad EK500 echosounder. In addition, we collected acoustic data during mid-water trawls. We set the threshold for data collection at -80 dB. We echo integrated acoustic data to the maximum depth encountered during surveys, excluding the top 7 m of the water column. We defined five depth strata for analysis, in 5 m increments; with the exception that the topmost stratum was 3 m deep (7-10 m). We summarized data as: 1) estimated water column biomass (relative density) by transect and 2) estimated relative biomass of prey by depth stratum over all transects. 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. We grouped acoustic data into 1 minute bins, encompassing the entire water column, before using them to generate prey density maps.

Fishing

Trawls and Tows.--We conducted mid-water and plankton trawls to enable relation of 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 10 to 15 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. We preserved plankton from the neuston and vertical nets for later identification. We recommend caution when interpreting abundance from the zooplankton data presented in this report, 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. We towed this trawl for 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 fishes to the nearest mm (total length) and preserved some specimens for later use.

Long-line Sets.--For the single long-line set, we deployed one skate of about 100 hooks (sizes 3.0 and 5.0) baited with salted herring and soaked for about 2 hours. Since no fishes were caught during this set no further processing was necessary.

Oceanographic Data

Water Column Temperature and Salinity Profile.--We deployed a portable CTD (Sea-Bird Seacat SBE-19 Profiler) approximately every five nautical miles along three transect lines (E, I and Q, Fig. 2) 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.

Sea Surface Temperature and Salinity.--We continuously recorded near sea surface temperature during transects using a Sea-Bird Seacat SBE21 thermosalinograph. We used the data to generate a temperature contour map as a way of illustrating the occurrence of surface structures such as fronts. The data from the conductivity cell of the thermosalinograph was not useable due to bubbles in the water stream within the cell. Consequently we were able to sample and map near sea surface temperature but not salinity in 2002. The water pump lost prime during Transect F so no thermosalinograph data were used from that part of the survey.

RESULTS

Bird and Marine Mammal Observations

In 2002 we counted a total of 2937 birds on 20 transects that covered 736 linear km of surveys (Table 2, Appendix A). This translated into a density of approximately 13 birds/km² over an area of some 221 km².

Loons.--We counted one Pacific loon during surveys in 2002 (Table 2).

Procellariids.--We counted two northern fulmars on transects in 2002 (Table 2).

Cormorants.--Cormorants were concentrated near shore (Table 2, Fig. 3).

Shorebirds.--Shorebirds seen on transects included western and pectoral sandpipers, and red and red-necked phalaropes (Table 2).

Jaegers, Gulls and Terns.--We saw a total of five jaegers in 2002 (Table 2). Large gulls (herring, glaucous-winged and glaucous) were widely distributed in the survey area (Fig. 4). Black-legged kittiwakes numbered in the mid-hundreds and also were widely distributed with concentrations near shore and near the seaward ends of transects F and G (Table 2, Fig. 5). We observed a few arctic terns on transects as well (Table 2).

Murres.--We counted almost 2000 murres on transects in 2002 (Table 2). Murres were widely distributed over the survey area with concentrations near the Bluff colony and near the seaward end of transect G (Fig. 6). Nearly all of the murres we identified to species were common murres (Table 2).

Murrelets and Auklets.--We observed one parakeet auklet on transects in 2002 (Table 2).

Puffins.--We counted low hundreds of horned puffins on transects in 2002 (Table 2, Fig. 7). We also observed a few tufted puffins during surveys (Table 2).

Marine Mammals.--We counted one minke whale and one largha (spotted) seal on transects in 2002, both near the eastern edge (transects M and N respectively) of the survey area (Table 2).

Prey

Acoustic Surveys.--In general, acoustic biomass was greatest near the middle and eastern portions of the survey area (Figs. 8 and 9). The estimated relative density of prey (excluding the surface stratum) appeared to be highest near the surface in 2002 (7 m to 15 m depth, Fig. 10).

Mid-water Trawls.--We conducted seven mid-water trawls in 2002 (Table 3, Fig. 11). Catches were dominated by Pacific herring and Pacific sand lance (Table 4). Table 5 shows total lengths of fishes caught in mid-water trawls. See Appendix B for photographs of a sample of fish species we captured.

Long-line Sets.--We set the long-line gear once in 2002 (Table 3, Fig. 11). The catch consisted of approximately 200 *Evasterias troschellii* sea stars. No fish were caught.

Bottom Trawls.--We conducted 10 bottom trawls in 2002 (Table 3, Fig. 11). Due to equipment problems during bottom trawl 1 (BOTR 1, try1, which did not touch the seafloor), another tow was made as close to the original as was practical (BOTR1, try2). We caught a wide variety of both invertebrate and fish species (Table 6). We captured more than 5000 tunicates in one trawl (BOTR 05, Table 6). Single bottom trawl tows were dominated by numbers of several other species as well (e. g., mysid, pandalid and crangonid shrimp, yellowfin sole). Saffron cod, slender eelblenny and yellowfin sole were caught in higher numbers than other fishes in 2002 (Table 6). Total lengths of fishes we captured in bottom trawls are presented in Table 7. See Appendix B for photographs of a sample of fish species we captured.

Plankton Tows.--We conducted 12 vertical plankton tows in 2002 (most at CTD stations along Transects I and Q; Table 3, Fig. 11). Juvenile polychaete worms, copepods and echinoderm larvae were the most numerous among the wide variety of species we captured in vertical tows (Table 8). We also did five neuston tows in 2002 (Table 3, Fig. 11). Copepods, insects and echinoderm larvae were the numerically dominant animals captured during neuston tows (Table 9).

Oceanography

Water Column Profile.--We conducted 34 CTD casts in 2002 (Table 10, Fig. 12). Profiles indicated a stratified water column with a complex structure (Figs. 13-15).

Sea Surface Temperature and Salinity.--Sea surface temperature generally was higher in the eastern portion of the survey area (Fig. 16).

DISCUSSION

Black-legged kittiwakes and common murrelets were by far the most numerous birds we encountered on transects during SMMOCI surveys near Bluff in Norton Sound in July 2002 (Table 2). The only other bird species for which we counted more than 100 individuals was the horned puffin. We found that overall bird densities from our Norton Sound surveys generally were lower than those from most other SMMOCI cruises (Table 11).

ACKNOWLEDGEMENTS

I would like to thank all of the people who helped gather data during the 2002 Norton Sound SMMOCI survey. Their perseverance, professionalism and good cheer were much appreciated. Brenda Holladay (University of Alaska Fairbanks) identified plankton samples. The fish photos are by Catherine W. (Kitty) Mecklenburg, Point Stephens Research, Auke Bay, Alaska. Brenda Holladay, 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 Tiġlaġ* without whose enthusiasm, professionalism and patience this work would not have been possible.

LITERATURE CITED

- 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. 2006. 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.
- _____, 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.
- Piatt, J. F., 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.
- Piatt, J. F., 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.
- 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. 2004. Ocean Data View, <http://www.awi-bremerhaven.de/GEO/ODV>.

Table 1. Locations (in decimal degrees) and times of surveys used for bird and marine mammal observations, and hydroacoustics surveys near Bluff, Norton Sound, Alaska in 2002.

Transect	Start Latitude (°N)	Start Longitude (°W)	Stop Latitude (°N)	Stop Longitude (°W)	Date	Start Time ^a	Stop Time ^a
A	64.5383°	164.3658°	64.3953°	164.7071°	7/24	14:08	15:18
B	64.3635°	164.6252°	64.5546°	164.1767°	7/24	16:23	19:22
C ^b	64.5503°	164.0303°	64.3247°	164.5410°	7/29	15:51	17:45
D	64.2942°	164.4553°	64.5563°	163.8535°	7/24	09:28	11:52
E	64.2307°	164.4092°	64.5513°	163.7074°	7/25	08:15	11:22
F	64.5452°	163.5708°	64.2576°	164.2297°	7/25	11:52	14:27
G	64.2277°	164.1162°	64.5244°	163.4556°	7/25	14:52	17:31
H	64.4880°	163.3713°	64.1948°	164.0592°	7/25	18:07	20:47
I	64.4582°	163.2993°	64.1615°	163.9597°	7/26	15:50	18:57
J	64.1160°	163.8984°	64.4150°	163.2238°	7/26	19:59	22:40
K	64.1393°	163.6988°	64.4015°	163.0993°	7/27	10:25	12:41
L	64.0789°	163.6832°	64.3811°	163.0280°	7/27	13:00	15:30
M	64.0872°	163.5043°	64.3857°	162.8295°	7/27	16:07	18:44
N	64.3222°	162.8198°	64.0243°	163.4888°	7/27	19:09	21:38
O	64.2570°	162.8343°	64.5823°	162.0656°	7/28	07:48	10:34
Q	64.5612°	161.7937°	64.3392°	162.2997°	7/28	12:01	14:53
S1 ^c	64.5435°	163.9575°	64.5418°	164.3465°	7/24	12:54	13:59
S2 ^c	64.4625°	163.3017°	64.5583°	163.6687°	7/26	07:58	09:06
S3 ^c	64.5573°	163.6935°	64.4530°	163.3547°	7/26	13:52	15:01
S4 ^c	64.3062°	162.7793°	64.4544°	163.2997°	7/28	16:49	18:24
S5 ^c	64.5555°	163.6782°	64.5552°	163.8438°	7/29	08:34	09:00

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

^bOnly acoustic and thermosalinograph data are available for this transect.

^cCoastal transect.

Table 2. Species composition and numbers of seabirds and marine mammals observed on 20 transects near Bluff, Norton Sound, Alaska in July 2002.

Species	Scientific Name	No. Observed	Density ^a	% Total
All Bird Species Total		2937	13.30	100.0
Pacific loon	<i>Gavia pacifica</i>	1	<0.01	0.03
Northern fulmar	<i>Fulmarus glacialis</i>	2	0.01	0.07
Pelagic cormorant	<i>Phalacrocorax pelagicus</i>	33	0.15	1.12
Unidentified cormorant	<i>Phalacrocorax</i> spp.	1	<0.01	0.03
Western sandpiper	<i>Calidris mauri</i>	27	0.12	0.92
Pectoral sandpiper	<i>Calidris melanotos</i>	1	<0.01	0.03
Red-necked phalarope	<i>Phalaropus fulicarius</i>	12	0.05	0.41
Red phalarope	<i>Phalaropus lobatus</i>	5	0.02	0.17
Pomarine jaeger	<i>Stercorarius pomarinus</i>	2	0.01	0.07
Parasitic jaeger	<i>Stercorarius parasiticus</i>	2	0.01	0.07
Unidentified jaeger	<i>Stercorarius</i> spp.	1	<0.01	0.03
Herring gull	<i>Larus argentatus</i>	2	0.01	0.07
Glaucous-winged gull	<i>Larus glaucescens</i>	13	0.06	0.44
Glaucous gull	<i>Larus hyperboreus</i>	28	0.13	0.95
Black-legged kittiwake	<i>Rissa tridactyla</i>	647	2.93	22.03
Arctic tern	<i>Sterna paradisaea</i>	7	0.03	0.24
Common murre	<i>Uria aalge</i>	1981	8.97	67.45
Unidentified murre	<i>Uria</i> spp.	4	0.02	0.14
Parakeet auklet	<i>Aethia psittacula</i>	1	<0.01	0.03
Horned puffin	<i>Fratercula corniculata</i>	161	0.73	5.48
Tufted puffin	<i>Fratercula cirrhata</i>	6	0.03	0.20
Minke whale	<i>Balaenoptera acutorostrata</i>	1	<0.01	0.03
Largha seal	<i>Phoca largha</i>	1	<0.01	0.03

^aIndividuals/km². A total of 220.8 km² was surveyed.

Table 3. Locations (decimal degrees), times and depths of fishing efforts near Bluff, Norton Sound, Alaska in 2002.

Tow ^b	Date	Start Latitude (N)	Start Longitude (W)	Start Time ^a	Depth Range (m)
MW01	7/24	64.5020°	164.2638°	18:14	0-12
MW02	7/25	64.1948°	164.0382°	21:14	0-14
MW03	7/27	64.1052°	163.6042°	07:11	0-16
MW04	7/28	64.2418°	162.8572°	06:51	0-20
MW05	7/28	64.4615°	163.3210°	19:43	0-10
MW06	7/29	64.4992°	163.8463°	07:05	0-14
MW07	7/29	64.5193°	164.1465°	10:18	0-17
BT01 (try 1) ^c	7/24	64.2967°	164.4467°	08:29	13-13
BT01 (try 2) ^c	7/24	64.3067°	164.4283°	08:50	13-13
BT02	7/25	64.3050°	164.5077°	03:27	12-13
BT03	7/25	64.2053°	164.3150°	04:50	16-16
BT04	7/25	64.2107°	163.9945°	22:57	16-16
BT05	7/26	64.4048°	163.6588°	00:53	16-16
BT06	7/27	64.5193°	164.0370°	01:42	15-15
BT07	7/27	64.4773°	164.0123°	02:19	15-15
BT08	7/27	63.9280°	163.5837°	22:33	16-16
BT09	7/27	64.0513°	163.3122°	00:04	20-20
LL01	7/27	64.0983°	163.6100°	06:51	20-20
NT01	7/24	64.3950°	164.7102°	15:45	0-0.5
NT02	7/26	64.4613°	163.3062°	15:30	0-0.5
NT03	7/26	64.1620°	163.9647°	19:09	0-0.5
NT04	7/28	64.5715°	161.7695°	-- ^d	0-0.5
NT05	7/28	64.3398°	162.2990°	-- ^d	0-0.5

Table 3. Locations (decimal degrees), times and depths of fishing efforts near Bluff, Norton Sound, Alaska in 2002 (continued).

Tow ^b	Date	Start Latitude (N)	Start Longitude (W)	Time ^a	Depth Range (m)
VT01	7/24	64.3950°	164.7102°	15:35	0-20
VT02	7/26	64.4595°	163.2972°	15:26	0-10
VT03	7/26	64.4060°	163.4233°	16:23	0-15
VT04	7/26	64.3441°	163.5518°	17:04	0-15
VT05	7/26	64.2852°	163.6875°	17:44	0-15
VT06	7/26	64.2243°	163.8248°	18:24	0-15
VT07	7/26	64.1608°	163.9632°	19:04	0-10
VT08	7/28	64.5715°	161.7695°	-- ^d	0-8
VT09	7/28	64.5188°	161.8947°	-- ^d	0-10
VT10	7/28	64.4597°	162.0292°	-- ^d	0-10
VT11	7/28	64.3995°	162.1700°	-- ^d	0-10
VT12	7/28	64.3398°	162.2990°	-- ^d	0-10

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

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

^cDue to equipment problems during the first try (which did not reach the bottom), another tow was made as close to the same position as was practical.

^dTimes not recorded.

Table 4. Species composition and numbers of individuals captured with mid-water trawls during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002.

Species	Tow Number							Total
	01	02	03	04	05	06	07	
Unidentified jellyfish (Cnidaria)	5	20	36	7	16	--	--	84
<i>Chrysaora</i> jellyfish (<i>Chrysaora</i> sp.)	--	2	--	1	--	31	13	47
<i>Staurophora</i> jellyfish (<i>Staurophora mertensii</i>)	--	--	1	--	--	1	--	2
<i>Yoldia</i> bivalve (<i>Yoldia</i> sp.)	--	--	--	--	--	--	1	1
Hyperiid amphipod (Hyperiidae)	--	--	1	--	--	--	--	1
Hyperiid amphipod (<i>Hyperia medusarum</i>)	1	1	4	1	--	--	--	7
<i>Evasterias</i> sea star (<i>Evasterias troschelii</i>)	--	--	--	--	--	--	15	15
Mysid (<i>Neomysis rayii</i>)	--	--	--	--	--	--	11	11
Arctic lamprey (<i>Lampetra camtschatica</i>)	--	--	--	--	--	--	1	1
Pacific herring (larval) (<i>Clupea pallasii</i>)	2	8	96	31	455	697	130	1419
Capelin (<i>Mallotus villosus</i>)	--	2	--	--	--	--	--	2
Chinook salmon (<i>Oncorhynchus tshawytscha</i>)	--	2	--	--	--	--	--	2
Saffron cod (<i>Eleginus gracilis</i>)	1	9	1	3	--	--	2	16
Walleye pollock (<i>Theragra chalcogramma</i>)	--	--	--	--	--	--	1	1
Great sculpin (<i>Myoxocephalus polyacanthocephalus</i>)	--	--	--	--	--	1	--	1
Veteran poacher (<i>Podothecus veterinus</i>)	--	--	--	--	--	1	--	1
Slender eelblenny (<i>Lumpenus fabricii</i>)	--	--	--	--	--	--	7	7
Pacific sand lance (<i>Ammodytes hexapterus</i>)	--	274	16	729	47	1	--	1067
Longhead dab (larval) (<i>Limanda proboscidea</i>)	--	3	--	4	4	7	--	18
Starry flounder (<i>Platichthys stellatus</i>)	--	--	--	--	--	1	--	1
Arctic flounder (<i>Pleuronectes glacialis</i>)	--	--	--	--	--	1	--	1

Table 5. Total lengths (mm) of species captured with mid-water trawls during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002.

Species	Mean	SD ^a	Range	n ^a
Arctic lamprey	191.0	--	--	1
Pacific herring (larval)	32.4	5.7	20-49	149
Capelin	90.0	17.0	78-102	2
Chinook salmon	172.0	80.6	115-229	2
Saffron cod	54.9	47.5	28-230	16
Walleye pollock	101.0	--	--	1
Great sculpin	69.0	--	--	1
Veteran poacher	158.0	--	--	1
Slender eelblenny	136.9	66.6	24-209	9
Pacific sand lance	61.7	12.1	36-132	115
Longhead dab (larval)	25.6	8.9	13-41	18
Starry flounder	190.0	--	--	1
Arctic flounder	24.0	--	--	1

^aSD = standard deviation, n = sample size.

Table 6. Species composition and numbers of individuals captured with bottom trawls during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002.

Common Name	Scientific Name	Tow										Total
		01(1) ^a	01(2) ^a	02	03	04	05	06	07	08	09	
Sea anemone (unid.)	Actiniaria	1	--	--	--	--	5	--	--	--	--	6
Jellyfish (unid.)	Scyphozoa	--	6	--	--	--	--	--	--	4	--	10
Sea raspberry (coral)	<i>Eunephyta</i> sp.	--	--	--	--	--	1	--	--	--	12	13
Depressed scaleworm	<i>Eunoe depressa</i>	--	--	10	1	--	--	--	--	--	--	11
Gastropod egg case	Gastropoda	--	--	--	--	--	1	--	--	--	--	1
Moon Snail egg case	<i>Natica</i> spp.	--	10	10	10	10	10	85	--	--	--	135
Neptunea gastropod	<i>Neptunea</i> sp.	--	--	--	--	--	6	--	5	--	--	11
Bivalve (unid.)	Bivalvia	--	--	--	--	--	1	--	2	--	--	3
Bivalve	<i>Yoldia</i> sp.	--	--	--	--	--	--	--	--	1	--	1
<i>Melita</i> amphipod	<i>Melita dentata</i>	--	--	--	--	--	1	--	--	--	--	1
Mysid	Mysidacea	--	--	--	--	--	100	--	--	435	--	535
Mysid	<i>Mysis litoralis</i>	--	--	--	--	--	--	--	--	5	--	5
Mysid	<i>Neomysis rayii</i>	--	--	--	--	--	--	110	--	3	--	113
Mysid	<i>Acanthymysis dybowski</i>	--	--	--	--	--	--	--	--	1	--	1
Pandalid shrimp	Pandalidae	3	11	10	--	201	40	53	--	--	1500	1818
Spiny lebbeid	<i>Lebbeus groenlandicus</i>	--	--	--	--	--	--	--	--	1	--	1
Yellow leg pandalid	<i>Pandalus tridens</i>	--	--	--	--	--	--	--	--	4	--	4
Crangonid shrimp (type 1)	Crangonidae	38	64	380	--	--	--	--	--	--	--	482
Crangonid shrimp (type 3)	Crangonidae	--	--	--	10	25	--	--	--	--	--	35
Crangonid shrimp	Crangonidae	--	--	--	--	--	170	--	150	--	83	405
Crangonid shrimp	<i>Crangon</i> sp.	--	--	--	185	562	--	--	--	--	--	747
Crangonid shrimp	<i>Argis lar</i>	1	6	--	--	--	--	--	--	--	5	12
Sculptured shrimp	<i>Sclerocrangon borealis</i>	--	--	--	1	--	--	--	--	--	--	1
Crangonid shrimp	<i>Neocrangon communis</i>	--	--	--	--	--	--	125	--	--	--	125

Table 6. Species composition and numbers of individuals captured with bottom trawls during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002 (continued).

Common Name	Scientific Name	Tow										Total
		01(1) ^a	01(2) ^a	02	03	04	05	06	07	08	09	
Red king crab	<i>Paralithodes camtschatica</i>	--	--	--	--	1	2	--	--	--	--	3
Hermit crab (unid.)	Paguroidea	1	2	16	3	61	11	5	9	5	52	165
Snow crab	<i>Chionoecetes opilio</i>	--	--	--	--	--	--	--	--	--	1	1
Arctic lyre crab	<i>Hyas coarctatus</i>	--	--	26	6	45	9	--	18	3	2	109
Helmet crab	<i>Telmessus cheiragonus</i>	--	--	2	--	1	2	3	2	2	2	14
<i>Ampelisca</i> amphipod	<i>Ampelisca</i> sp.	--	--	--	--	--	--	2	--	--	--	2
Bryozoan	Bryozoa	--	--	--	--	--	1	1	--	--	--	2
Sea star (unid.)	Asteroidea	1	--	--	--	--	--	--	1	--	--	2
<i>Evasterias</i> sea star	<i>Evasterias troschelii</i>	1	5	255	17	689	197	37	156	22	41	1420
Blackspined sea star	<i>Lethasterias nanimensis</i>	1	--	--	--	--	--	--	--	--	--	1
Basket star	<i>Gorgonocephalus caryi</i>	--	--	--	--	2	--	--	--	--	46	48
<i>Ophiura</i> brittle star	<i>Ophiura</i> sp.	--	1	55	--	31	21	--	--	--	--	108
Notched brittle star	<i>Ophiura sarsi</i>	--	--	--	--	--	--	--	--	1	--	1
Tumid sea star	<i>Henricia tumida</i>	--	--	--	--	--	--	--	--	--	1	1
<i>Leptasterias</i> sea star	<i>Leptasterias</i> sp.	--	--	--	1	14	1	2	--	1	--	19
Green sea urchin	<i>Strongylocentrotus droebachiensis</i>	--	--	--	--	33	16	5	6	1	8	69
Salp (unid.)	Thaliacea	--	1	--	--	--	--	--	--	--	--	1
Tunicates	Ascidiacea	--	--	--	--	5650	--	--	--	--	--	5650
Fish eggs (unid.)	Teleost eggs (unid.)	--	--	--	--	--	1	--	--	--	--	1
Pacific herring	<i>Clupea pallasii</i>	--	--	--	--	--	--	7	--	--	--	7
Saffron cod	<i>Eleginus gracilis</i>	--	13	3	--	25	18	31	17	19	77	203
Walleye pollock	<i>Theragra chalcogramma</i>	--	--	--	--	--	--	3	1	--	19	23
Spatulate sculpin	<i>Icelus spatula</i>	--	--	--	--	--	1	--	--	--	--	1
Arctic staghorn sculpin	<i>Gymnocanthus tricuspis</i>	--	--	6	--	--	--	--	--	--	--	6

Table 6. Species composition and numbers of individuals captured with bottom trawls during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002 (continued).

Common Name	Scientific Name	Tow										Total
		01(1) ^a	01(2) ^a	02	03	04	05	06	07	08	09	
Threaded sculpin	<i>Gymnocephalus pistilliger</i>	--	--	--	--	1	--	1	--	--	--	2
Antlered sculpin	<i>Enophrys diceraus</i>	--	--	2	1	2	--	--	--	1	7	13
Shorthorn sculpin	<i>Myoxocephalus scorpius</i>	--	1	4	--	1	--	--	1	--	--	7
Great sculpin	<i>Myoxocephalus polyacanthocephalus</i>	--	--	--	--	2	--	1	--	--	--	3
Eyeshade sculpin	<i>Nautichthys pribilovius</i>	--	--	--	--	9	2	--	2	--	1	14
Tube-nose poacher	<i>Pallasina barbata</i>	--	--	--	--	3	3	2	1	--	--	9
Bering poacher	<i>Occella dodecaedron</i>	--	--	--	--	--	--	--	1	--	--	1
Veteran poacher	<i>Podothecus veterinus</i>	--	--	--	--	5	2	--	1	1	1	10
Kelp snailfish	<i>Liparis tunicatus</i>	--	--	1	--	--	--	--	1	--	--	3
Wattled eelpout	<i>Lycodes palearis</i>	--	--	--	--	--	--	1	--	1	25	27
Arctic shanny	<i>Stichaeus punctatus</i>	--	--	--	--	2	1	--	4	3	7	17
Slender eelblenny	<i>Lumpenus fabricii</i>	--	--	38	15	65	44	65	21	11	69	328
Blackline prickleback	<i>Acantholumpenus mackayi</i>	--	--	--	--	2	1	1	1	--	--	5
Pacific sand lance	<i>Ammodytes hexapterus</i>	--	6	--	--	1	--	--	--	--	--	7
Bering flounder	<i>Hippoglossoides robustus</i>	--	--	--	--	--	--	3	1	--	--	4
Starry flounder	<i>Platichthys stellatus</i>	--	--	--	--	--	--	--	--	--	1	1
Alaska plaice	<i>Pleuronectes quadrituberculatus</i>	--	--	1	--	--	--	--	--	--	--	1
Longhead dab	<i>Limanda proboscidea</i>	2	1	1	1	--	--	--	--	--	--	5
Yellowfin sole	<i>Limanda aspera</i>	--	6	133	16	50	43	14	25	6	--	293

^aNumber in parentheses indicates the first or second try of BOTR 01 (see methods).

Table 7. Total lengths (mm) of species captured with the bottom trawl during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002.

Species	Mean	SD ^a	Range	n ^a
Pacific herring	26.9	2.3	24-30	7
Saffron cod	65.1	54.4	26-310	141
Walleye pollock	119.4	12.3	85-136	23
Spatulate sculpin	39.0	--	--	1
Arctic staghorn sculpin	89.0	24.6	66-130	6
Threaded sculpin	99.5	0.7	99-100	2
Antlered sculpin	117.2	12.8	105-150	13
Shorthorn sculpin	87.3	20.9	70-114	6
Great sculpin	73.3	34.8	34-100	3
Eyeshade sculpin	49.4	22.5	25-80	14
Tube-nose poacher	99.9	34.8	49-130	9
Bering poacher	109.0	--	--	1
Veteran poacher	118.4	32.4	37-153	10
Kelp snailfish	57.0	7.1	52-62	2
Wattled eelpout	79.7	61.4	51-356	27
Arctic shanny	103.1	10.6	83-124	17
Slender eelblenny	171.8	30.5	50-241	195
Blackline prickleback	84.4	34.1	42-125	5
Pacific sand lance	111.1	10.8	100-128	7
Bering flounder	60.0	6.5	52-67	4
Starry flounder	425.0	--	--	1
Alaska plaice	166.0	--	--	1
Longhead dab	132.8	9.8	121-145	5
Yellowfin sole	69.2	37.1	28-193	281

^aSD = standard deviation, n = sample size.

Table 8. Species composition and numbers of individuals captured with the vertical plankton net (bongo net) during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002.

Species	Approximate % sorted	Tow												Total
		01 25%	02 50%	03 25%	04 34%	05 50%	06 100%	07 100%	08 38%	09 13%	10 25%	11 6%	12 6%	
Jellyfish														
<i>Aequorea</i> sp.	--	--	--	--	--	--	1	--	--	--	--	--	--	1
<i>Aglantha digitale</i>	--	--	--	--	--	--	--	--	--	8	--	--	--	8
<i>Bougainvillea</i> sp.	--	--	--	--	--	--	--	--	--	1	--	--	--	1
Cyaneidae	--	--	--	1	--	3	--	5	4	--	4	18	35	
Cyaneidae, fragment	--	--	--	--	--	1	1	--	--	--	--	--	2	
Bryozoa - contained tissue	--	--	--	--	--	1	--	--	--	--	--	--	1	
Polychaete worm														
Magelonidae juvenile	3240	--	304	198	860	8	25	--	--	--	--	32	4667	
Phyllodocidae juvenile	--	--	--	--	--	--	--	--	16	--	--	--	16	
Polynoidae juvenile (scaleworm)	--	--	4	--	2	1	--	8	--	--	--	--	15	
Bivalve														
Cardiidae juvenile (cockle)	--	--	122	38	8	5	17	8	--	--	--	--	198	
Gastropoda juvenile	--	--	--	--	6	--	10	--	8	--	--	32	56	
Nudibranch Nudibranch	--	--	--	--	--	--	--	4	--	4	--	--	8	
Pteropod														
<i>Limacina helicina</i>	4	--	--	--	--	--	--	--	--	--	32	--	36	
Cirripedia nauplius (barnacle)	4	--	--	--	--	--	--	--	--	--	--	--	4	
Calanoid copepod														
<i>Acartia longiremis</i>	52	--	8	13	2	2	11	--	--	--	--	--	88	
Aetideidae	--	--	--	--	2	--	--	--	--	--	--	--	2	
<i>Calanus marschallae</i>	36	--	--	--	22	--	--	--	--	--	--	--	58	
<i>Calanus pacificus</i>	--	--	--	--	--	--	1	--	--	--	--	--	1	
<i>Centropages abdominalis</i>	192	56	196	38	138	10	51	512	1528	164	2080	768	5733	
<i>Chiridius gracilis</i>	--	--	--	--	--	--	--	--	--	--	--	16	16	
<i>Epilabidocera longipedata</i>	4	2	4	5	--	--	1	40	24	--	704	48	832	
<i>Eurytemora</i> sp.	--	--	--	--	--	--	--	8	--	--	16	--	24	
<i>Neocalanus plumchrus</i>	--	--	--	9	--	2	--	--	16	--	--	16	43	

Table 8. Species composition and numbers of individuals captured with the vertical plankton net (bongo net) during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002 (continued).

Species	Tow												Total
	01	02	03	04	05	06	07	08	09	10	11	12	
<i>Pseudocalanus</i> sp.	60	2	12	--	2	--	2	536	32	--	16	16	678
<i>Tortanus discaudatus</i>	--	--	4	--	2	--	1	8	72	4	48	112	251
Cladoceran													
<i>Evadne</i> sp.	48	--	18	5	4	--	--	--	--	--	--	--	75
<i>Podon</i> sp.	32	230	126	5	6	2	15	248	40	8	--	--	712
Gammarid amphipod													
Oedicerotidae juvenile	--	--	12	--	--	--	2	--	--	--	--	--	14
Podoceridae juvenile	4	--	--	--	2	1	--	--	--	--	--	--	7
Hyperiid amphipod													
<i>Hyperia medusarum</i>	4	--	--	1	--	--	--	--	--	--	1	--	6
<i>Hyperia</i> sp. juvenile	--	--	--	--	--	13	--	--	--	--	--	--	13
Hyperiididae juvenile	--	--	--	--	--	--	--	--	24	--	--	16	40
Cumacean													
<i>Lamprops</i> sp. juvenile	--	--	8	--	--	--	--	--	--	--	--	--	8
Paguridae mysis-zoea (hermit crab)	12	2	76	21	2	--	3	8	8	--	--	--	132
Euphausiid furcilia	4	--	--	--	--	--	--	--	--	--	--	--	4
Crangonidae zoea (shrimp)	68	6	172	5	16	--	9	20	96	16	16	112	536
Mysidae juvenile	--	--	12	--	--	--	--	--	--	--	--	--	12
Insect													
Insect, unid.	--	--	--	--	--	1	--	2	--	--	--	1	4
Diptera (fly)	--	--	--	--	--	--	--	1	--	--	--	--	1
Echinodermata larvae	--	--	--	--	--	--	--	40	568	280	48	544	1480
Arrow worm													
<i>Eukrohnia hamatas</i>	84	2	52	77	36	6	55	--	12	--	--	144	468
Larvacean													
<i>Oikopleura</i> sp.	4	--	--	--	--	--	1	4	--	--	--	--	9
Unid. Invertebrate													
Unid. taxon, trochophore stage	--	--	--	--	--	--	--	--	--	--	16	--	16
Unid. fragments-poss. Larvacean	1	--	1	2	1	--	--	--	--	--	--	--	5

Table 8. Species composition and numbers of individuals captured with the vertical plankton net (bongo net) during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002 (continued).

Species	Tow												Total
	01	02	03	04	05	06	07	08	09	10	11	12	
Fish													
Liparidae larvae (snailfish)	4	--	--	--	--	--	--	--	--	--	--	--	4
<i>Mallotus villosus</i> larvae (capelin)	4	--	--	--	--	--	--	--	--	--	--	--	4
Pleuronectidae larvae	--	--	--	--	--	--	--	--	--	1	--	--	1
Fish eggs, small (<1 mm)	20	6	24	59	14	17	4	40	24	8	112	64	392
Fish larvae, unidentified	8	--	8	--	4	1	2	--	56	4	16	--	99
Debris													
Bryozoa fragment - no tissue	--	--	--	--	--	--	--	1	--	--	--	--	1
Fish scale, fragment	--	--	--	--	--	1	1	1	1	--	--	--	17
Shell, fragment	--	--	--	--	--	1	--	--	1	--	--	--	2
Sponge, spicules	--	--	--	--	--	--	--	--	1	--	--	--	1
Terrestrial plant, fragment	--	--	--	--	--	--	--	--	--	--	--	1	1
Sand grains	--	--	--	--	--	1	1	--	--	--	--	--	2

Table 9. Species composition and numbers of individuals captured with the neuston plankton net (surface tow) during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002.

Approximate % sorted	Tow					Total
	01 10%	02 13%	03 100%	04 6%	05 6%	
Jellyfish						
<i>Aequorea</i> sp.	--	4	--	--	--	4
Cyaneidae	--	--	--	2	2	4
Polychaete worm						
<i>Onuphis</i> sp.	--	--	--	--	1	1
Gastropod						
Gastropoda	--	--	--	1	--	1
Calanoid copepod						
<i>Acartia longiremis</i>	118	--	--	--	--	118
<i>Calanus marschallae</i>	--	--	--	16	--	16
<i>Centropages abdominalis</i>	16	2072	2	1840	2240	6170
<i>Epilabidocera longipedata</i>	--	80	11	2320	1936	4347
<i>Eurytemora</i> sp.	--	--	--	16	16	32
<i>Pseudocalanus</i> spp.	148	--	--	1136	32	1316
<i>Tortanus discaudatus</i>	--	8	--	48	80	136
Cladoceran						
<i>Podon</i> sp.	1	--	--	16	16	33
<i>Evadne</i> sp.	68	--	--	--	--	68
Hyperiid amphipod						
<i>Hyperia medusarum</i>	--	2	--	--	--	2
Crab						
Atelecytidae megalopa	12	--	--	--	--	12
Insect						
Insect, fragment	1	--	--	--	1	2
Diptera (fly)	3	--	10	--	1	14
Diptera (mosquito)	1	--	--	--	--	1
Ephemoptera (mayfly)	18	--	--	--	--	18
Hymenoptera (ant)	35	--	1	--	--	36
Hymenoptera (bee or wasp)	230	24	8	--	--	262

Table 9. Species composition and numbers of individuals captured with the neuston plankton net (surface tow) during SMMOCI sampling near Bluff, Norton Sound, Alaska in July 2002 (continued).

		Tow					Total
		01	02	03	04	05	
	Unknown Insect A	168	16	11	16	--	211
	Insect, unid.	52	96	1	144	4	297
Echinoderm	Echinodermata larvae	16	--	--	--	432	448
Fish	Fish eggs, small (<1 mm)	230	24	52	1056	304	1666
	Fish larvae, unidentified	--	--	--	16	--	16
Debris	Aquatic plant, fragment	1	1	--	--	--	2
	Aquatic plant, fragment (<i>Zostera</i> sp.)	--	--	--	1	--	1
	Barnacle, molt of adult exoskeleton	--	1	--	--	--	1
	Bone, fragment	--	1	--	--	--	1
	Feather, fragment	2	--	--	--	--	2
	Fish scale, fragment	1	1	1	1	--	4
	Shell, fragment	1	1	--	--	--	2
	Terrestrial plant, fragment	1	1	1	--	--	3

Table 10. Locations (decimal degrees), times and dates of CTD casts made near Bluff, Norton Sound, Alaska in July 2002.

Station	Latitude (N)	Longitude (W)	Date	Time ^a	Depth ^b (m)	Notes ^c
1	64.2907°	164.4582°	24 July	08:08	8 (13)	BOTR 01
2	64.3950°	164.7102°	24 July	15:23	23 (28)	VERT 01, NEUS 01
3	64.5113°	164.2730°	24 July	18:36	16 (19)	MWTR 01
4	64.3045°	164.5082°	25 July	03:46	10 (13)	BOTR 02
5	64.2075°	164.3163°	25 July	04:39	12 (16)	BOTR 03
6	64.2583°	164.3767°	25 July	08:14	9 (14)	S. end of TX E, Sta. 1
7	64.3217°	164.3217°	25 July	08:50	8 (14)	TX E, Sta. 2
8	64.3813°	164.0957°	25 July	09:26	8 (16)	TX E, Sta. 3
9	64.4444°	163.9455°	25 July	10:14	8 (16)	TX E, Sta. 4
10	64.5000°	163.8272°	25 July	10:50	9 (16)	TX E, Sta. 5
11	64.5513°	163.7064°	25 July	11:23	7 (14)	N. end of TX E, Sta. 6
12	64.1943°	164.0610°	25 July	20:56	9 (18)	MWTR 02
13	64.2103°	163.9935°	25 July	22:47	14 (17)	BOTR 04
14	64.4068°	163.6583°	26 July	00:42	15 (16)	BOTR 05
15	64.4595°	163.2972°	26 July	15:20	7 (11)	N. end of TX I, Sta. 1, VERT 02, NEUS 02
16	64.4057°	163.4225°	26 July	16:20	14 (17)	TX I, Sta. 2, VERT 03
17	64.3437°	163.5475°	26 July	16:58	15 (19)	TX I, Sta. 3, VERT 04
18	64.2848°	163.6853°	26 July	17:38	14 (16)	TX I, Sta. 4, VERT 05
19	64.2243°	163.8215°	26 July	18:18	10 (17)	TX I, Sta. 5, VERT 06
20	64.1613°	163.9623°	26 July	18:59	12 (19)	S. end of TX I, Sta. 6, VERT 07, NEUS 03
21	64.5213°	164.0433°	27 July	01:32	14 (15)	BOTR 06
22	64.4793°	164.0125°	27 July	02:09	13 (15)	BOTR 07
23	64.0918°	163.5977°	27 July	07:00	15 (20)	MWTR 03
24	63.9272°	163.5960°	27 July	22:25	13 (16)	BOTR 8
25	64.0510°	163.3112°	27 July	23:58	17 (20)	BOTR 9
26	64.5715°	161.7695°	28 July	11:32	6 (8)	N end of TX Q, Sta. 1, VERT 08, NEUS 04
27	64.5188°	161.8947°	28 July	12:25	7 (10)	TX Q, Sta. 2, VERT 09
28	64.4597°	162.0292°	28 July	13:12	9 (14)	TX Q, Sta. 3, VERT 10
29	64.3995°	162.1700°	28 July	14:15	10 (16)	TX Q, Sta. 4, VERT 11
30	64.3398°	162.2990°	28 July	14:58	18 (18)	S. end of TX Q, Sta. 5, VERT 12, NEUS 05
31	64.4583°	163.2990°	28 July	18:32	10 (10)	Prior to MWTR 05
32	64.4448°	163.3352°	28 July	20:18	7 (10)	After MWTR 05
33	64.5068°	163.8558°	29 July	06:50	13 (15)	MWTR 06
34	64.5278°	164.1498°	29 July	10:06	17 (18)	MWTR 07

^aAll times are Alaska Daylight (Universal Coordinated Time minus 8 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 11. Estimates of at-sea densities of seabirds near colonies at several Alaskan sites. Data are from cruises similar to the 2002 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	This Study
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	D. Dragoo Unpubl. Data
Aiktak Island / Unimak Pass, Eastern Aleutians	38	Byrd et al. 1997
Semidi Islands / Northern Gulf of Alaska (2001)	93 ^b	Dragoo 2006
Semidi Islands / Northern Gulf of Alaska (2004)	68	Dragoo 2006
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.

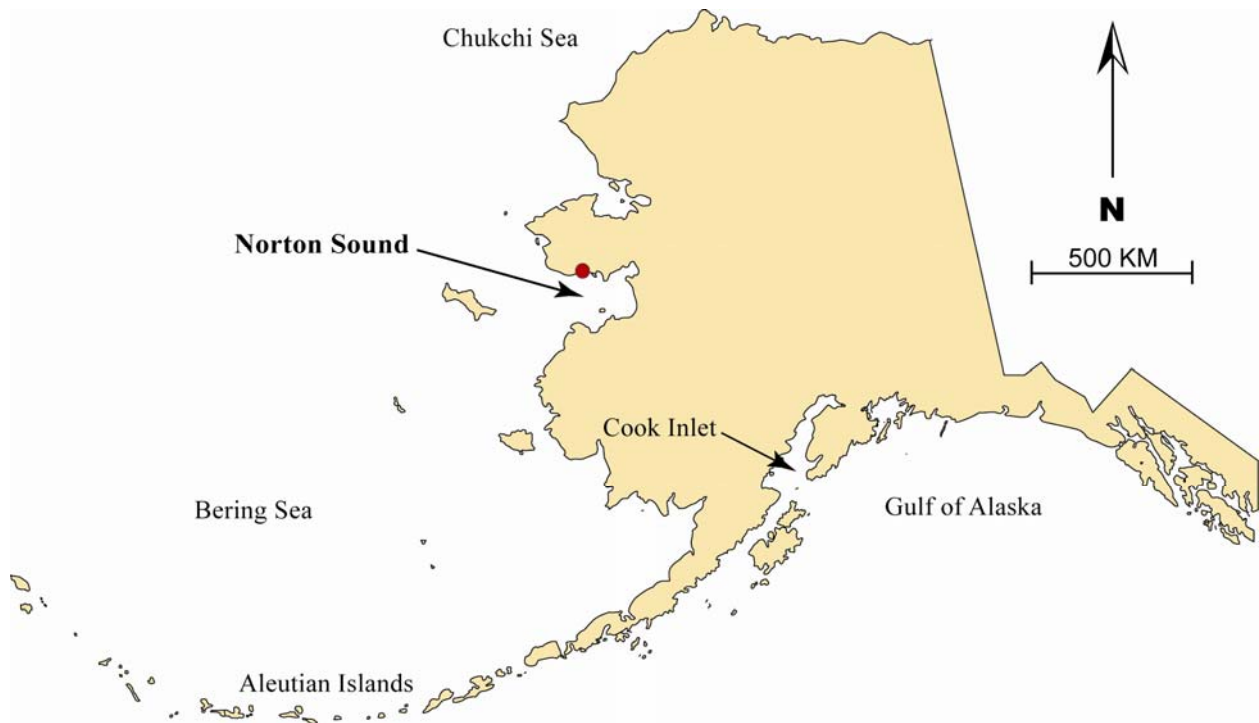


Figure 1. Map of Alaska showing the location of Norton Sound. Red dot indicates the approximate location of the Bluff seabird colony.

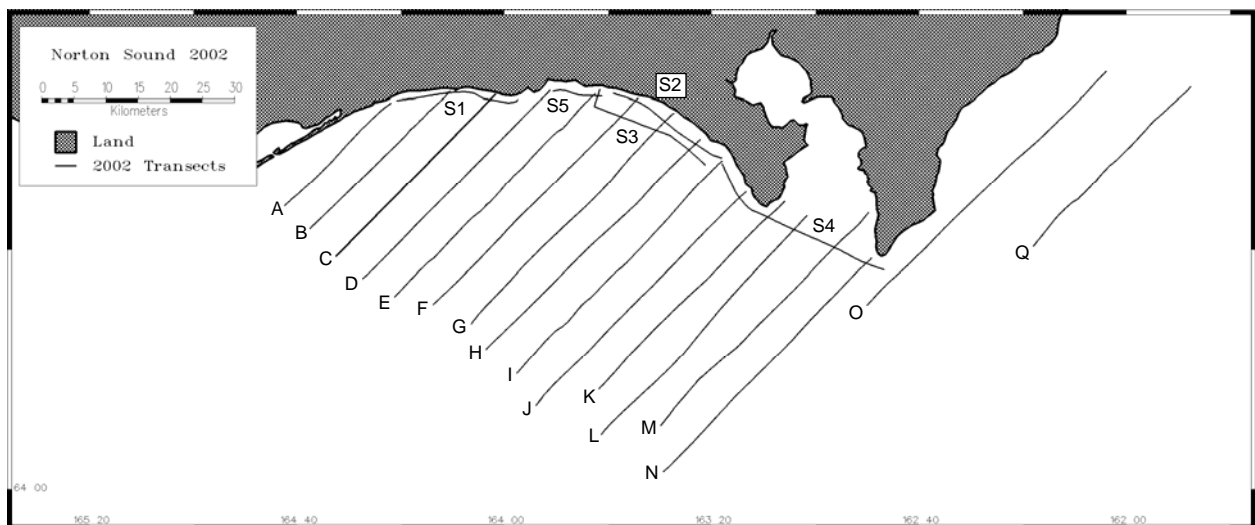


Figure 2. Map of transects surveyed near Bluff, Norton Sound, Alaska in July 2002. Transects shown were derived from GPS positions recorded during surveys.

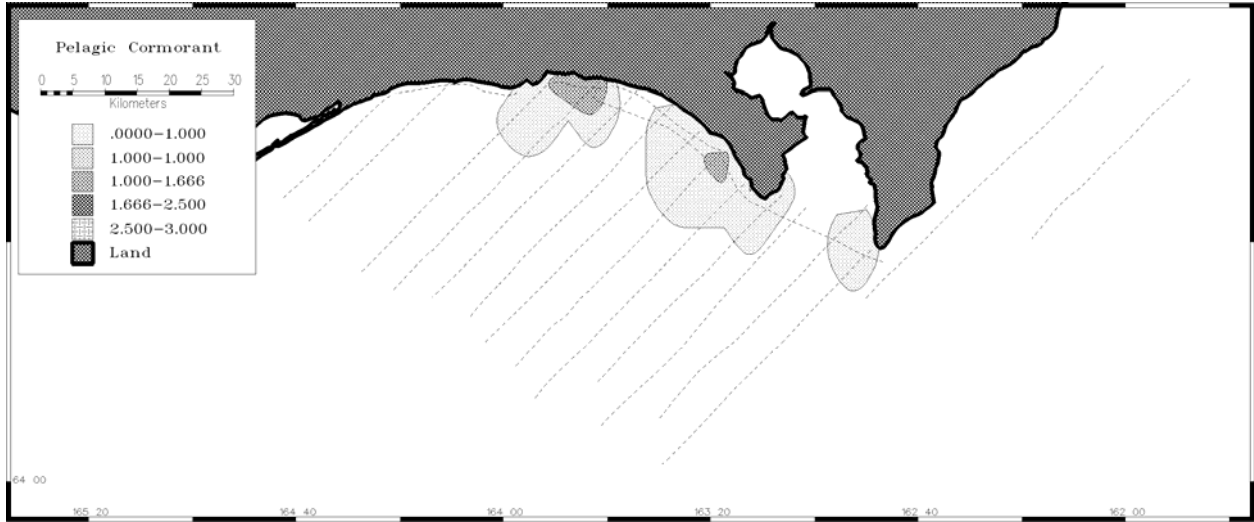


Figure 3. Distribution of pelagic cormorants on transects surveyed near Bluff, Norton Sound, Alaska in July 2002. Includes birds on the water and flying.

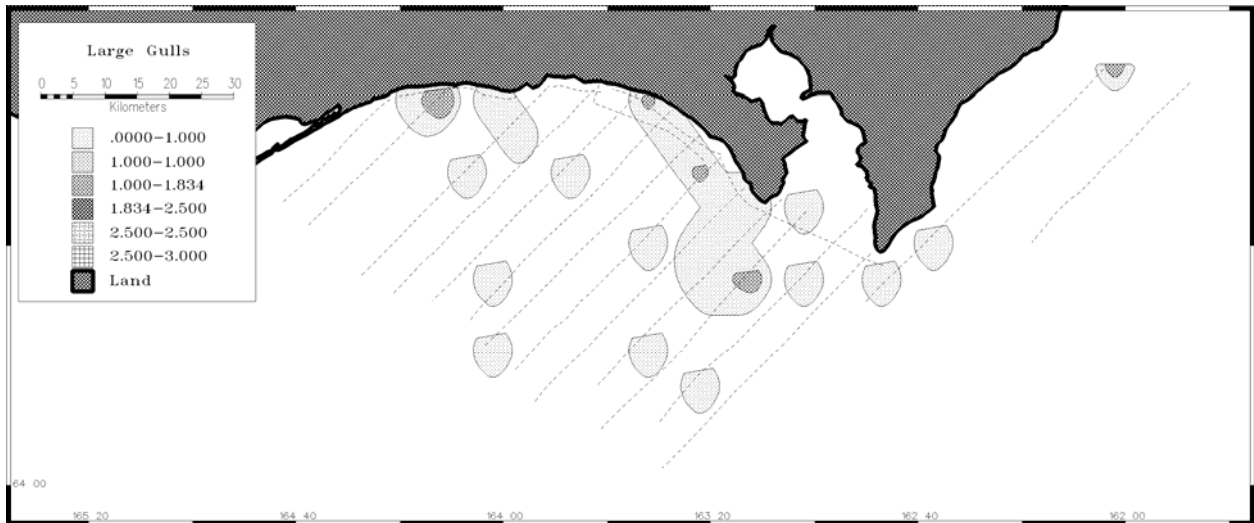


Figure 4. Distribution of large gulls on transects surveyed near Bluff, Norton Sound, Alaska in July 2002. Includes birds on the water and flying.

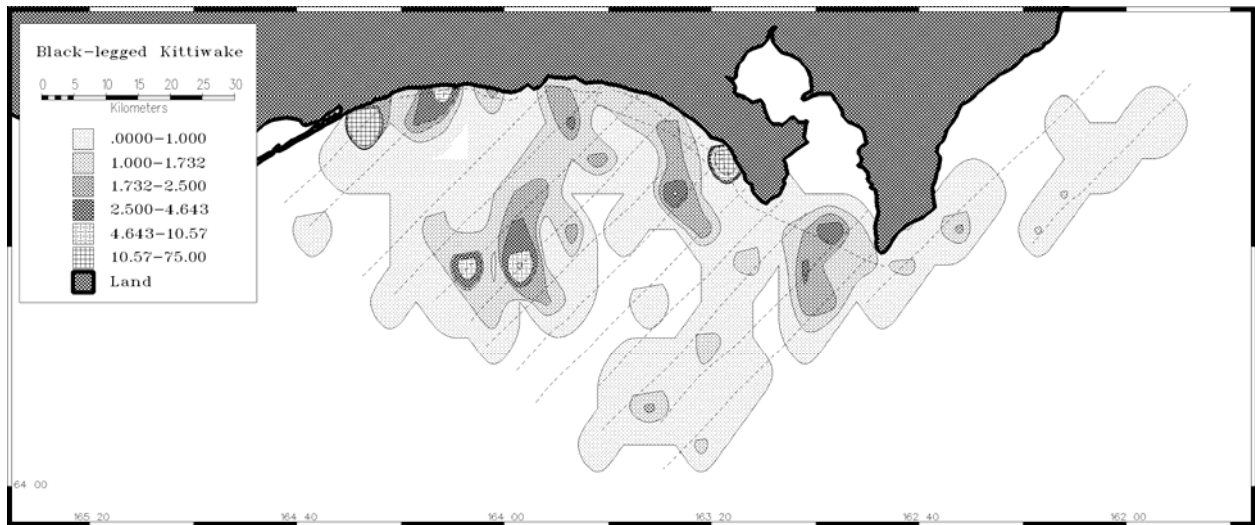


Figure 5. Distribution of black-legged kittiwakes on transects surveyed near Bluff, Norton Sound, Alaska in July 2002. Includes birds on the water and flying.

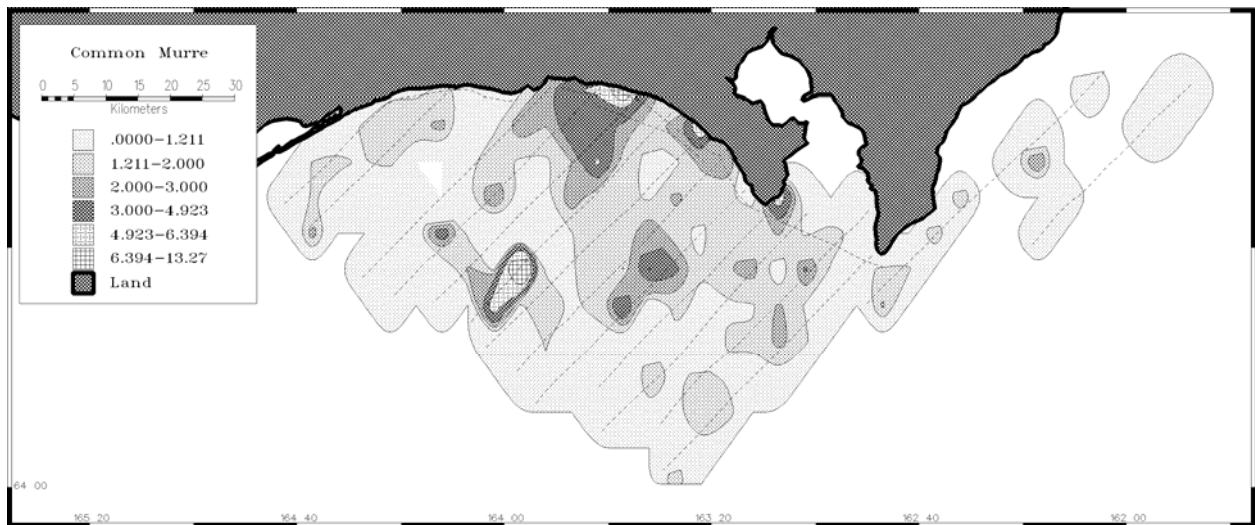


Figure 6. Distribution of common murres on transects surveyed near Bluff Norton Sound, Alaska in July 2002. Includes birds on the water and flying.

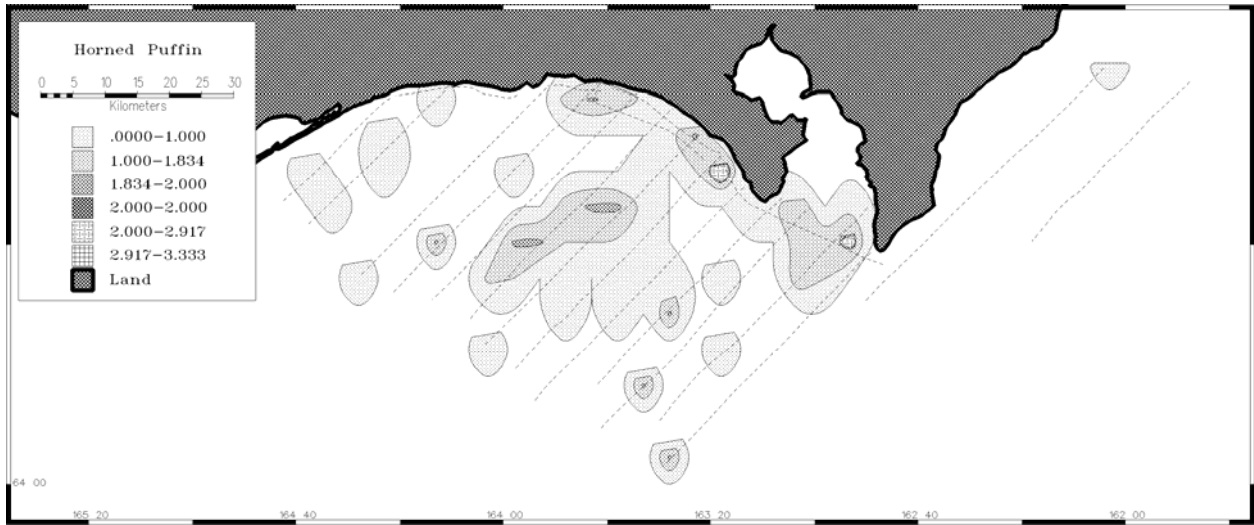


Figure 7. Distribution of horned puffin on transects surveyed near Bluff, Norton Sound, Alaska in July 2002. Includes birds on the water and flying.

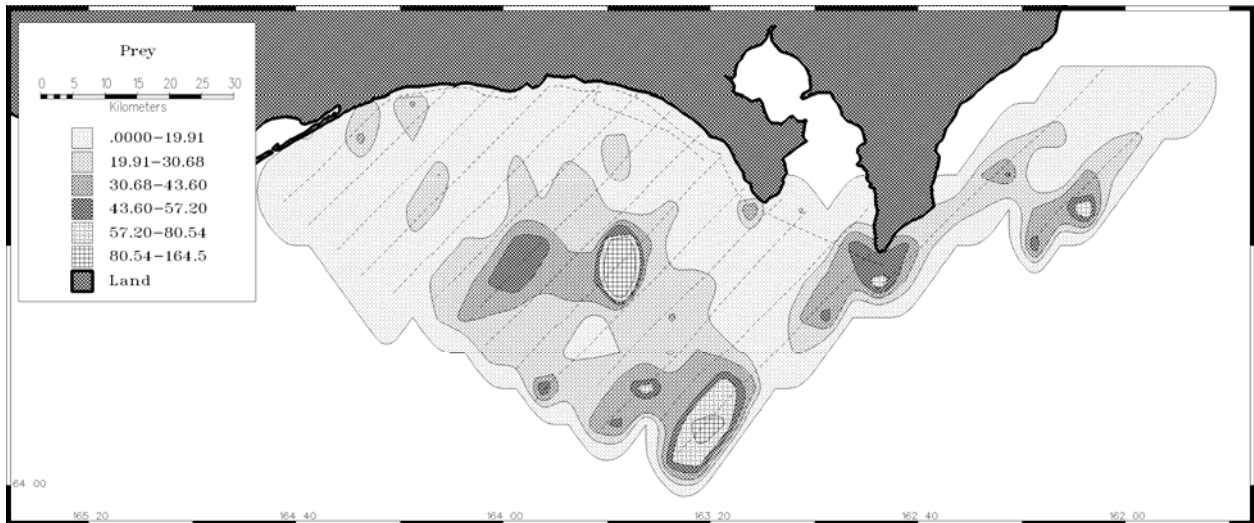


Figure 8. Distribution of prey in the water column (below 7 m), based on acoustic surveys near Bluff, Norton Sound, Alaska in July 2002.

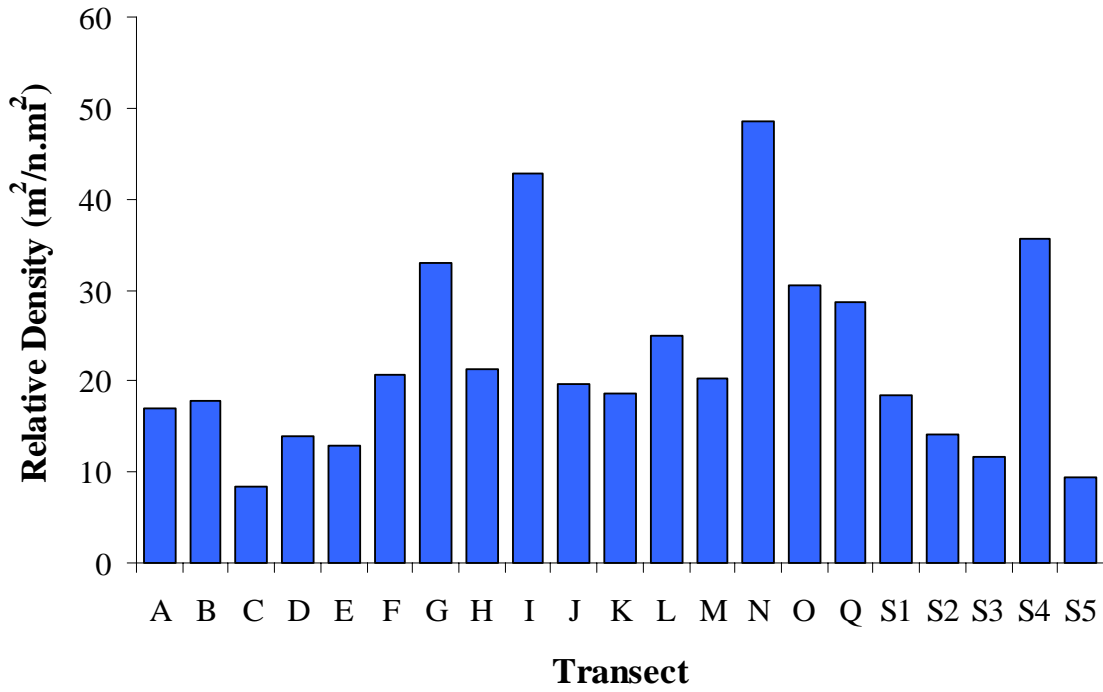


Figure 9. Water column relative prey densities measured during acoustic surveys on transects near Bluff, Norton Sound, Alaska in July 2002.

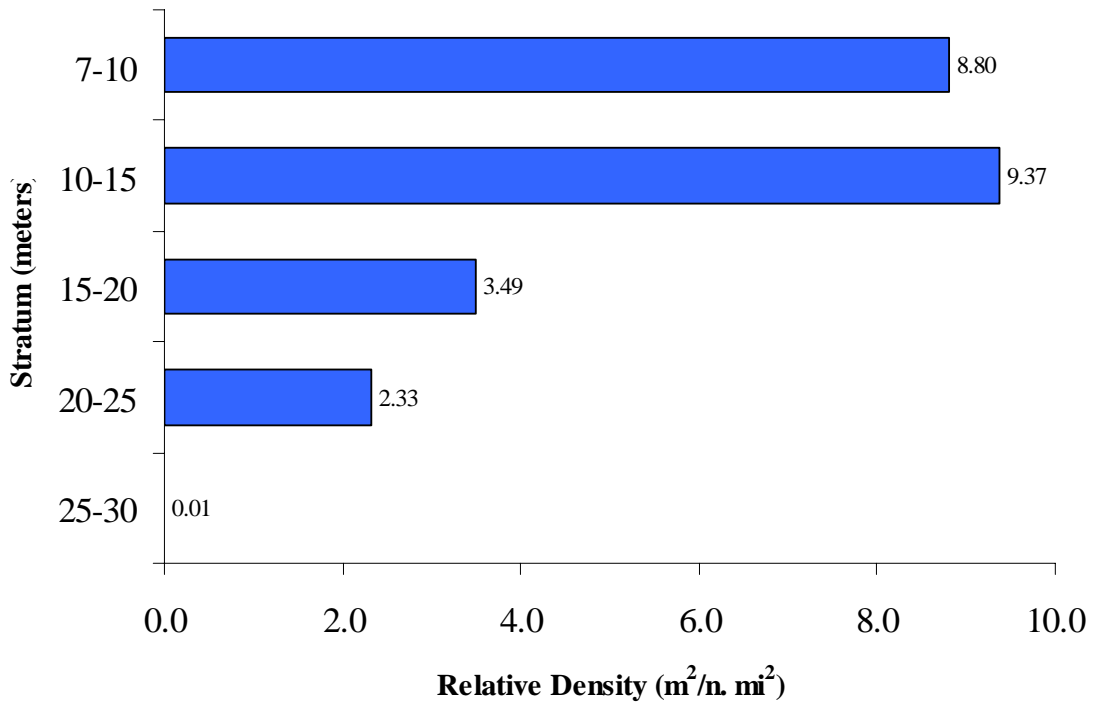


Figure 10. Relative density of prey by depth stratum (excluding surface stratum: 0-7m) measured during acoustic surveys on transects near Bluff, Norton Sound, Alaska in July 2002.

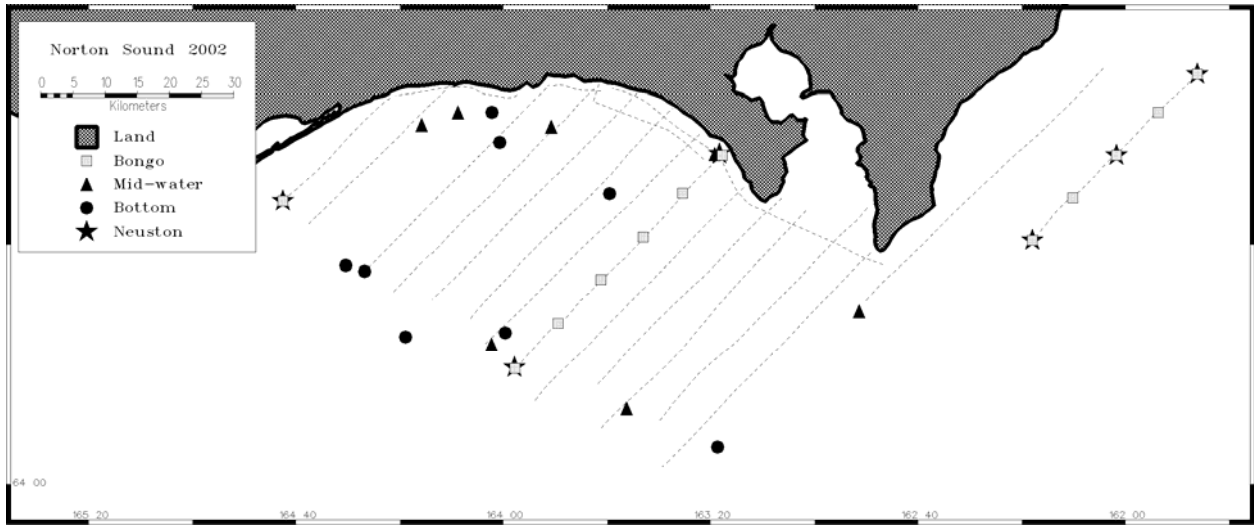


Figure 11. Locations of fishing efforts near Bluff, Norton Sound, Alaska in July 2002.

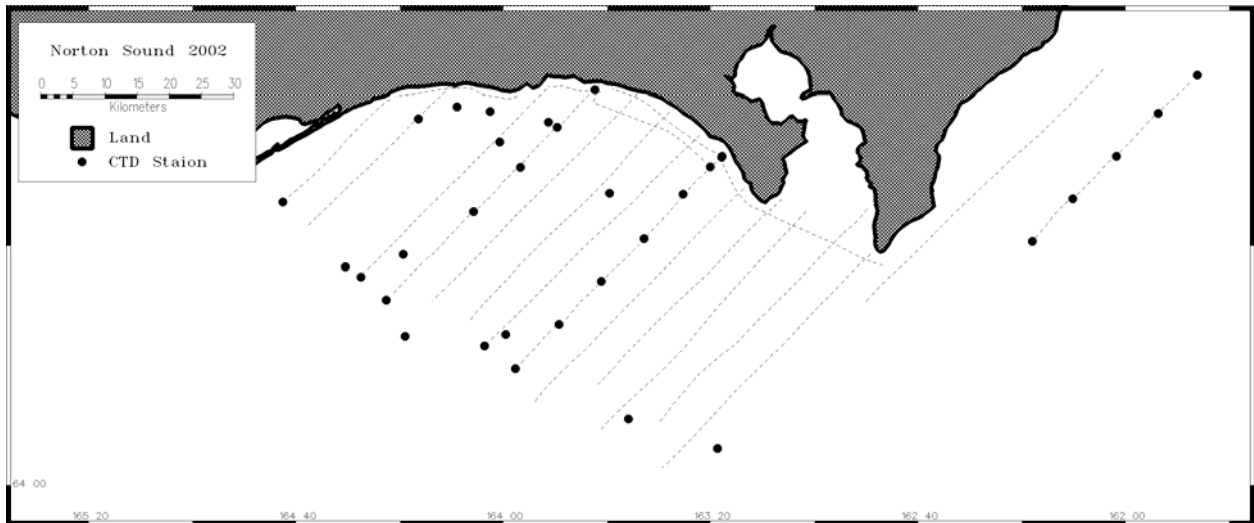


Figure 12. Locations of CTD stations sampled near Bluff, Norton Sound, Alaska in 2002.

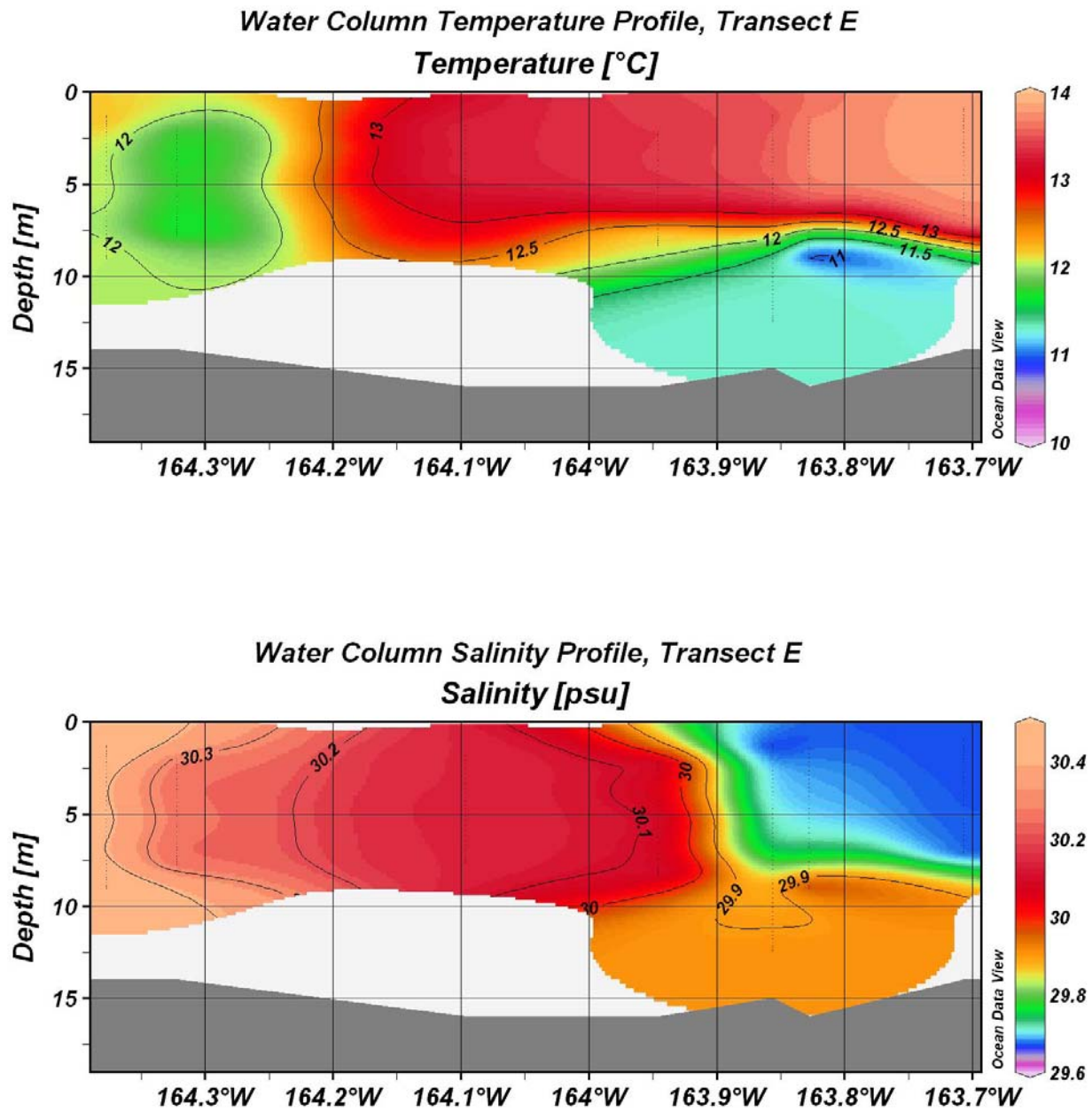


Figure 13. CTD profiles obtained from Norton Sound, Alaska transect E in 2002.

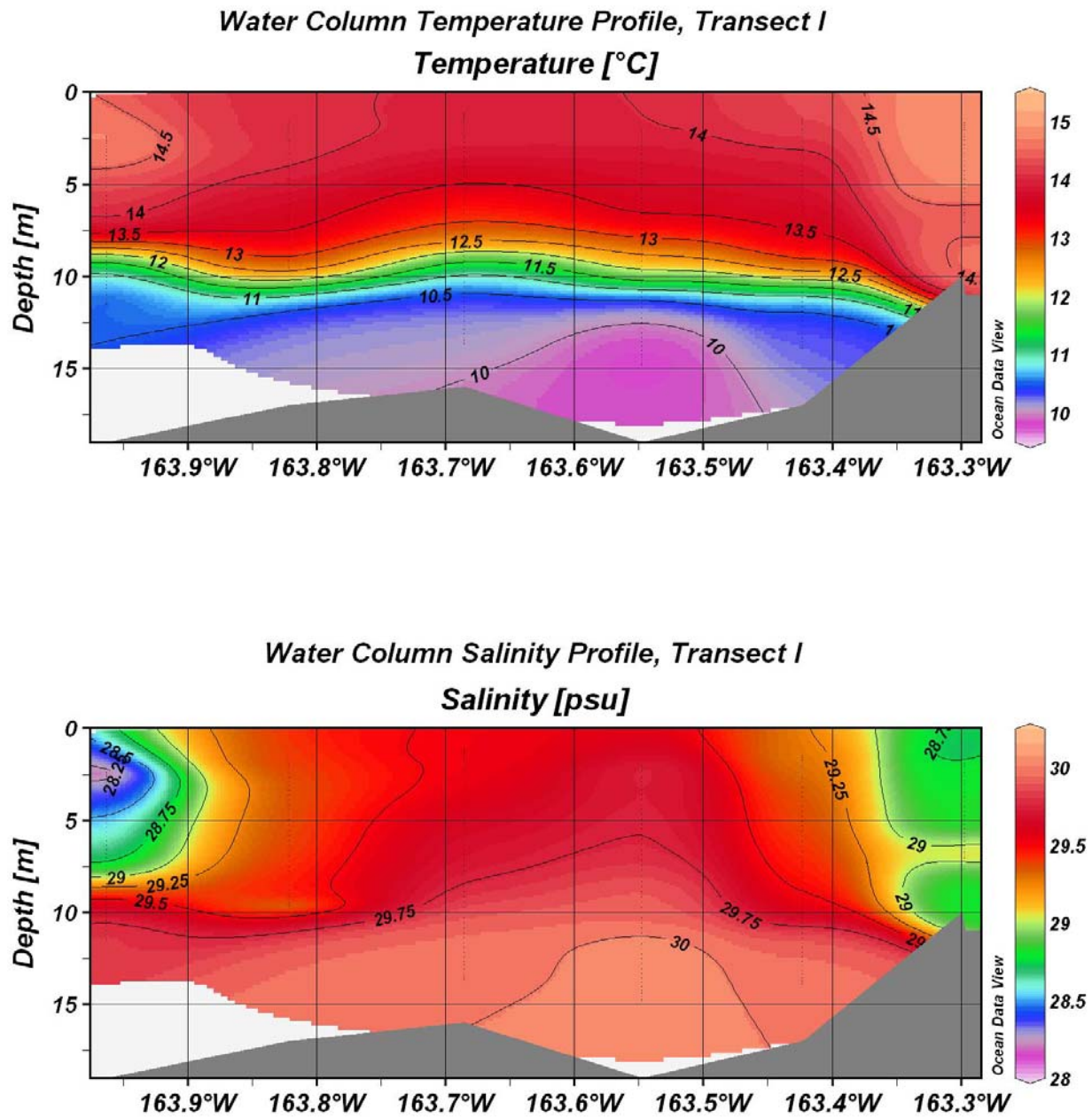


Figure 14. CTD profiles obtained from Norton Sound, Alaska transect I in 2002.

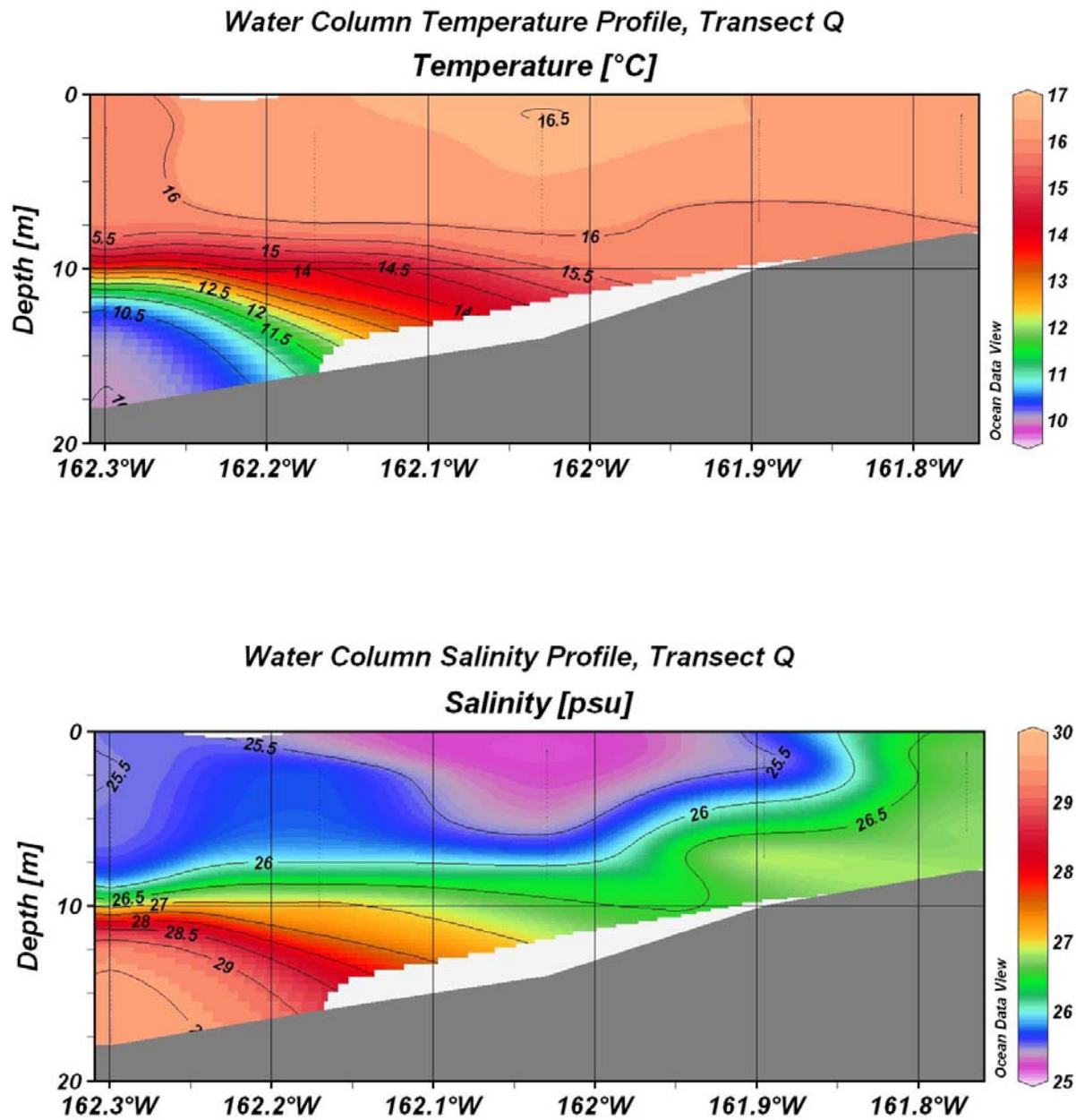


Figure 15. CTD profiles obtained from Norton Sound, Alaska transect Q in 2002.

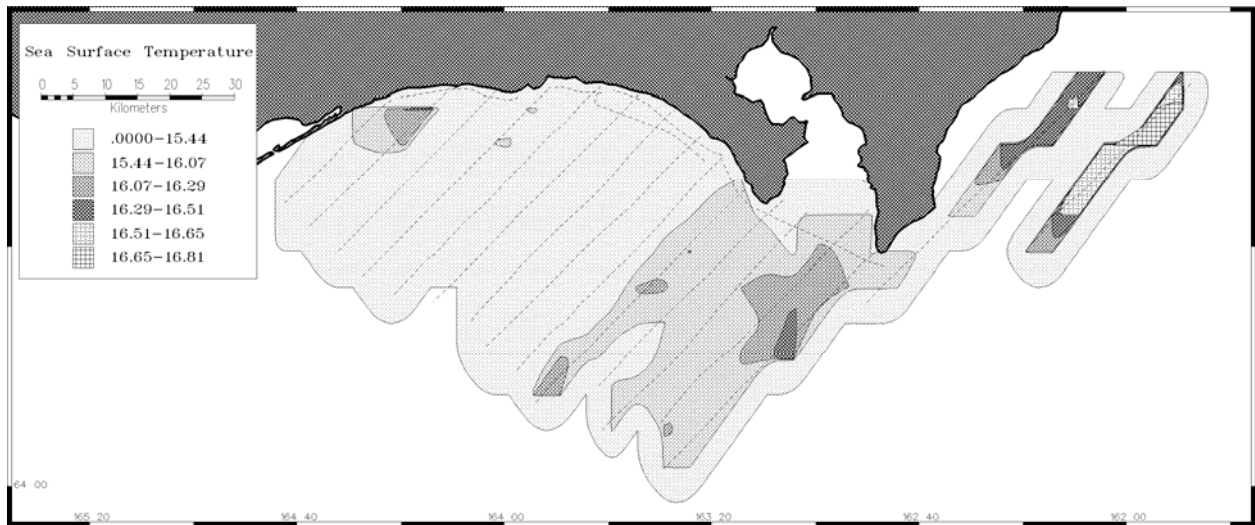


Figure 16. Sea surface temperatures interpolated from thermosalinograph records on transects surveyed near Bluff, Norton Sound, Alaska in 2002.

Appendix A. Numbers of seabirds and marine mammals observed on 20 transects near Bluff, Norton Sound, Alaska in July 2002.

Species/Transect Number ^a	A	B	D	E	F	G	H	I	J	K	L	M	N	O	Q	S1	S2	S3	S4	S5
Pacific loon	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Northern fulmar	--	--	--	--	1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Pelagic cormorant	--	--	2	2	1	1	3	3	--	4	--	1	--	--	--	--	--	6	8	2
Unidentified cormorant	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--
Western sandpiper	--	--	1	--	--	--	--	--	--	--	20	2	--	2	--	--	2	--	--	--
Pectoral sandpiper	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Red-necked phalarope	--	--	--	--	--	1	--	--	1	--	--	--	--	4	--	--	--	--	1	5
Red phalarope	--	--	--	--	--	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--
Pomarine jaeger	--	--	--	1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Parasitic jaeger	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unidentified jaeger	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Herring gull	--	--	--	--	--	--	--	--	--	1	--	--	--	1	--	--	--	--	--	--
Glaucous-winged gull	--	--	2	--	1	1	1	4	1	1	--	--	--	1	--	1	--	--	--	--
Glaucous gull	--	--	--	--	--	1	--	2	1	6	3	2	--	2	--	7	4	--	--	--
Black-legged kittiwake	80	17	17	38	54	110	15	18	9	14	22	45	29	15	17	22	30	7	79	9
Arctic tern	--	--	5	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Common murre	59	104	61	210	111	356	56	144	52	88	80	131	70	39	10	19	95	38	39	219
Unidentified murre	--	--	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Parakeet auklet	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--
Horned puffin	1	6	1	10	2	30	11	6	4	4	20	21	3	1	--	3	7	6	20	5
Tufted puffin	--	--	--	2	--	1	--	--	--	--	--	2	--	--	--	--	--	--	--	1
Minke whale	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--
Largha seal	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--

^aBird/marine mammal data not available for Transect C.

Appendix B. Photographs of some fish species caught during the SMMOCI cruise to Norton Sound, Alaska in 2002 (all by C. Mecklenburg).



Blackline Prickleback



Threaded Sculpin



Arctic Lamprey



Wattled eelpout



Bering Poacher



Tubenose Poacher



Arctic Shanny



Veteran Poacher