

AMNWR 99/05

SEABIRD, MARINE MAMMAL, AND OCEANOGRAPHY COORDINATED
INVESTIGATIONS AT BULDIR ISLAND, ALEUTIAN ISLANDS, ALASKA,
JULY 1998 (SMMOCI-98-3)

by

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Key Words: Alaska, Aleutian Islands, Bering Sea, Buldir Island, CTD, fishes, hydroacoustics, marine mammals, oceanography, pelagic surveys, prey surveys, salinity, seabirds, temperature, thermosalinograph

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November 1999

Cite as: Dragoo, D. E., and G. V. Byrd. 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.

EXECUTIVE SUMMARY

During the period 25 July to 2 August 1998, a group of biologists from the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and the University of Alaska conducted investigations of the distribution of seabirds and marine mammals at sea, assessed prey with acoustic surveys and test fishing, and recorded oceanographic characteristics of the near shore marine waters near Buldir Island, Alaska aboard *M/V Tiġlaġ*. The studies in 1998 were part of a program begun in 1995, called “Seabird, Marine Mammal, and Oceanography Coordinated Investigations” (SMMOCI), whose purpose is to evaluate near shore marine resources near sites where marine birds and mammals are being monitored on shore.

We observed animals on approximately 740 km of transects, covering an area of more than 200 km². The most frequently observed birds were shearwaters, auklets, storm-petrels and fulmars. The highest densities of birds occurred in areas to the southeast of Buldir Island, at the shoal area near Buldir Reef. We also saw three species of cetaceans during transects.

Hydroacoustic surveys were run simultaneously with bird and marine mammal surveys on all 13 transects. The highest estimated water column prey biomass (relative density) occurred on transect 4E. The lowest prey biomass was on Transect 8. The estimated relative density of prey (excluding the surface, 2-12 m, stratum) was highest between about 192 m and 202 m and lowest between about 22 m and 32 m (below the hull-mounted transducer).

We conducted neuston (surface) tows, vertical plankton tows, mid-water trawls, long-line sets and bottom trawls to assess the availability and distribution of prey species, as well as to ground truth the hydroacoustics data. A variety of invertebrate and fish species were captured during this sampling effort. Copepods and amphipods dominated both the vertical and surface plankton tows. Northern rockfish was the most numerous fish species caught during mid-water trawls. Several invertebrate species also were captured. Pacific cod and yellow Irish lords dominated the long-line catch. Pandalid shrimp predominated in bottom trawls.

We made 48 CTD casts and continuously recorded sea surface temperature and salinity. Water column temperatures varied more in some areas than others, indicating the existence of thermoclines at some locations. Water column temperatures ranged from 2.71°C to 9.04°C and salinity ranged from 25.67‰ to 35.05‰. Several fronts were evident where surface temperature or salinity (or both) changed rapidly in a relatively short distance. Surface water temperatures ranged from 4.76°C to 9.19°C and surface salinity ranged from 30.35‰ to 33.52‰.

The results from our surveys show that the near shore waters of Buldir Island are complex, oceanographically and biologically. The fact that Buldir Island is home to a large and varied seabird colony attests to the high productivity of the island’s near shore waters. Future plans for the SMMOCI project include returning to Buldir Island to assess changes that may occur in the near shore environment and biota.

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INTRODUCTION

During the period 25 July to 2 August 1998 a group of biologists from the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and University of Alaska Fairbanks conducted investigations of the distribution at sea of seabirds and marine mammals, assessed prey with acoustics surveys and test fishing, and recorded oceanographic characteristics of the near shore marine waters near Buldir Island, Alaska (Fig. 1). The studies in 1998 were part of a program begun in 1995, called “Seabird Marine Mammal and Oceanography Coordinated Investigations” (SMMOCI) whose purpose is to evaluate near shore marine resources near sites where marine birds and mammals are being monitored on shore (Byrd et al. 1997).

Personnel

The following personnel besides the crew of the *M/V Tiġlaġ* participated in the cruise:

Fish and Wildlife Service: Karen Boylan, Vernon Byrd, Don Dragoo, Richard Heath, Doug Palmer, and Jeff Williams

National Marine Fisheries Service: Mike Strick

Univ. Of Alaska: Brenda Holladay and Bob Foy

Volunteers: Laura Cowen, Gail Fraser, Alejandra de la Mora Nunez

Cruise Schedule

Personnel boarded the *M/V Tiġlaġ* at Adak Island on 23 July 1998. We dropped off several Fish and Wildlife field crews at Kanaga Island and proceeded to Buldir, arriving in the area on the afternoon of 25 July. Observations began on a transect (# 4E, Fig. 2) as we approached Buldir Island and transects and fishing continued throughout the period as weather allowed. Specific activities were as follows:

25 July	Transect conducted as ship approached Buldir Island, fish all night
26 July	Transects conducted all day, fish all night
27 July	Transects conducted all day, fish all night
28 July	Gale force winds, at anchor North Bight, Buldir Island
29 July	Gale force winds, at anchor North Bight, Buldir Island
30 July	Gale force winds, at anchor North Bight, Buldir Island during morning Fish in afternoon, evening and all night
31 July	Transects conducted all day, fish all night
01 Aug.	Transects conducted all day, fish all night
02 Aug.	Transects conducted as vessel departed for Adak Island

METHODS

Bird Observations

We followed methods described in Gould and Forsell (1989) for transects at sea. On transects up to 80 km long (Fig. 2, Table 1), all birds on the water and all marine mammals were recorded to a distance of 150 m on each side of the ship by two observers located on the flying bridge. The transect width was sometimes reduced to 50 m on each side of the ship when visibility was limited by fog. Every three minutes flying birds seen on a 360 degree scan also were recorded. Birds known to be following the ship were not counted. Information was relayed by radio from observers on the flying bridge to an operator in the electronics room who entered the data into a program called “dlog” (developed by Glenn Ford, Ecological Consulting Inc., Portland, OR). The computer was hooked to the ship’s Global Positioning System (GPS) so that every observation was recorded with its exact location and time.

Hydroacoustic Surveys

Acoustics data were collected along the same transects used for marine bird and mammal observations (Fig. 2). Surveys were conducted with the BioSonics 102 system installed on the *M/V Tiglaê*, which has hull mounted (4 m deep) 38 kHz and 120 kHz transducers that can be operated in the multiplexing mode or separately. We used the 120 kHz transducer for transects, all of which occurred during daylight hours. Settings for the 102 unit were: receiver gain -6 dB, TVG=20Log(R), band width 5 kHz, pulse width 0.5 ms, blanking distance 1.0 m, trigger interval 0.5 sec, and transmit power -3dB. All data were echo integrated using BioSonics ESP (version 3.2) software to a maximum depth of 200m. Twenty depth strata were defined for analysis, beginning at 2 m below the transducer to a depth of 202 m, in 10 m increments. The hydroacoustic survey did not sample the upper 6 m of the water column. Data were summarized as: 1) estimated water column biomass (relative density) by transect, and 2) estimated relative density of prey by depth stratum.

Trawls

Mid-water trawls were conducted to describe prey recorded with the hydroacoustics equipment. We used a 6 m modified herring trawl towed for 10 or 15 minutes at 2-3 kts. A net minder was attached to the foot rope of the trawl to determine fishing depth. Samples collected were identified, counted, and measured for length (a subsample only).

To evaluate surface prey we towed a neuston net for 10 or 15 min at 2-3 kts in areas where birds were seen feeding. A plankton hoop net also was deployed vertically in the water column while the vessel was drifting in areas where birds were seen feeding. Prey were preserved for later identification.

Bottom trawls were conducted at subjectively selected locations with a 3.05 m plumb staff beam trawl with a 4 mm stretched mesh at the cod end. This device was towed for 10 min in the direction of the water current at approximately 1.5 kts. Prior to each bottom trawl, a Ponar grab

was used to evaluate the substrate. Samples were identified, counted, measured, and some were preserved for later use.

Long-line Sets

Single skates with 100 hooks baited with herring was deployed at subjectively selected sites for about 2 h. Fish caught (usually halibut, and Pacific cod) were identified, measured, sexed, and their stomachs were removed for later analysis.

Oceanographic Data

A continuous thermosalinograph record was maintained during hydroacoustic surveys with the ship's Seabird Seacat SBE 21 thermosalinograph. A portable CTD (Seabird Seacat SBE-19 Profiler) was deployed at the beginning and end of each transect, and at the end of each fishing event (tow or long-line set). In this way temperature and salinity profiles were obtained for the entire water column.

RESULTS

Bird and Marine Mammal Observations

We observed animals on approximately 740 km of transects, covering an area of more than 200 km² (Fig. 2). Gale force winds precluded surveys on transects for three days. Otherwise the sea conditions were good to excellent. Transect widths were reduced on some surveys due to foggy conditions (Appendix A). The most frequently observed birds were shearwaters, auklets, storm-petrels and fulmars (Table 2). The highest densities of birds occurred in areas to the southeast of Buldir Island, at the shoal area near Buldir Reef (Fig. 3). The transect covering this area (T3) had by far the highest numbers of birds observed during the survey of the near shore waters of Buldir Island. Least auklets, short-tailed shearwaters, fork-tailed storm-petrels and northern fulmars were the most numerous birds seen on transect T3 (Appendix B).

Dall's porpoise were the most commonly seen marine mammal (Table 3). The highest number of whales seen on a single transect was 28 killer whales on transect 1 (Appendix C). The following annotated list summarizes our observations.

Procellariids.--More than 400 albatross (nearly all Laysan) were seen during this survey (Table 2). The highest numbers of both species of albatross occurred on transect T3 (Appendix B). Northern fulmars were one of the most numerous birds observed on our transects with 3,426 individuals observed. The highest density of fulmars occurred on transects 9 and T3 (Fig. 4). Mottled petrels were observed on three transects. Shearwaters were more numerous than fulmars with nearly 10,000 individuals seen (Table 2). Short-tailed shearwaters comprised the vast majority of shearwaters seen, mostly on transect T3 (Fig. 5, Appendix B). Most of the nearly 5,000 storm-petrels we observed were fork-tailed (Table 2). Fork-tailed storm-petrels were seen

in the highest densities in two areas; southeast and northwest of Buldir Island (Fig. 6). We found the highest densities of Leach's storm-petrels south of the island on transects T1 and T2 (Fig. 7).

Cormorants.--We observed six red-faced cormorants on two transects (Table 2, Appendix B), all near the island (Fig. 8).

Shorebirds.--Phalaropes were the only shorebird we saw during our transects near Buldir Island (Table 2). All of the identified phalaropes were red phalaropes but most phalaropes were recorded as unidentified. The highest concentration of phalaropes occurred south of Buldir Island on transect T1 (Fig. 9, Appendix B).

Jaegers and Gulls (other than kittiwakes).--We observed one pomarine jaeger, one parasitic jaeger and one slaty-backed gull on transect 1 (Table 2, Appendix B). The 461 glaucous-winged gulls we counted during this survey were fairly widely dispersed on all transects (Table 2, Appendix B), with the highest densities west of Buldir Island (Fig. 10).

Kittiwakes.--The highest densities of black-legged kittiwakes occurred southeast of Buldir Island (Fig. 11, Appendix B). The vast majority of kittiwakes we identified to species were black-legged kittiwakes (Table 2). Nearly all of the red-legged kittiwakes we counted occurred on transect T3 (Fig. 12, Appendix B). This species was encountered in very low numbers during our transects (Table 2).

Murres.--Murre densities were highest northwest of Buldir Island (Fig. 13). Nearly half of the murres sighted were not identified to species (Table 2). The highest densities of both common (Fig. 14) and thick-billed (Fig. 15) murres occurred west and northwest of the island. We counted the highest numbers of murres on transect 3 (Appendix B).

Murrelets and Auklets.--We encountered the highest densities of murrelets and auklets (including the category "unidentified small dark Alcid") southeast of Buldir Island on Transect T3 (Fig. 16). This was primarily due to the large number of least auklets that we counted on this transect (Appendix B). We counted over 8,500 small dark Alcids in the waters near Buldir Island (Table 2). In contrast to least auklets, parakeet auklets exhibited higher densities to the northwest of the island (Fig. 17). The vast majority of the least auklets we saw were on transect T3 southeast of Buldir Island, with another area of relatively high density northwest of the island (Fig. 18, Appendix B). Like parakeet auklets, both whiskered auklets (Fig. 19) and crested auklets (Fig. 20) exhibited the highest densities northwest of Buldir Island.

Puffins.--The majority of puffins we identified during this survey were tufted puffins (Table 2). The densest concentrations of this species occurred northwest of Buldir Island (Fig. 21), with the highest numbers being seen on transect 3 (Appendix B). The highest densities of horned puffins were south and southeast of Buldir Island (Fig. 22).

Cetaceans.--All species of cetaceans observed on our transects had a density of fewer than one animal per square kilometer (Table 3). Most of the minke whales we counted were on

transect T3, while all of the killer whales were seen on transect 1 (Appendix C). Dall's porpoise were seen in low numbers on nine of the 13 transects we surveyed near Buldir Island (Table 3, Appendix C).

Prey

Acoustics Surveys.--Hydroacoustic surveys were run simultaneously with bird and marine mammal surveys on all 13 transects. The highest estimated water column prey biomass (relative density) occurred on transect 4E. The lowest prey biomass was on Transect 8 (Table 4, Fig. 23). The estimated relative density of prey (excluding the surface, 2-12 m, stratum) was highest in stratum 20 (192-202 m below the hull-mounted transducer). Relative prey density was lowest in stratum 3 (22-32 m below the hull-mounted transducer) (Table 5, Fig. 24).

Neuston Tows.--We made 7 neuston tows in areas where we observed birds feeding on the surface (Fig. 25, Appendix D). Larval fishes and several invertebrate species were captured during these tows (Table 6). Calanoid copepods and Hyperiid amphipods were the most numerous organisms we identified.

Vertical Plankton Tows.--We sampled plankton with the vertical hoop plankton net six times (Fig. 25, Appendix D). Larval fishes and several invertebrate species were captured during these tows (Table 7). Calanoid copepods were the most numerous organisms we identified. Hyperiid amphipods and Chaetognaths (arrow worms) were present in every tow.

Mid-water Trawls.--We deployed the mid-water trawl four times in 1998 (Fig. 25, Appendix D) but only two (number 1 and number 4) contained identifiable prey samples (Table 8). Northern rockfish was the most numerous fish species caught. Atka mackerel, yellow Irish lord and northern ronquil were the only other species identified (Table 8). Invertebrates captured included jellyfish, crustaceans, sea salps and arrow worms.

Long-line Surveys.--Long-lines were set in two locations near Buldir Island in 1998 (Fig. 25, Appendix D). Pacific cod and yellow Irish lords dominated the catch (Table 9). Low numbers of other species also were present.

We collected the stomachs from Pacific cod and Pacific halibut so their contents could be identified. We sent a total of 69 cod stomachs and 5 halibut stomachs to be analyzed. Of those, 48 cod and 1 halibut contained prey, the remainder were empty. Atka mackerel made up a large portion (by both frequency and weight) of the contents of Pacific cod stomachs (Table 10, Fig. 26). Cephalopods, crustaceans and other fishes also were important components of cod stomach contents. The single non-empty Pacific halibut stomach contained a small amount of hermit crab remains.

Bottom Trawls.--We conducted 18 bottom trawls (Fig. 25, Appendix D), capturing a wide variety of species (Table 11). Pandalid shrimp were the most numerous animals caught, with more than 1300 individuals represented in our trawls. Over 1000 shrimp were captured

during bottom trawl 17, near the east end of transect 4W (Fig. 25). Bivalves, polychaete worms, amphipods, sea stars, brittle stars and sand dollars also were numerous (Table 11).

Sculpins of the genus *Triglops* were the most numerous fishes caught during bottom trawls (Table 11), mostly on trawl 6 just north of Buldir Island (Fig. 25). Other sculpins also were present, including yellow Irish lord and northern sculpin. The rock sole was one of the more abundant fish species captured. Several other fish species were represented by one to a few individuals (Table 11).

Oceanography

CTD Casts.--We made 48 CTD casts including those on transects and those at some fishing stations (Fig. 26, Appendix E). Most CTD casts showed a pattern of decreasing temperatures with increasing depth. This was fairly pronounced in some casts (e.g., Station 32, Appendix F) but temperature changes were very small in other casts (e.g., Stations 10 through 14, Appendix F). Water column temperatures ranged from 2.71°C at the east end of Transect 3 to 9.04°C at the east end of Transect 5 (appendix E).

Salinity did not vary as much as temperature in our CTD casts (Appendix F). Water column salinity ranged from 25.67‰ at bottom trawl 10 to 35.05‰ at long-line set 1 (Appendix E).

Thermosalinograph.--We continuously recorded (every 60 seconds) readings of the temperature and salinity of surface water (Appendix G). Both the temperature and salinity of the surface water near Buldir Island varied. Surface water temperature ranged from 4.76°C on transects 6 and 7 to 9.19°C on transect 5. We often encountered lower surface water temperatures as we transected over shallower water (e.g., transects 4E and 5). Salinity of surface water ranged from 30.35‰ on transect 4E to 33.52‰ on transect 5.

DISCUSSION

None of the birds sampled during this study displayed a uniform distribution. We found that all species or groups for which we produced maps exhibited a patchy distribution with a few to several higher density areas. This patchiness may be due, in part, to the probable occurrence of frontal systems and upwellings associated with local bathymetry, such as Buldir and Tahoma reefs, and shoaling near the island (Fig. 2, Appendix G [e.g. Transects 5 and 7]). Water circulation is known to be intense in this area of the Aleutian Islands (Springer et al. 1999). The highest density of all birds combined was in the Buldir Reef area (Fig. 3). Relatively few red-legged kittiwakes were seen during transects, possibly because we surveyed during daylight and, with their larger eyes they probably are more nocturnal than black-legged kittiwakes (Storer 1987).

As stated earlier, the highest estimated water column prey biomass occurred on Transect 4E and the lowest was on Transect 8 (Table 4, Fig. 23). Both Transect 4E and Transect 8 had fairly low bird densities. The transect with the highest overall bird densities (T3) had only moderately high

estimated prey biomass. The estimated relative density of prey was highest between 192 m and 202 m depth (Table 5, Fig. 24). The prey at these depths is probably within the diving range of murre (Piatt and Nettleship 1985).

The results from our surveys show that the near shore waters of Buldir Island are complex, oceanographically and biologically. The fact that Buldir Island is home to a large and varied seabird colony attests to the high productivity of the island's near shore waters. Future plans for the SMMOCI project include returning to Buldir Island to assess changes that may occur in the near shore environment and biota.

ACKNOWLEDGMENTS

We would like to thank all of the people who helped gather data during the 1998 Buldir Island SMMOCI survey. Their perseverance, professionalism and good cheer were much appreciated. John Piatt and Gary Drew gave Don Dragoo valuable assistance with editing the hydroacoustics data for this report. Robert Foy identified the specimens from the plankton tows, and Mei-Sun Yang identified the contents of the cod and halibut stomach samples. We appreciate their assistance. We would also like to thank the staff of Alaska Maritime National Wildlife Refuge, Homer for their help and support, especially Belinda Dragoo who helped copy, review and compile this report. Finally, we would like to express our sincere thanks to the captain and crew of *M/V Tiġlaġ* without whose enthusiasm, professionalism and patience this work would not have been possible.

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Table 1. Locations (decimal degrees) and times of surveys of transects used for bird and marine mammal observations and hydroacoustics surveys near Buldir Island, Alaska, during 1998 summer surveys (July and August).

Transect	Date	Start Latitude (N)	Start Longitude (E)	Stop Latitude (N)	Stop Longitude (E)	Start Time ^a	Stop Time ^a
1	7/25	52.5028°	175.4948°	52.5004°	176.4999°	0835	1236
2	7/31	52.4510°	176.4982°	52.4505°	175.5037°	1510	1902
3	7/31	52.4021°	175.5033°	52.3996°	176.4983°	1018	1411
4E	7/25	52.3508°	176.6140°	52.3502°	175.9827°	1221	1445
4W	7/31	52.3481°	175.8475°	52.3516°	175.4998°	0811	0938
5	7/27	52.3030°	175.5002°	52.3004°	176.6178°	1418	1858
6	7/27	52.2536°	176.6225°	52.2500°	175.4988°	0946	1325
7	7/26	52.2008°	175.5154°	52.2001°	176.6134°	1330	1745
8	8/01	52.5521°	176.4924°	52.5500°	175.5033°	1324	1728
9	7/26	52.1295°	176.6120°	52.1336°	175.5050°	0811	1231
T1	8/02	51.8769°	175.7216°	51.7745°	176.0002°	0808	0927
T2	8/02	51.7748°	175.9998°	52.0656°	176.0353°	0944	1134
T3	8/02	52.0859°	176.3296°	52.1091°	177.0498°	1312	1545

^aAll times are Aleutian Daylight.

Table 2. Species composition and numbers of seabirds observed on 13 transects near Buldir Island, Alaska during 1998 summer surveys (July and August).

Species	Scientific Name	No. Observed	% Total	Density ^a
All bird species total		30,483	100.0	145
Black-footed Albatross	<i>Diomedea nigripes</i>	24	<0.1	<1
Laysan Albatross	<i>Diomedea immutabilis</i>	386	1.3	2
Northern Fulmar	<i>Fulmarus glacialis</i>	3,426	11.2	16
Mottled Petrel	<i>Pterodroma inexpectata</i>	6	<0.1	<1
All Shearwaters	<i>Puffinus</i> spp.	9,945	32.6	47
Sooty Shearwater	<i>Puffinus griseus</i>	24	<0.1	<1
Short-tailed Shearwater	<i>Puffinus tenuirostris</i>	8,959	29.4	43
Fork-tailed Storm-petrel	<i>Oceanodroma furcata</i>	4,449	14.6	21
Leach's Storm-petrel	<i>Oceanodroma leucorhoa</i>	533	1.8	3
Red-faced Cormorant	<i>Phalacrocorax urile</i>	6	<0.1	<1
All Phalaropes	<i>Phalaropus</i> spp.	425	1.4	2
Red Phalarope	<i>Phalaropus fulicaria</i>	179	0.6	<1
Pomarine Jaeger	<i>Stercorarius pomarinus</i>	1	<0.1	<1
Long-tailed Jaeger	<i>Stercorarius longicaudus</i>	1	<0.1	<1
Slaty-backed Gull	<i>Larus schistsagus</i>	1	<0.1	<1
Glaucous-winged Gull	<i>Larus glaucescens</i>	461	1.5	2
All Kittiwakes	<i>Rissa</i> spp.	575	1.9	3
Black-legged Kittiwake	<i>Rissa tridactyla</i>	498	1.6	2
Red-legged Kittiwake	<i>Rissa brevirostris</i>	25	<0.1	<1
All Murres	<i>Uria</i> spp.	513	1.7	2
Common Murre	<i>Uria aalge</i>	24	<0.1	<1
Thick-billed Murre	<i>Uria lomvia</i>	250	0.8	1
Pigeon Guillemot	<i>Cephus columba</i>	1	<0.1	<1
All Small Dark Alcids	<i>Alcidae</i>	8,563	28.1	41
Ancient Murrelet	<i>Sinthliboramphus antiquus</i>	77	0.3	<1
Cassin's Auklet	<i>Ptychoramphus aleuticus</i>	3	<0.1	<1
Parakeet Auklet	<i>Cyclorrhynchus psittacula</i>	448	1.5	2
Least Auklet	<i>Aethia pusilla</i>	6,458	21.2	31
Whiskered Auklet	<i>Aethia pygmaea</i>	164	0.5	<1
Crested Auklet	<i>Aethia cristatella</i>	1,140	3.7	5
All Puffins	<i>Fratercula</i> spp.	1,167	3.8	6
Tufted Puffin	<i>Fratercula cirrhata</i>	912	3.0	4
Horned Puffin	<i>Fratercula corniculata</i>	252	0.8	1

^aIndividuals/km². A total of 210.4 km² was surveyed.

Table 3. Species composition and numbers of marine mammals observed on 13 transects near Buldir Island, Alaska during 1998 summer surveys (July and August).

Species	Scientific Name	No. Observed	% Total	Density ^a
Minke Whale	<i>Balaenoptera acutorostrata</i>	12	12.9	<1
Killer Whale	<i>Orcinus orca</i>	28	30.1	<1
Dall's Porpoise	<i>Phocoenides dalli</i>	53	57.0	<1

^aIndividuals/km². A total of 210.4 km² was surveyed.

Table 4. Estimated water column biomass (relative density) by transect near Buldir Island, Alaska in 1998.

Transect	Water Column Relative Density	Date (Time)
1 (239) ^a	0.00034907 (0.00074268) ^b	01 August (0835-1236)
2 (227)	0.00051599 (0.00247838)	31 July (1510-1902)
3 (234)	0.00037898 (0.00145574)	31 July (1018-1411)
4E (149)	0.00433782 (0.00518011)	25 July (1221-1445)
4W (81)	0.00039290 (0.00080347)	31 July (0811-0938)
5 (279)	0.00105279 (0.00455247)	27 July (1418-1858)
6 (280)	0.00251079 (0.00636018)	27 July (0946-1325)
7 (258)	0.00027288 (0.00138958)	26 July (1330-1745)
8 (229)	0.00014677 (0.00077049)	01 August (1324-1728)
9 (260)	0.00315607 (0.00387668)	26 July (0811-1231)
T1 (80)	0.00175564 (0.00498764)	02 August (0808-0927)
T2 (111)	0.00106159 (0.00366955)	02 August (0944-1134)
T3 (155)	0.00161834 (0.01039787)	02 August (1312-1545)

^aSample size (number of records) in parentheses.

^bStandard deviation in parentheses.

Table 5. Estimated relative density of prey by depth stratum near Buldir Island, Alaska in 1998.

Surface stratum (2-12 m) excluded.

Stratum	Relative Density ^a	Number of Transects in Which Stratum Occurred
2 (12 to 22 m) ^b	0.00083 (0.00162) ^c	13
3 (22 to 32 m)	0.00073 (0.00158)	13
4 (32 to 42 m)	0.00077 (0.00200)	13
5 (42 to 52 m)	0.00082 (0.00177)	13
6 (52 to 62 m)	0.00142 (0.00773)	13
7 (62 to 72 m)	0.00164 (0.00717)	13
8 (72 to 82 m)	0.00131 (0.00390)	13
9 (82 to 92 m)	0.00138 (0.00429)	13
10 (92 to 102 m)	0.00146 (0.00476)	13
11 (102 to 112 m)	0.00149 (0.00567)	13
12 (112 to 122 m)	0.00137 (0.00464)	13
13 (122 to 132 m)	0.00136 (0.00414)	13
14 (132 to 142 m)	0.00135 (0.00425)	13
15 (142 to 152 m)	0.00131 (0.00402)	13
16 (152 to 162 m)	0.00128 (0.00345)	13
17 (162 to 172 m)	0.00142 (0.00417)	13
18 (172 to 182 m)	0.00157 (0.00446)	13
19 (182 to 192 m)	0.00170 (0.00486)	13
20 (192 to 202 m)	0.00192 (0.00473)	13

^aEstimated water column relative prey density for the current stratum averaged over all transects.

^bDepth range of stratum.

^cStandard deviation in parentheses.

Table 6. Percent count of species captured with neuston net during Buldir Island, Alaska SMMOCI sampling in 1998.

Species	Tow Number						
	1	2	3	4	5	6	7
Gastropoda	5.29	1.35	0.00	8.42	0.00	0.00	1.68
Polychaeta (Tomopteridae)	0.00	0.00	0.00	0.70	0.00	0.00	0.00
Ostracoda	0.00	1.35	0.00	0.00	0.00	0.00	0.00
<i>Neocalanus cristatus</i> (Calanoida)	1.32	0.00	6.40	0.00	3.96	0.00	0.00
<i>Neocalanus plumchrus</i> (Calanoida)	22.03	16.67	52.80	4.56	36.12	0.15	4.62
<i>Eucalanus bungii</i> (Calanoida)	6.61	57.66	4.00	5.26	1.32	6.17	34.45
<i>Gaidius variabilis</i> (Calanoida)	26.43	0.90	0.00	0.00	0.00	67.17	0.00
<i>Calanus marshallae</i> (Calanoida)	17.62	9.01	12.00	4.21	8.37	7.53	33.61
Unidentified copepod (Calanoida)	0.44	0.00	0.00	0.00	0.00	0.00	0.00
Mysidae (Mycidacea)	1.76	0.00	8.80	0.00	4.41	0.60	9.66
Gammaridea (Amphipoda)	0.00	0.00	0.00	0.00	0.00	0.15	0.00
Hyperidea (Amphipoda)	7.93	0.90	16.00	76.84	45.81	17.02	6.30
<i>Sagitta elegans</i> (Chaetognatha)	10.57	11.71	0.00	0.00	0.00	0.90	9.66
Larval Fishes	0.00	0.45	0.00	0.00	0.00	0.30	0.00

Table 7. Percent count of species captured with vertical hoop plankton net during Buldir Island, Alaska SMMOCI sampling in 1998.

Species	Tow Number					
	1	2	3	4	5	6
Gastropoda	0.51	0.85	0.00	0.00	0.00	0.65
<i>Neocalanus cristatus</i> (Calanoida)	0.51	0.00	0.00	1.37	0.00	0.32
<i>Neocalanus plumchrus</i> (Calanoida)	4.10	14.53	3.70	2.74	3.88	1.29
<i>Eucalanus bungii</i> (Calanoida)	54.36	37.61	38.89	56.85	52.43	17.48
<i>Gaidius variabilis</i> (Calanoida)	24.62	8.55	14.81	3.42	0.00	13.59
<i>Calanus marshallae</i> (Calanoida)	0.00	10.26	0.00	5.48	7.18	2.91
Unidentified copepod (Calanoida) ^a	11.28	17.95	38.89	23.29	32.04	51.13
Mysidae (Mycidacea)	1.54	3.42	0.00	0.00	0.00	5.18
Hyperiidia (Amphipoda)	1.54	3.42	1.85	2.74	3.50	0.65
<i>Sagitta elegans</i> (Chaetognatha)	1.54	1.71	1.85	4.11	0.78	6.80
Larval Fishes	0.00	1.71	0.00	0.00	0.19	0.00

^aAlthough these specimens were not identified to species it is likely that they all were members of the same species in all tows.

Table 8. Species captured with mid-water trawl during Buldir Island, Alaska SMMOCI sampling in 1998.

Species	Tow Number ^a	
	1	4
Jellyfish (<i>Aequorea</i> spp.)	0	X ^b
Calanoid copepods (<i>Calanus</i> spp.)	0	X
Amphipods (<i>Amphipoda</i>)	0	X
Euphausiids (<i>Euphaisiacea</i>)	0	X
Sea salps (<i>Salpida</i>)	0	X
Arrow worms (<i>Chaetognatha</i>)	0	X
Northern rockfish (<i>Sebastes polyspinis</i>)	14	0
Atka mackerel (<i>Pleurogrammus monopterygius</i>)	0	
Yellow Irish lord (<i>Hemilepidotus jordani</i>)	2	0
Northern ronquil (<i>Ronquilus jordani</i>)	1	0
Unidentified larval fishes	0	X

^aTows 2 and 3 were empty.

^bPresent but individuals not enumerated

Table 9. Species captured with long-line gear during Buldir Island, Alaska SMMOCI sampling in 1998.

Species	Set Number	
	1	2
Skates and rays (<i>Rajidae</i>)	1	0
Alaska skate (<i>Bathyraja parmifera</i>)	0	1
Pacific cod (<i>Gadus macrocephalus</i>)	44	26
Red Irish lord (<i>Hemilepidotus hemilepidotus</i>)	5	1
Yellow Irish lord (<i>Hemilepidotus jordani</i>)	15	26
Pacific halibut (<i>Hippoglossus stenolepis</i>)	2	3

Table 10. Prey composition of stomach samples from Pacific cod caught during long-line sets near Buldir Island, Alaska in 1998 ($n = 48$ non-empty stomachs).

Prey Name	% Frequency	% Count	% Weight
Polychaeta (worm)	4.17	1.31	0.02
Teuthoidea (squid)	4.17	1.31	1.37
<i>Teuthoidea oegopsida</i> (squid)	10.42	8.50	2.92
Octopoda (octopus)	6.25	1.96	0.05
Gammaridea (amphipod)	2.08	0.65	0.01
Caridea (shrimp)	2.08	0.65	0.12
<i>Lebbeus groenlandicus</i> (shrimp)	2.08	0.65	0.07
Pandalidae (shrimp)	12.50	31.37	1.22
<i>Pandalus</i> sp. (shrimp)	4.17	5.88	0.23
Crangonidae (shrimp)	2.08	2.61	0.07
<i>Crangon</i> sp. (shrimp)	2.08	3.92	0.17
Paguridae (hermit crab)	6.25	1.96	0.23
<i>Paralithodes camtschatica</i> (red king crab)	2.08	0.65	0.28
Echinoidea (sea urchin and sand dollar)	4.17	1.31	0.17
Osteichthyes Teleostei (fish)	12.50	3.92	0.56
Non-gadoid Fish Remains	6.25	7.84	3.08
<i>Theragra chalcogramma</i> (walleye pollock)	10.42	3.27	4.28
Zoarcidae (eelpout)	2.08	0.65	0.31
<i>Sebastes</i> sp. (rockfish)	2.08	0.65	9.57
<i>Sebastes ciliatus</i> (dusky rockfish)	2.08	0.65	27.13
<i>Pleurogrammus monopterygius</i> (Atka mackerel)	43.75	15.03	45.97
Cottidae (sculpin)	2.08	1.96	0.42
<i>Ammodytes hexapterus</i> (Pacific sandlance)	2.08	0.65	0.04
Pleuronectidae (flatfish)	2.08	0.65	0.04
Unidentified organic material	4.17	1.31	1.14
Unidentified algae	2.08	0.65	0.51

Table 11. Species captured with bottom trawl during Buldir Island, Alaska SMMOCI sampling in 1998 (continued).

Species	Tow Number																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Smooth alligatorfish (<i>Anoplagonus inermis</i>)																		1
Sturgeon poacher (<i>Podothecus acipenserinus</i>)												1						
Pacific spiny lumpsucker (<i>Eumicrotremus orbis</i>)		1																
Snailfishes (<i>Liparididae</i>)		3	1	2														
Searcher (<i>Bathymaster signatus</i>)							2											
Decorated warbonnet (<i>Chirolophis decoratus</i>)		2			1													
<i>Pholis</i> spp.																		2
Pacific sand lance (<i>Ammodytes hexapterus</i>)																		1
Pacific halibut (<i>Hippoglossus stenolepis</i>)						1		4	5	1	1							1
Rock sole (<i>Pleuronectes bilineata</i>)	61	1				1	3	23	18	3	14	9			2	18	2	

^aFish data are from Holladay 1998.

^bPresent but individuals not enumerated.



Figure 1. Map of Alaska showing the location of Buldir Island.

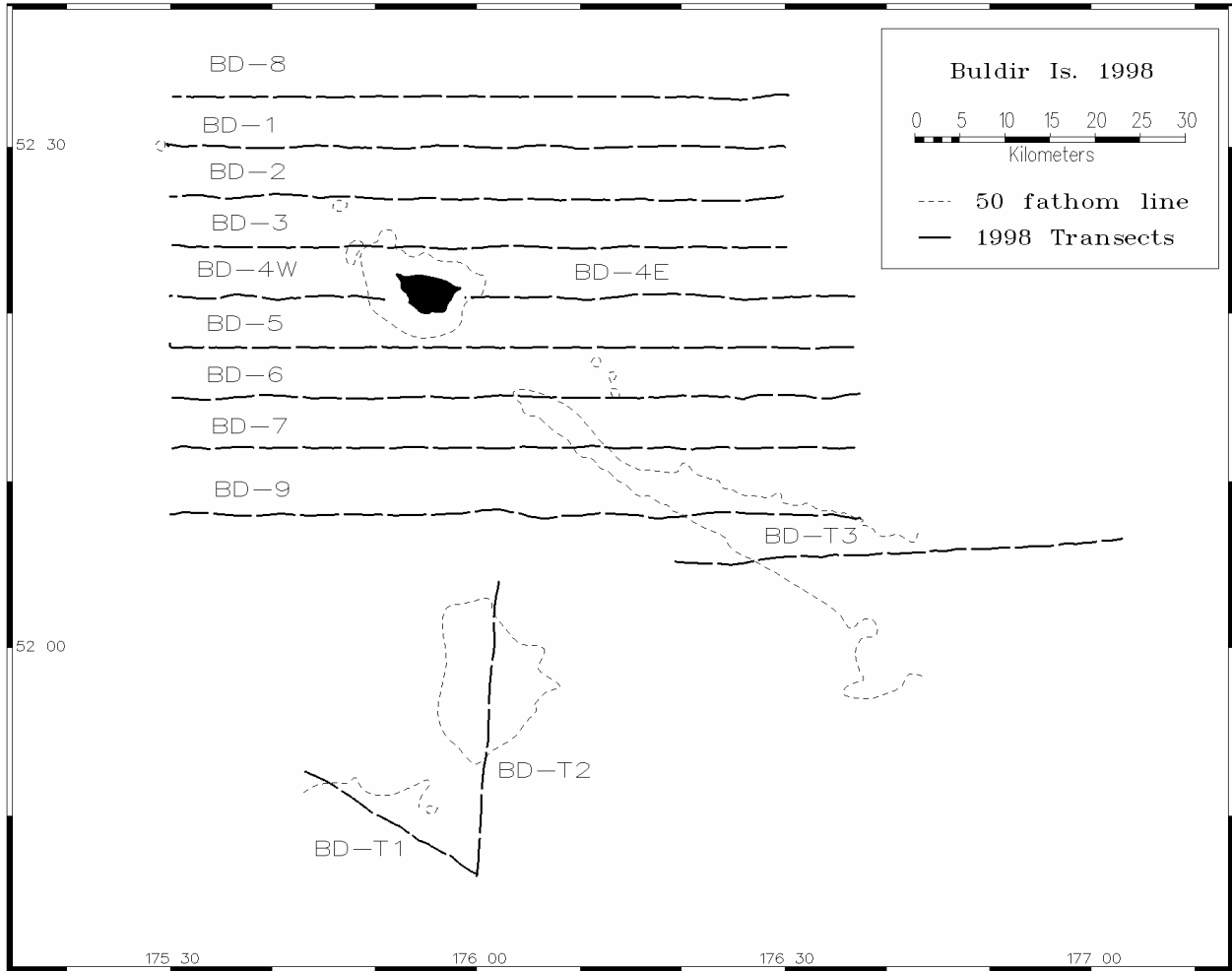


Figure 2. Map of Buldir Island, Alaska transects surveyed in 1998.

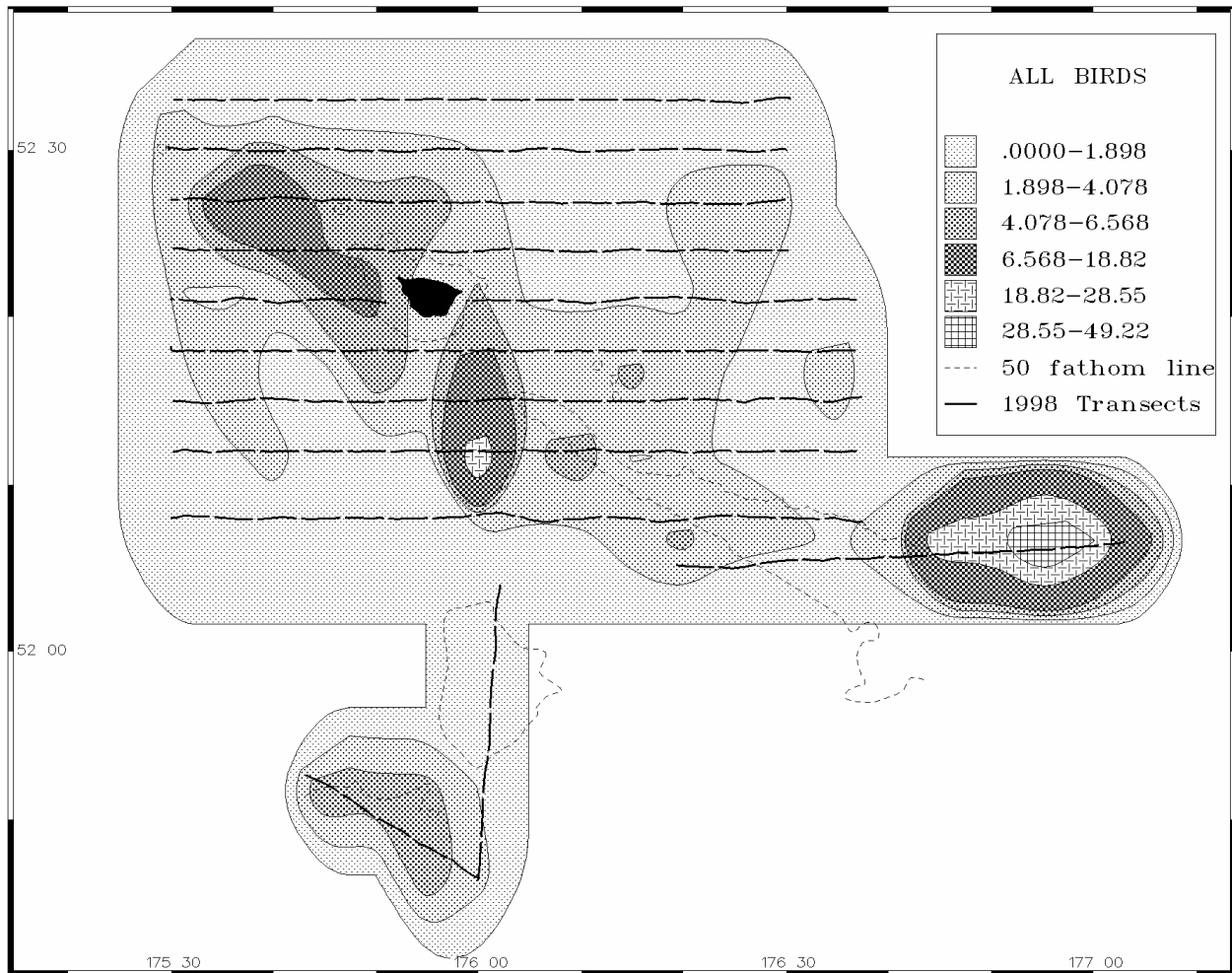


Figure 3. Densities of all birds on transects surveyed at Buldir Island, Alaska in 1998.

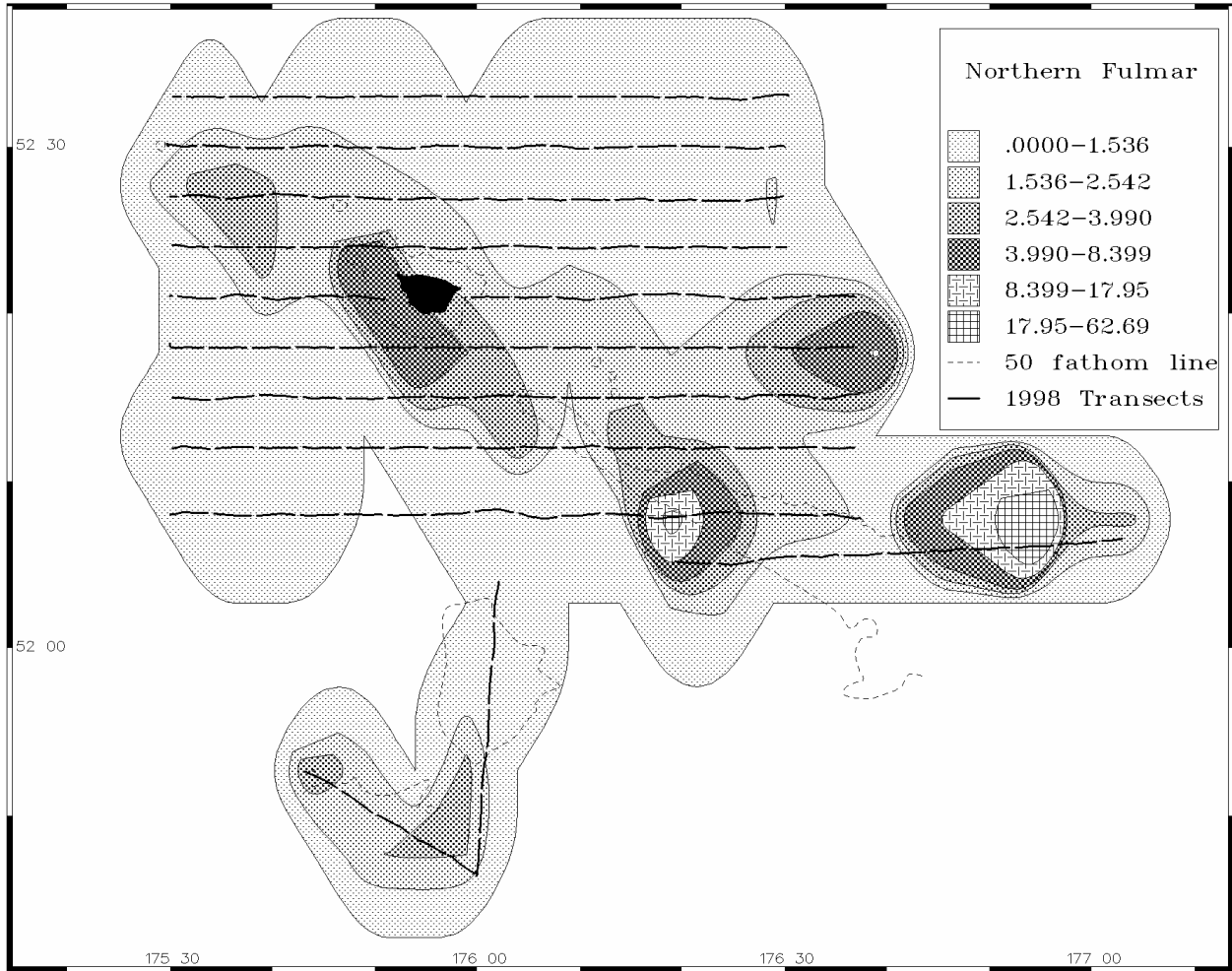


Figure 4. Densities of northern fulmars on transects surveyed at Buldir Island, Alaska in 1998.

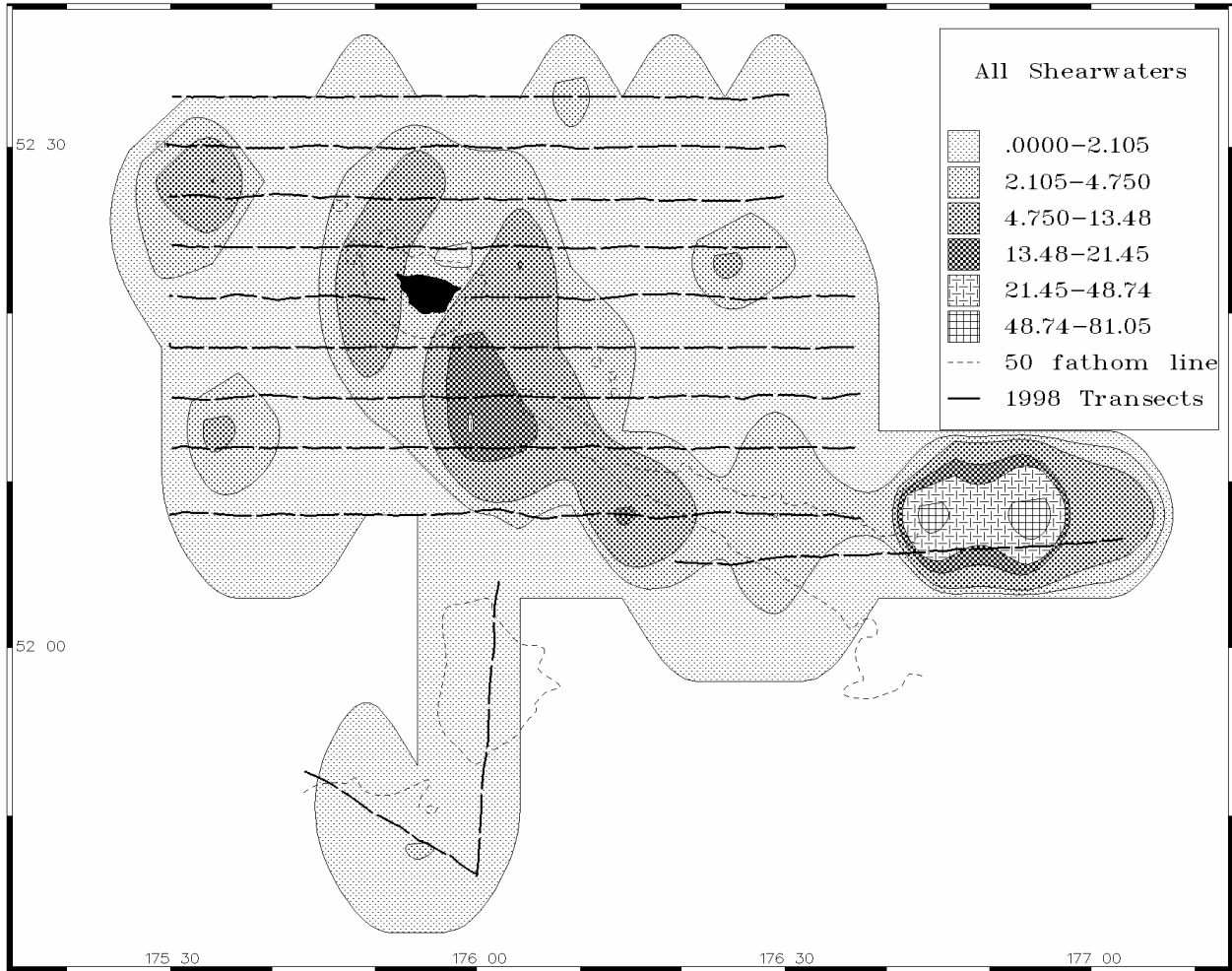


Figure 5. Densities of all shearwaters on transects surveyed at Buldir Island, Alaska in 1998.

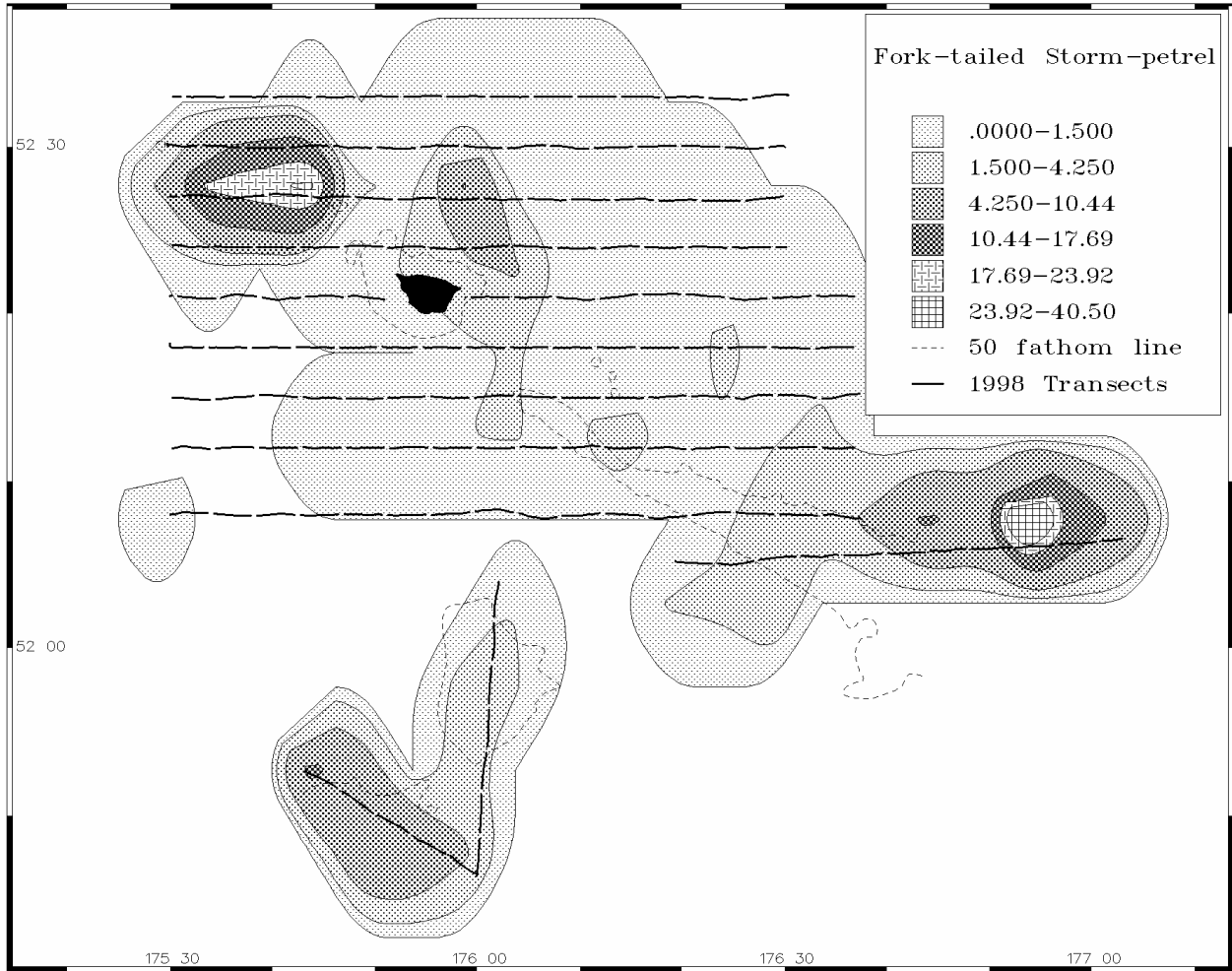


Figure 6. Densities of fork-tailed storm-petrels on transects surveyed at Buldir Island, Alaska in 1998.

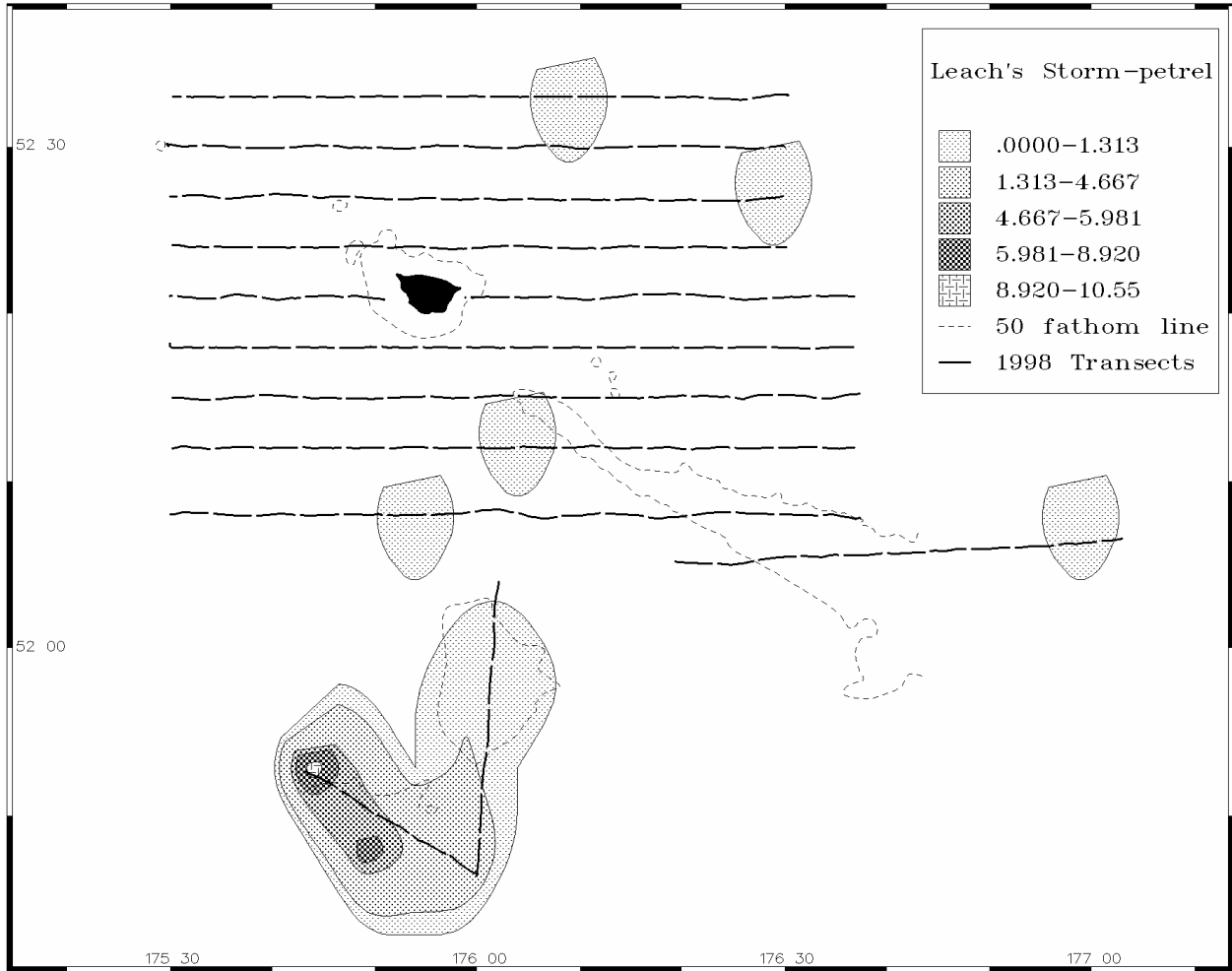


Figure 7. Densities of Leach's storm-petrels on transects surveyed at Buldir Island, Alaska in 1998.

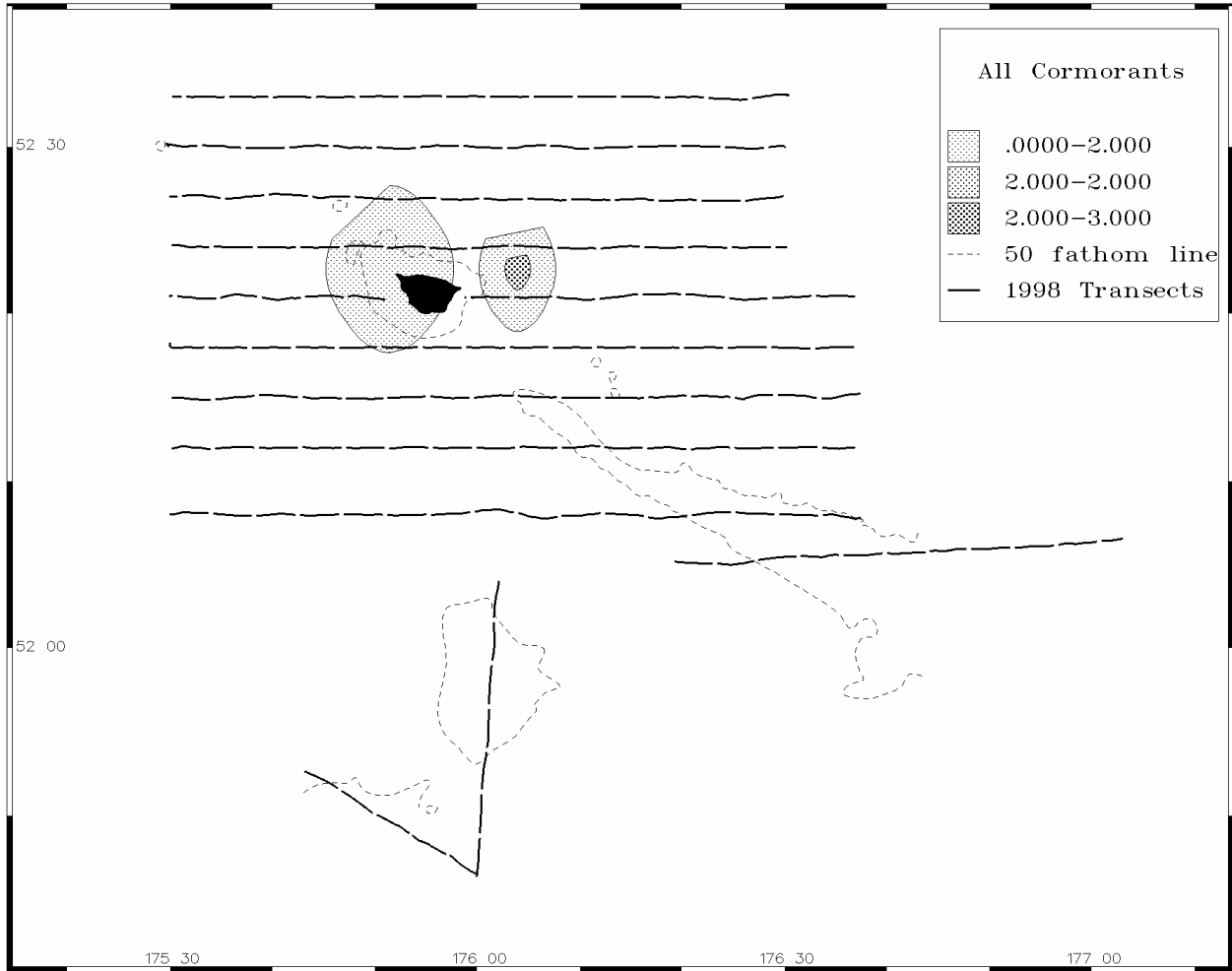


Figure 8. Densities of all cormorants on transects surveyed at Buldir Island, Alaska in 1998.

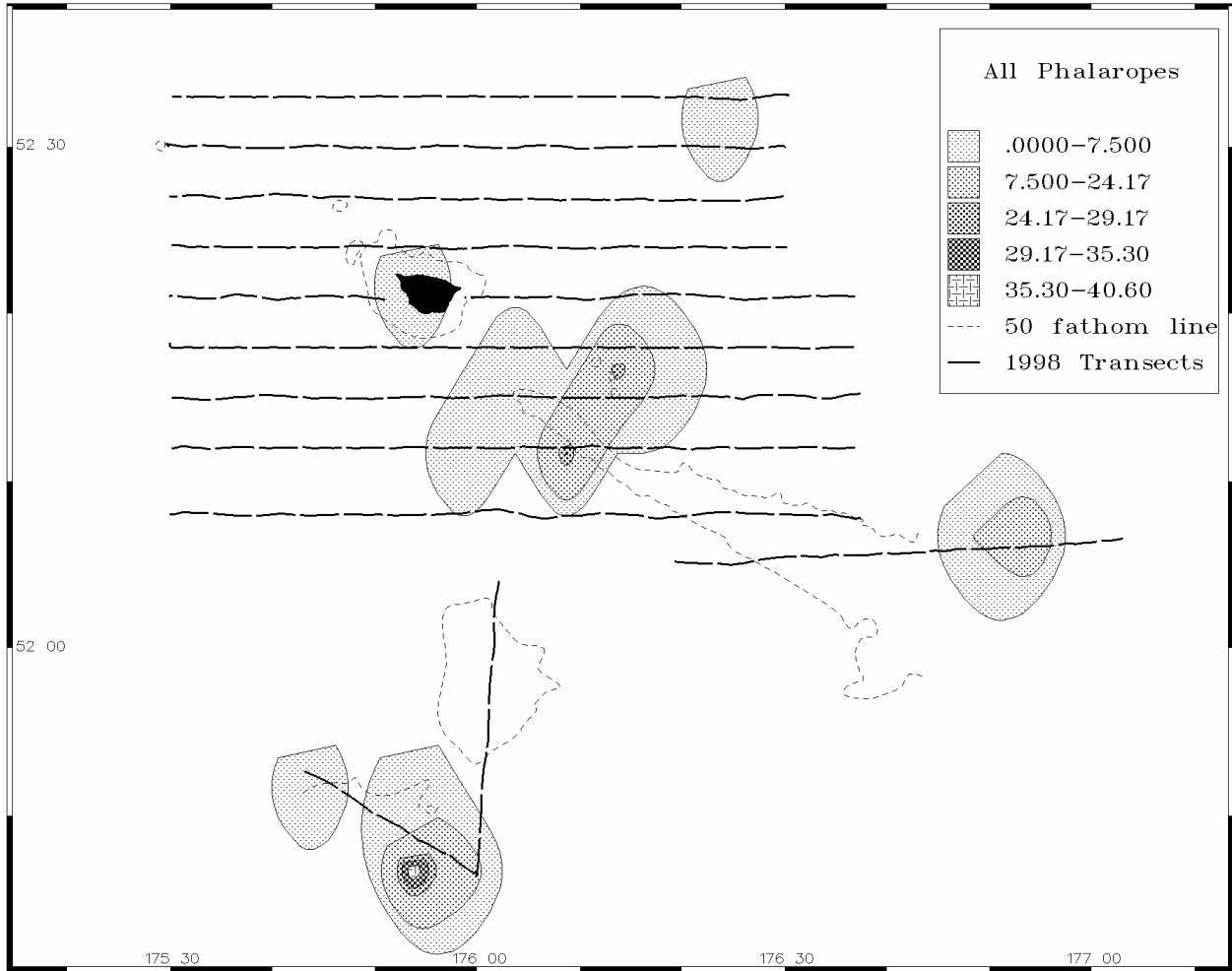


Figure 9. Densities of all phalaropes on transects surveyed at Buldir Island, Alaska in 1998.

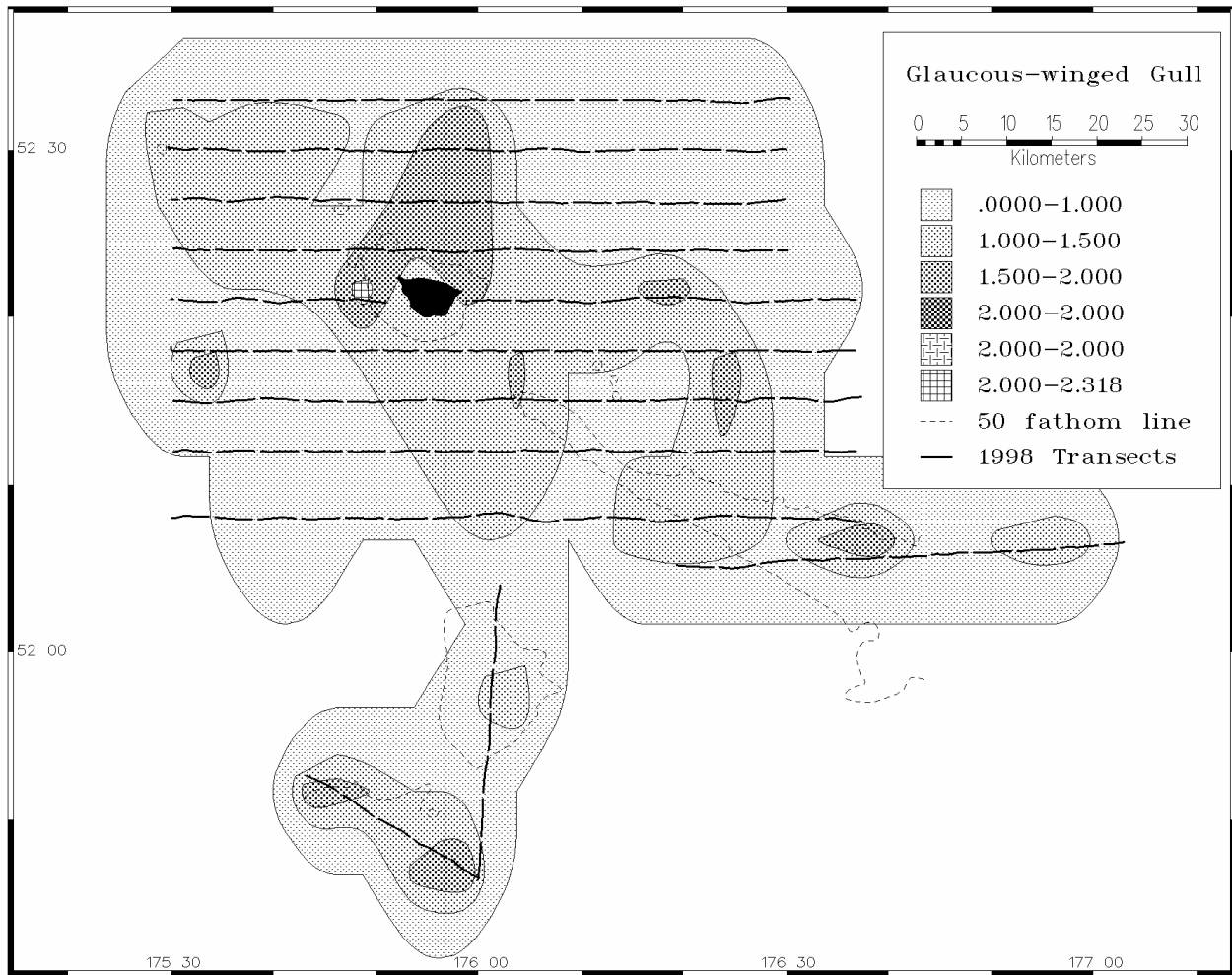


Figure 10. Densities of glaucous-winged gulls on transects surveyed at Buldir Island, Alaska in 1998.

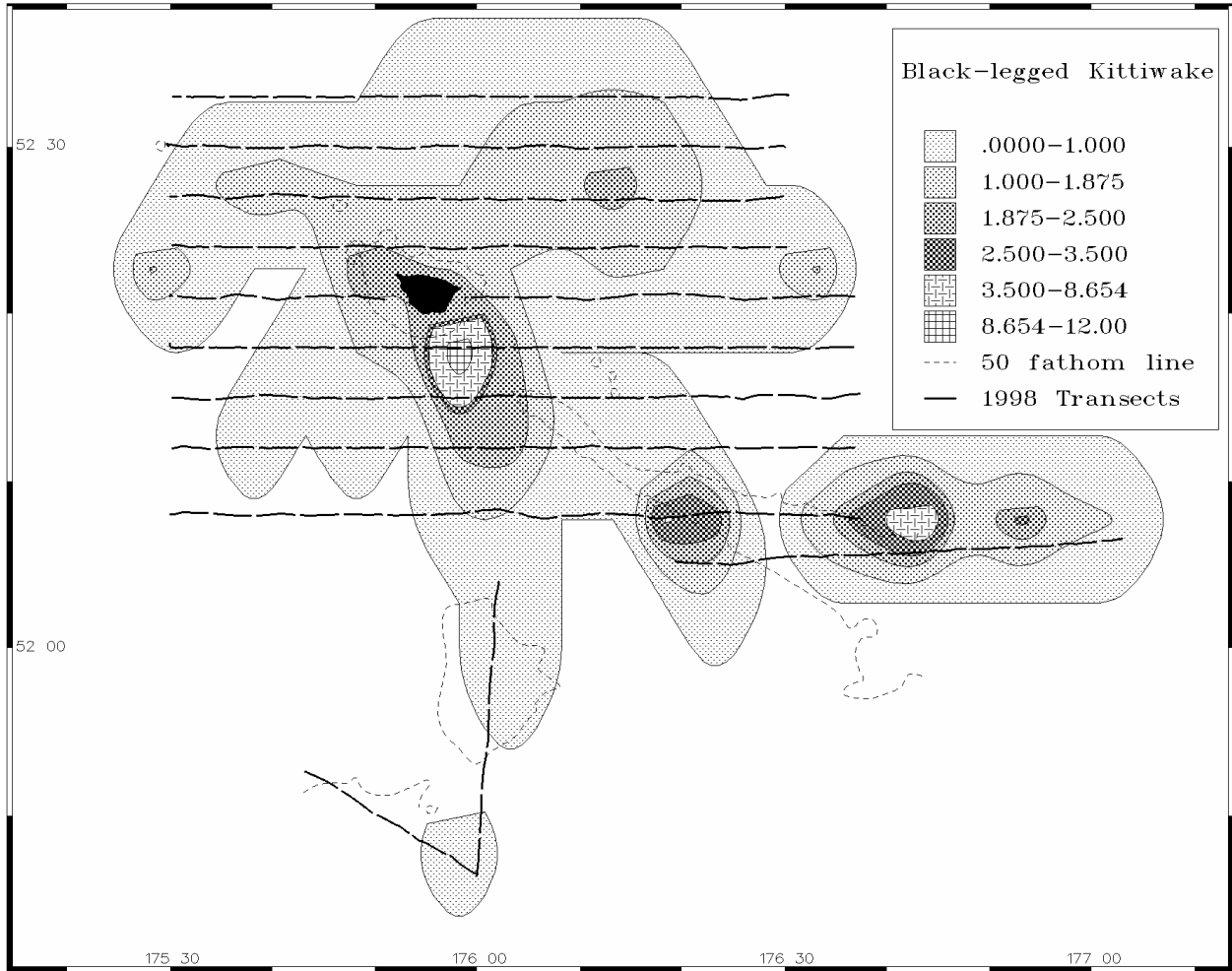


Figure 11. Densities of black-legged kittiwakes on transects surveyed at Buldir Island, Alaska in 1998.

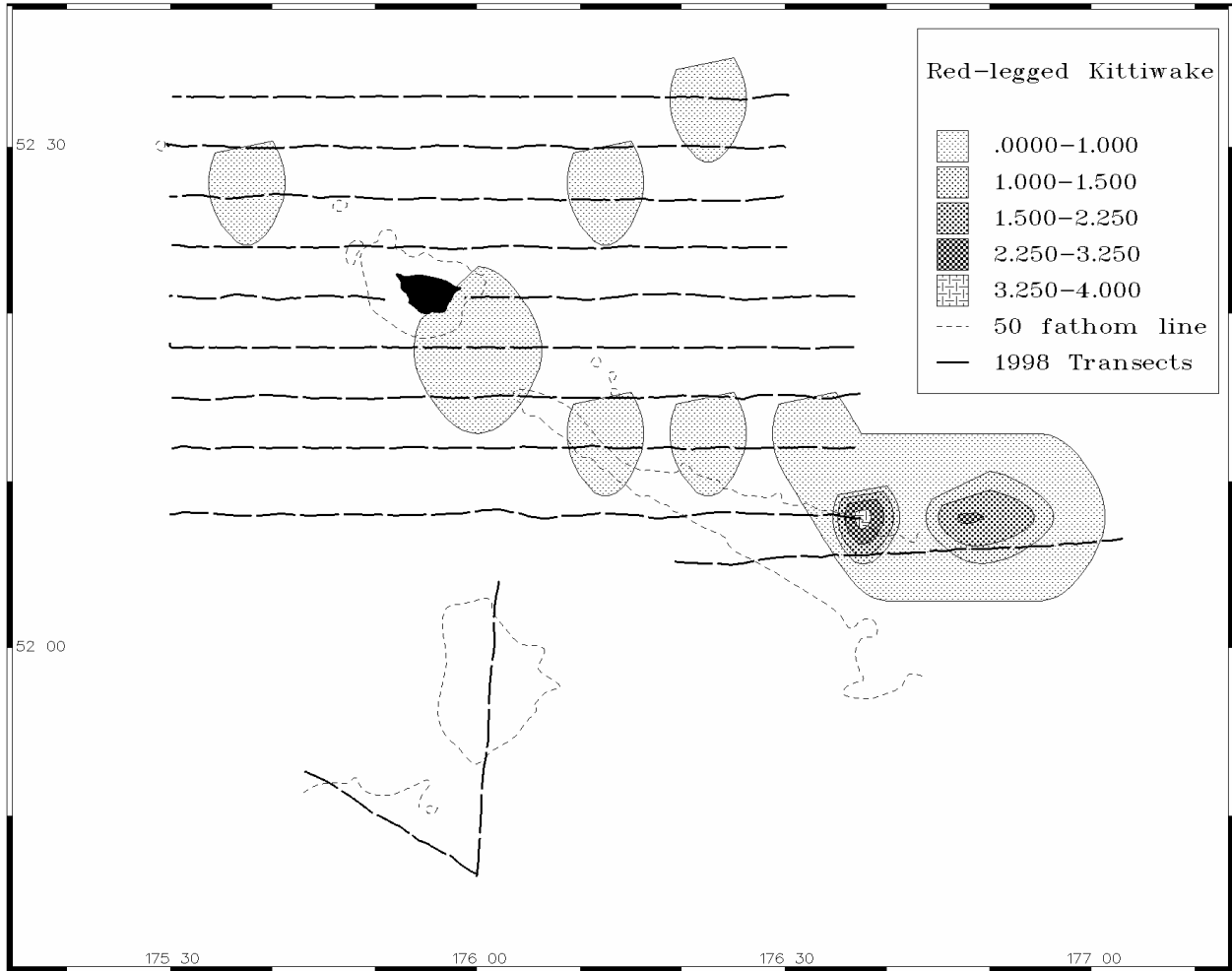


Figure 12. Densities of red-legged kittiwakes on transects surveyed at Buldir Island, Alaska in 1998.

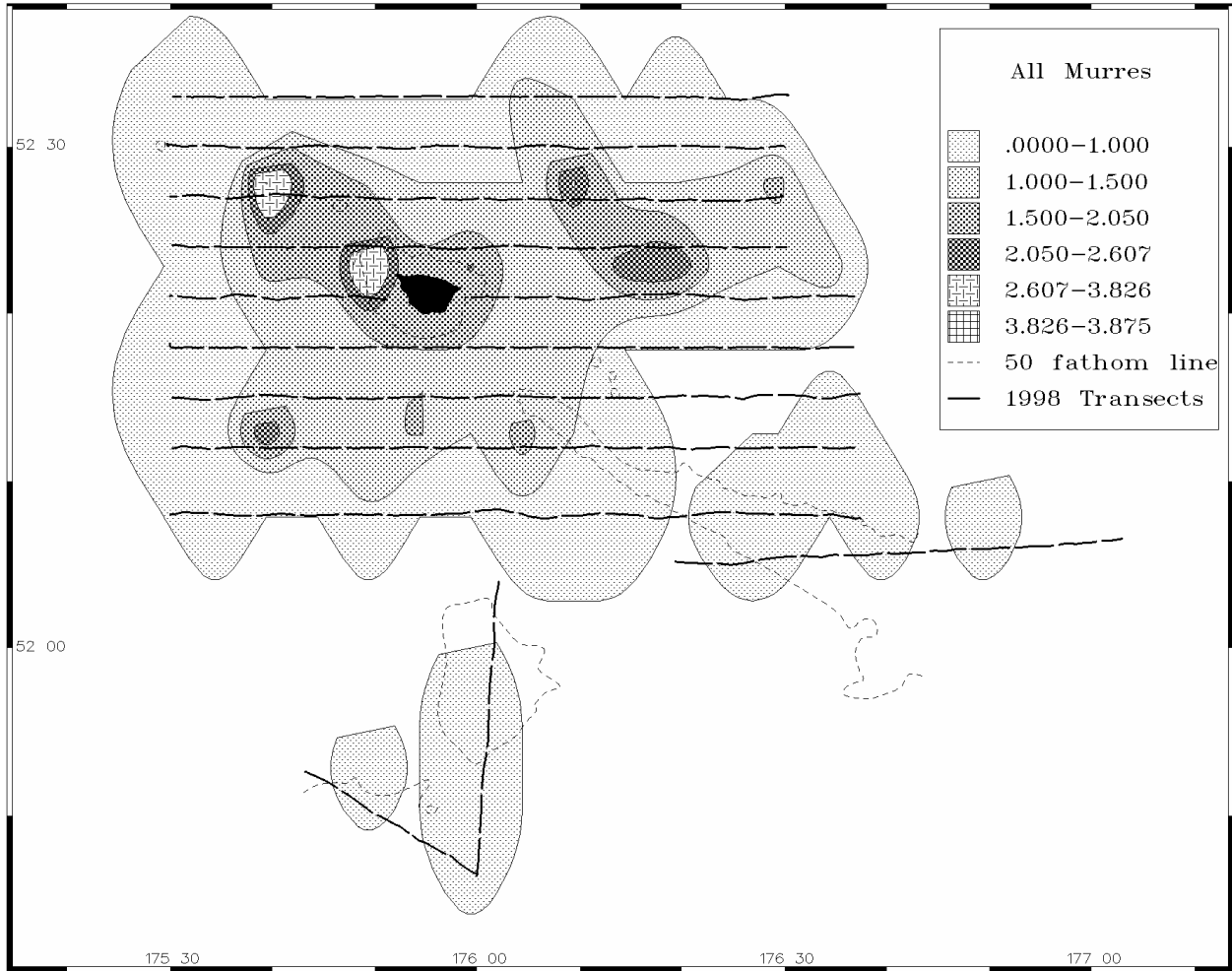


Figure 13. Densities of all murre on transects surveyed at Buldir Island, Alaska in 1998.

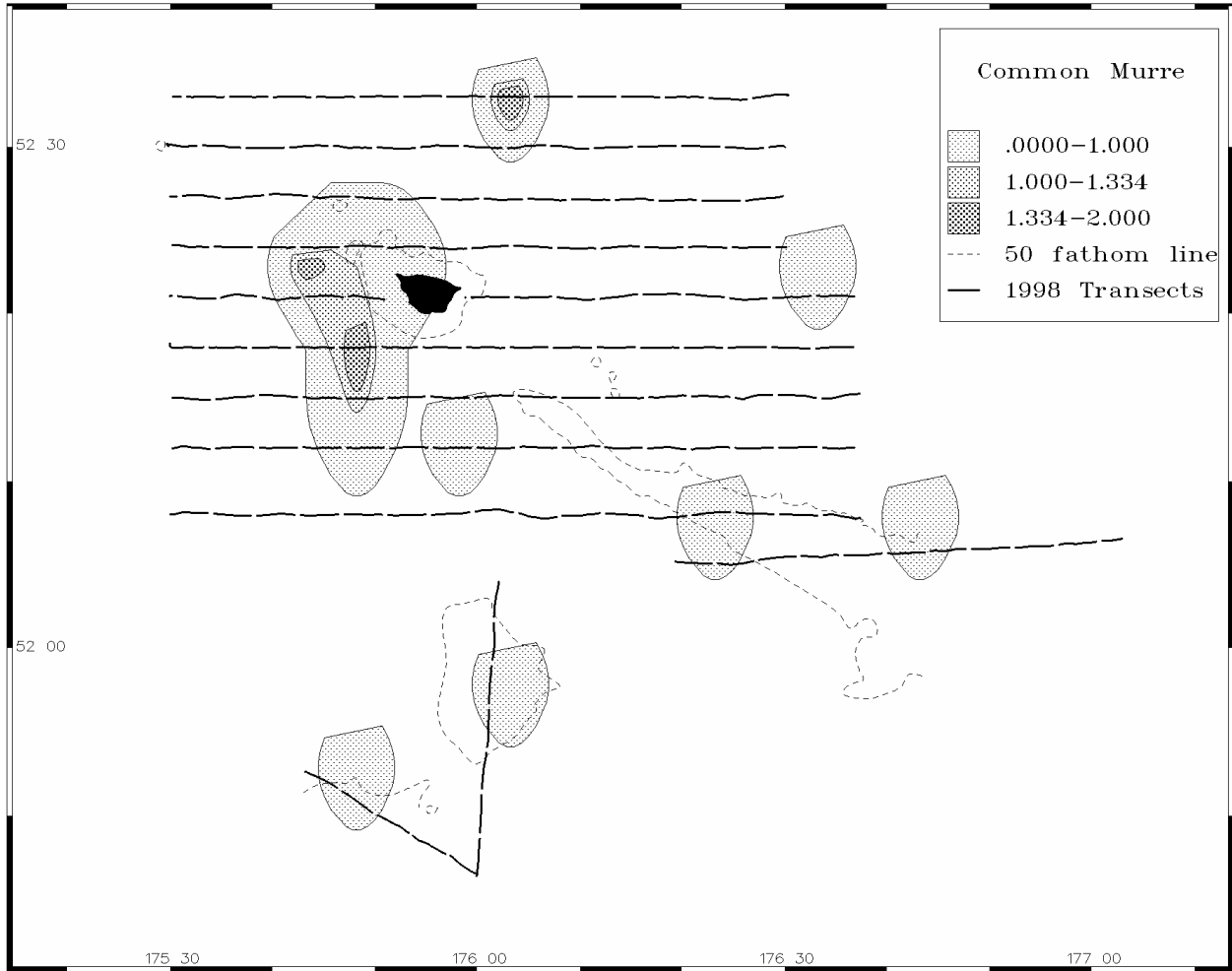


Figure 14. Densities of common murres on transects surveyed at Buldir Island, Alaska in 1998.

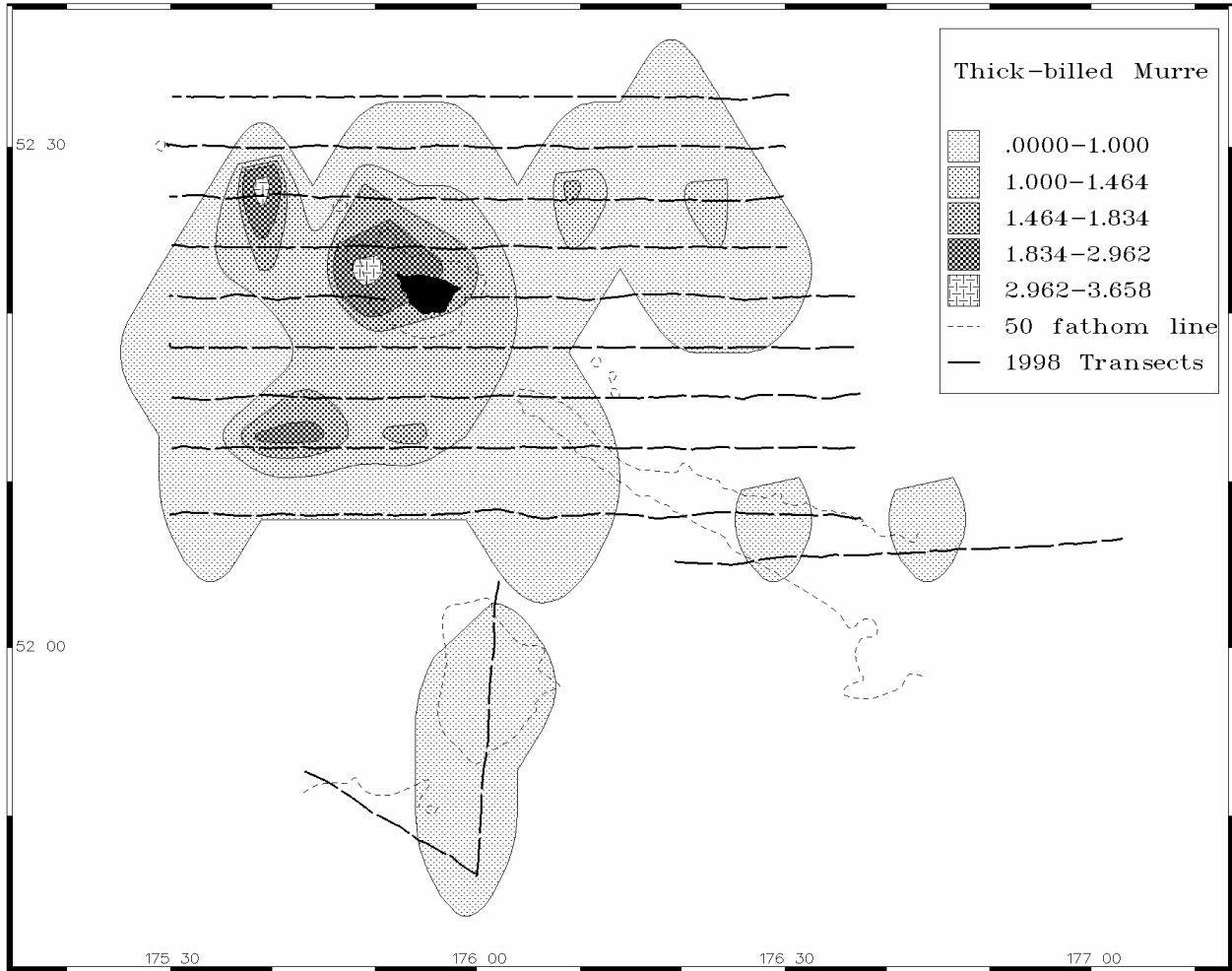


Figure 15. Densities of thick-billed murres on transects surveyed at Buldir Island, Alaska in 1998.

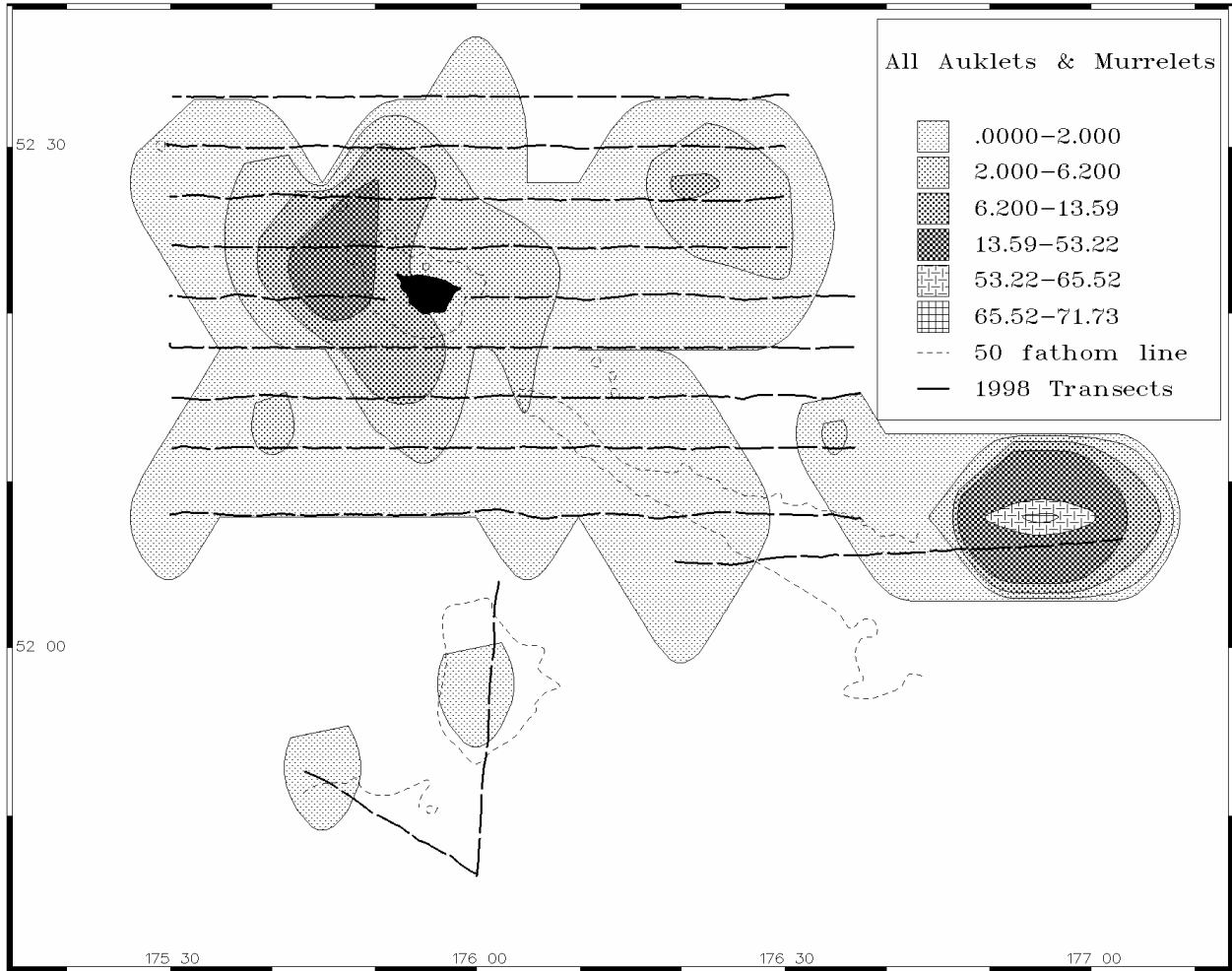


Figure 16. Densities of all auklets and murrelets on transects surveyed at Buldir Island, Alaska in 1998.

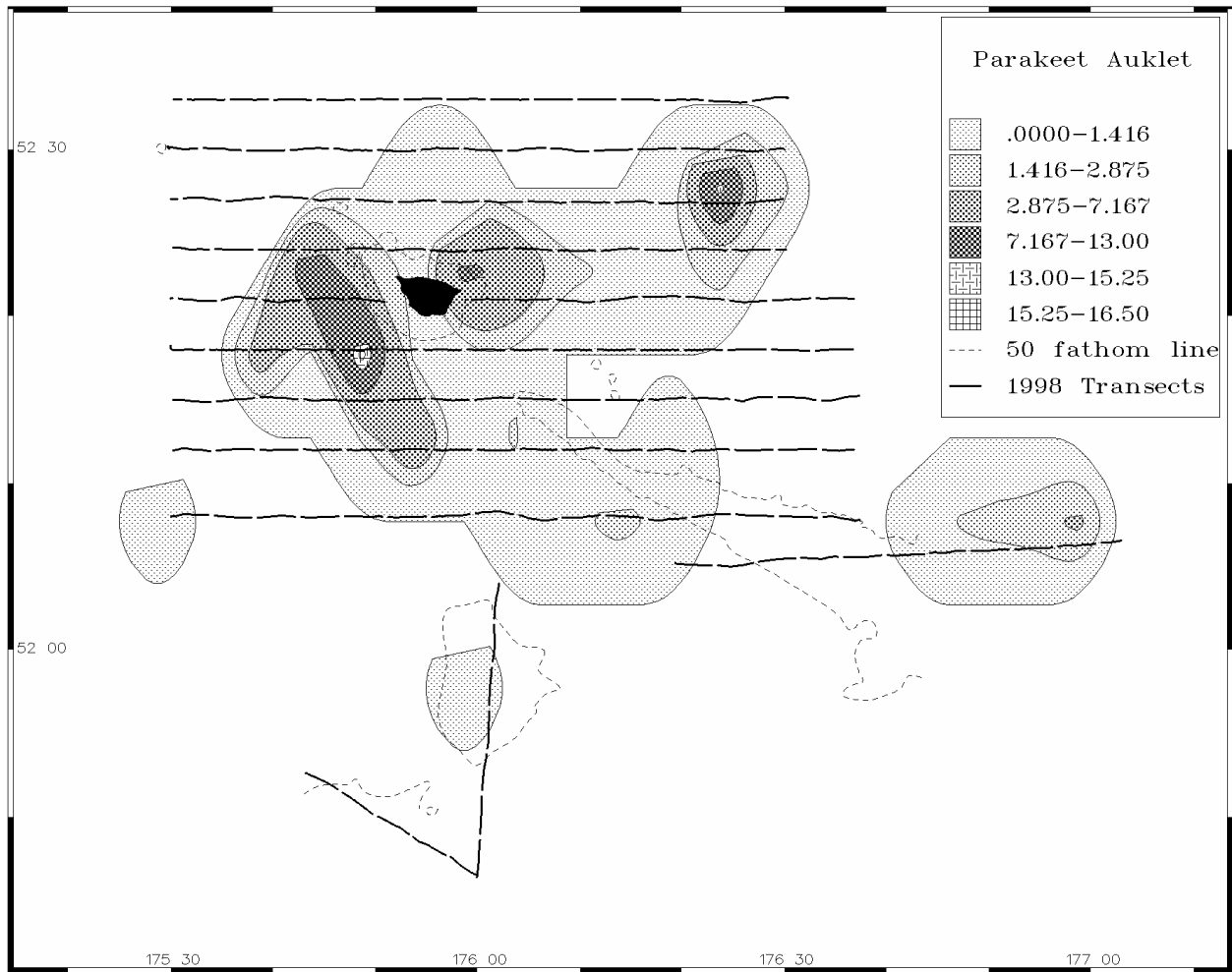


Figure 17. Densities of parakeet auklets on transects surveyed at Buldir Island, Alaska in 1998.

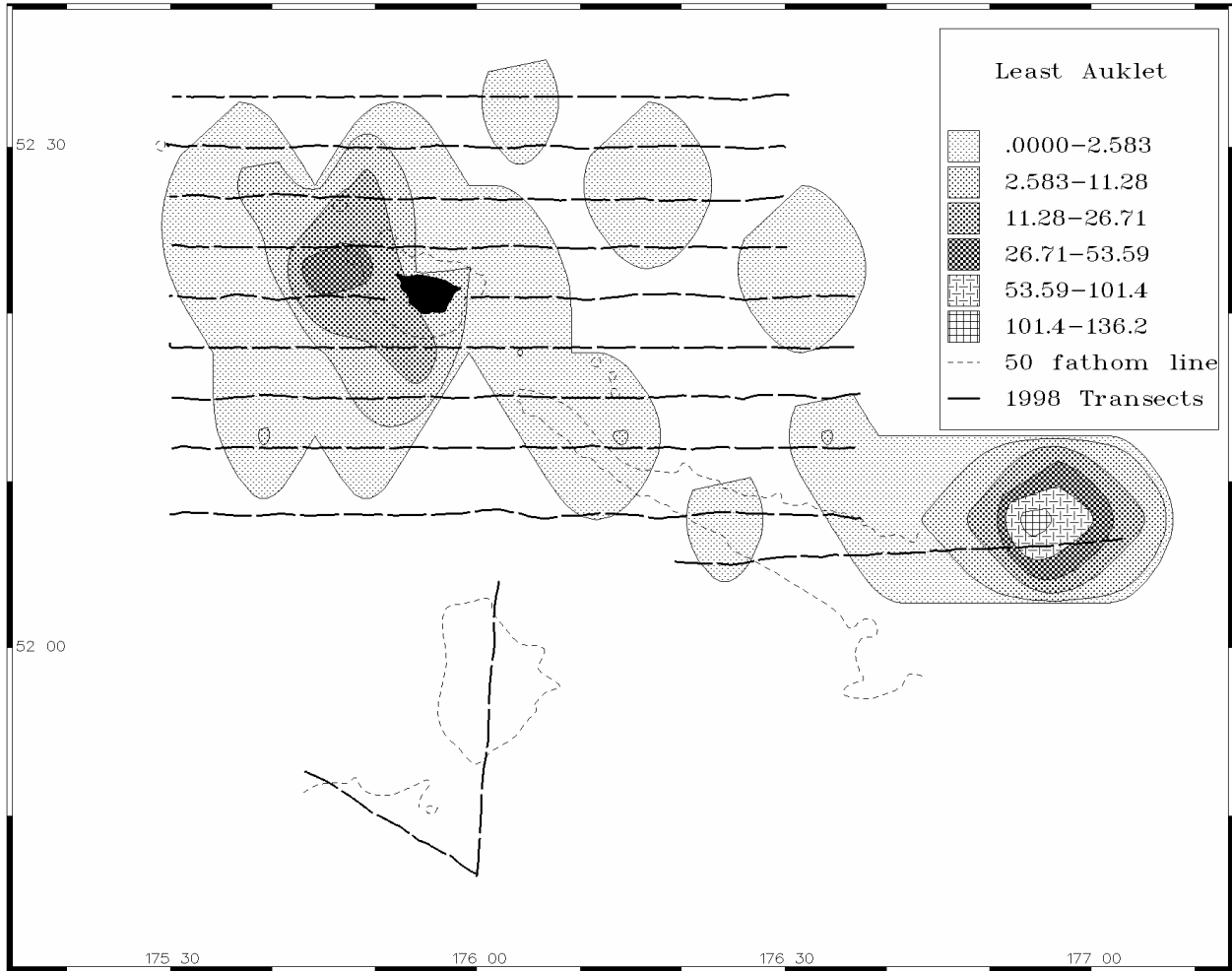


Figure 18. Densities of least auklets on transects surveyed at Buldir Island, Alaska in 1998.

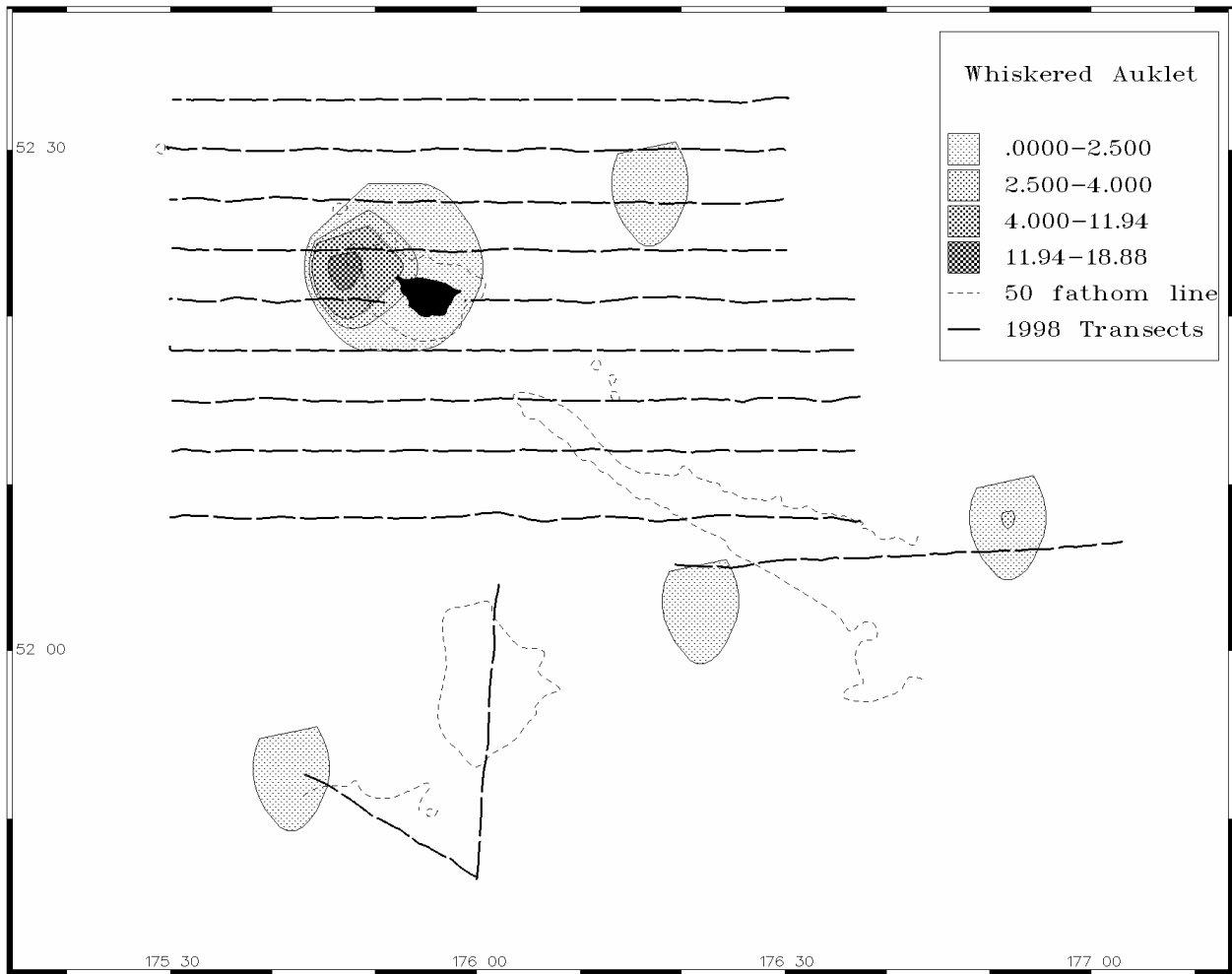


Figure 19. Densities of whiskered auklets on transects surveyed at Buldir Island, Alaska in 1998.

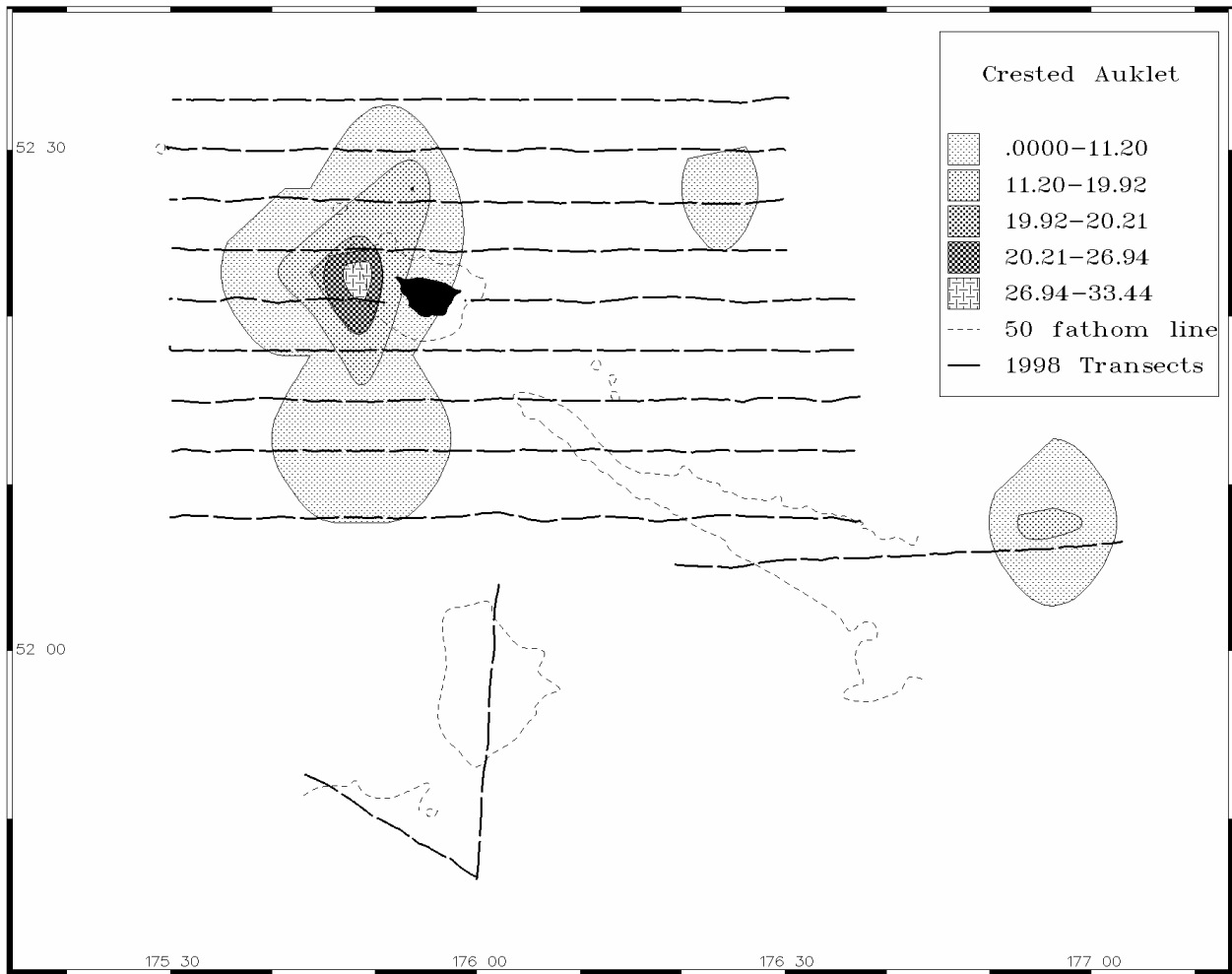


Figure 20. Densities of crested auklets on transects surveyed at Buldir Island, Alaska in 1998.

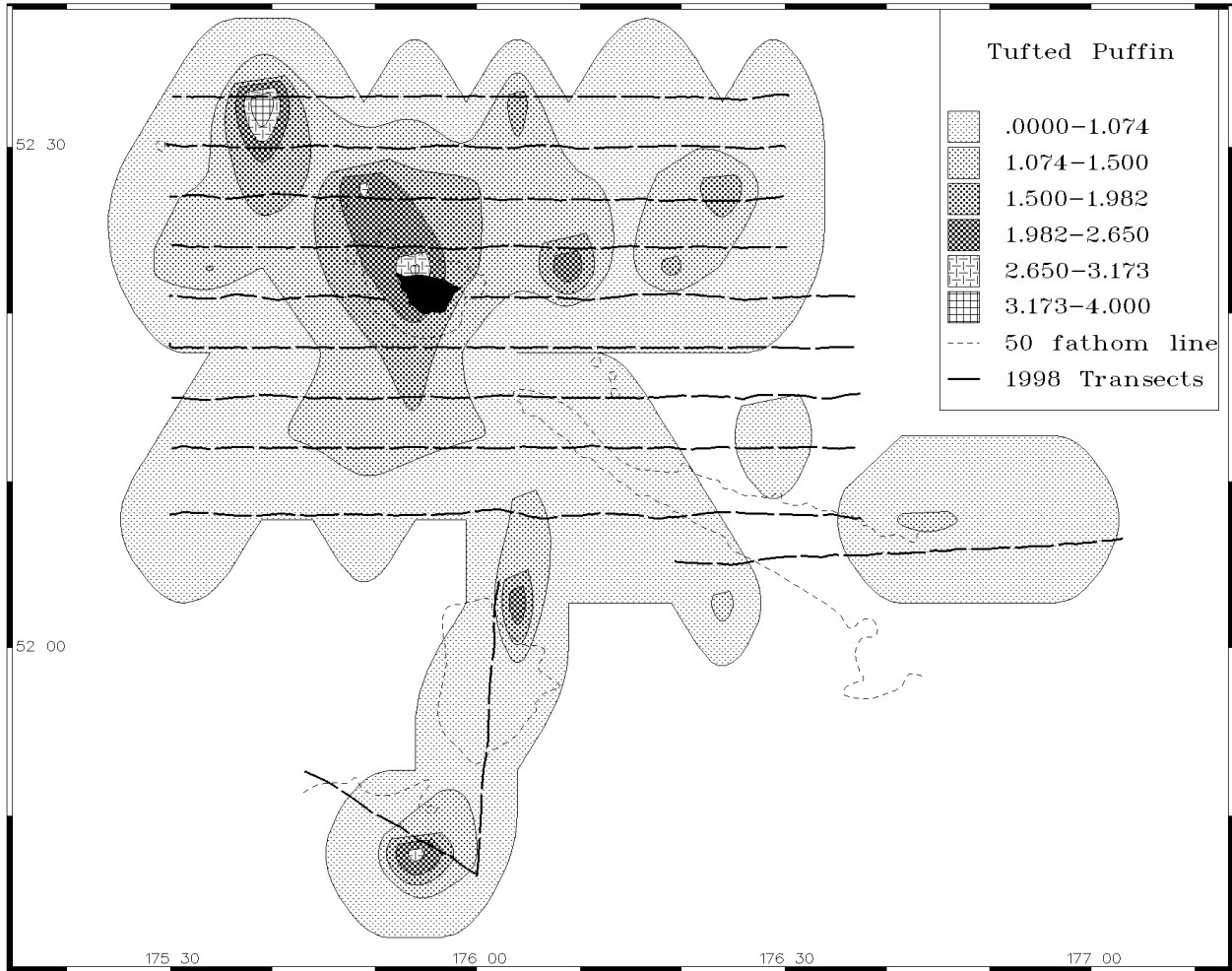


Figure 21. Densities of tufted puffins on transects surveyed at Buldir Island, Alaska in 1998.

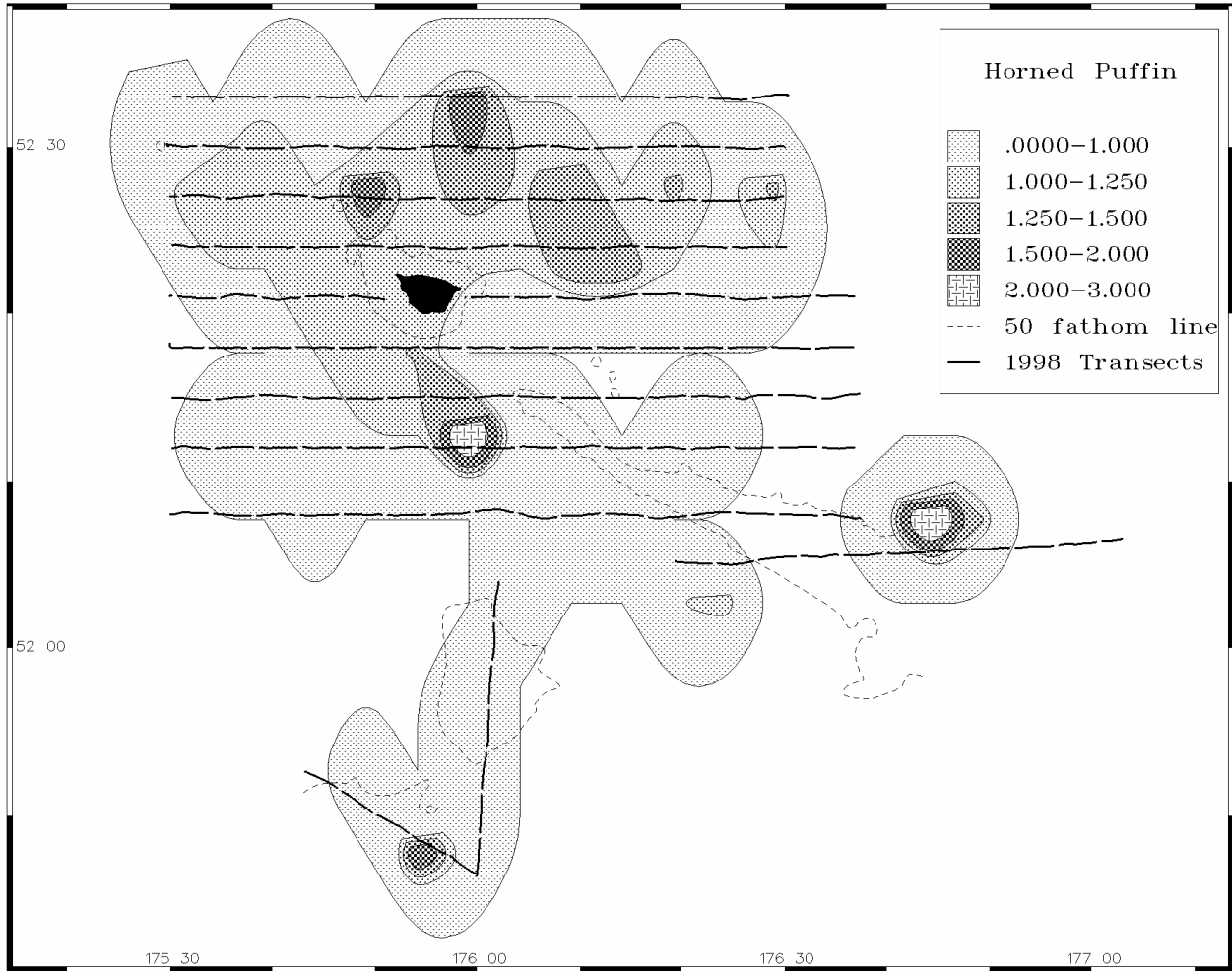


Figure 22. Densities of horned puffins on transects surveyed at Buldir Island, Alaska in 1998.

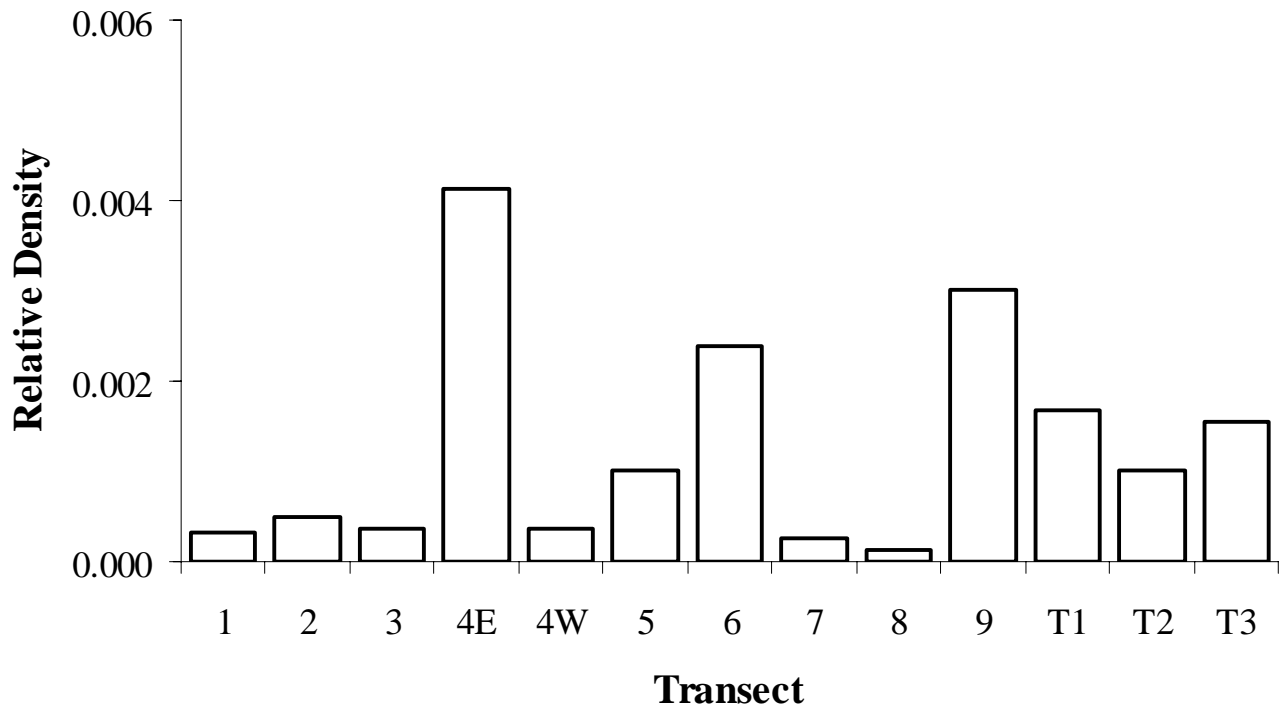


Figure 23. Water column relative prey densities detected by hydroacoustics gear on transects surveyed near Buldir Island, Alaska in 1998.

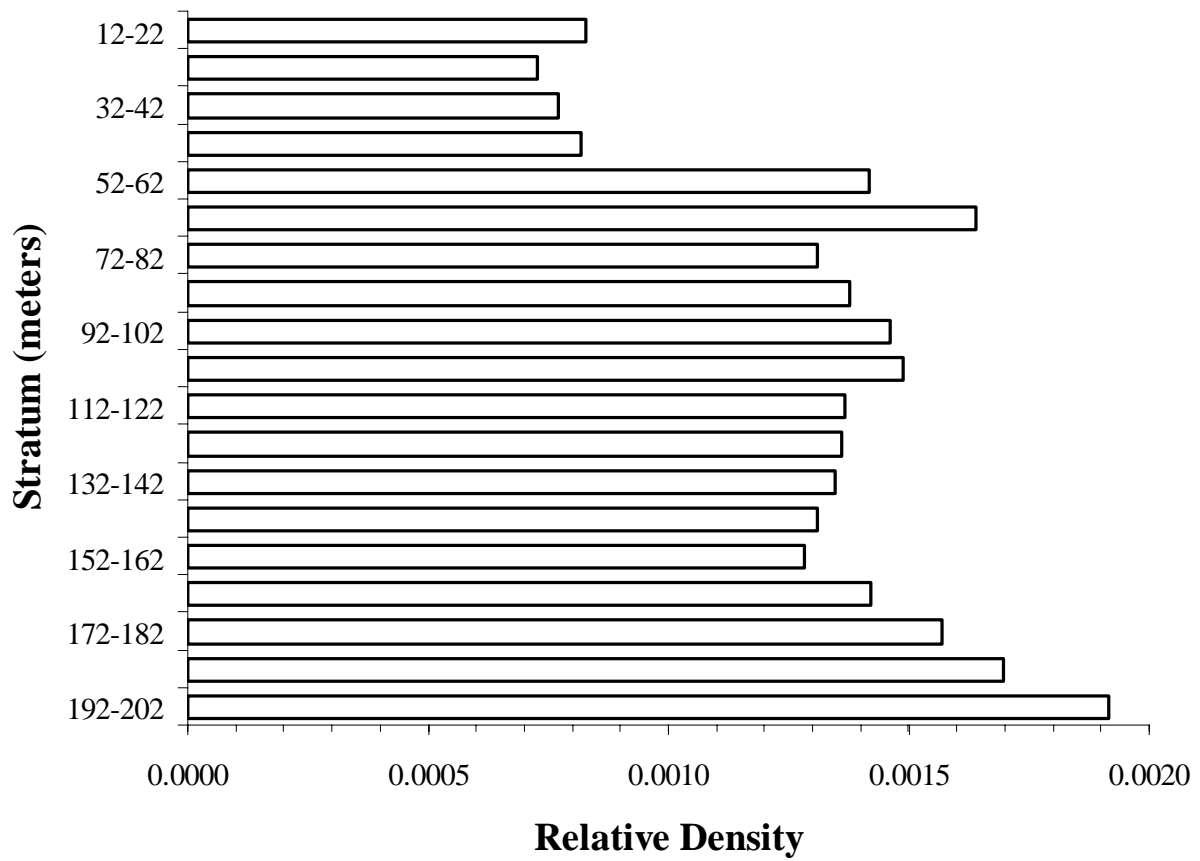


Figure 24. Relative density of prey by depth stratum on transects surveyed near Buldir Island, Alaska in 1998 (excluding surface stratum: 2-12m). Depth in meters.

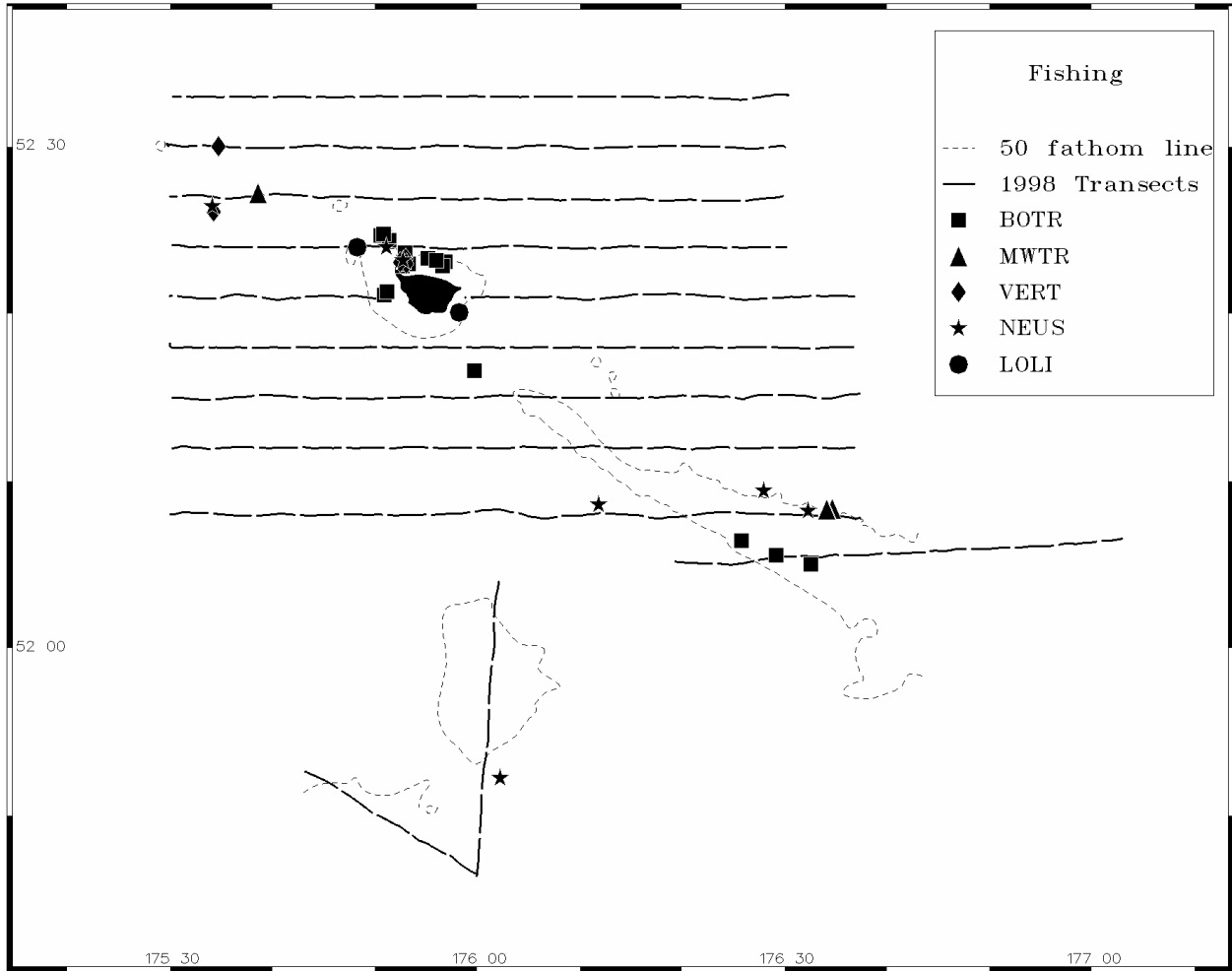


Figure 25. Locations of fishing efforts near Buldir Island, Alaska in 1998. LOLI = long-line set, BOTR = bottom trawl, NEUS = neuston net tow, VERT = vertical plankton hoop net tow, MWTR = mid-water trawl.

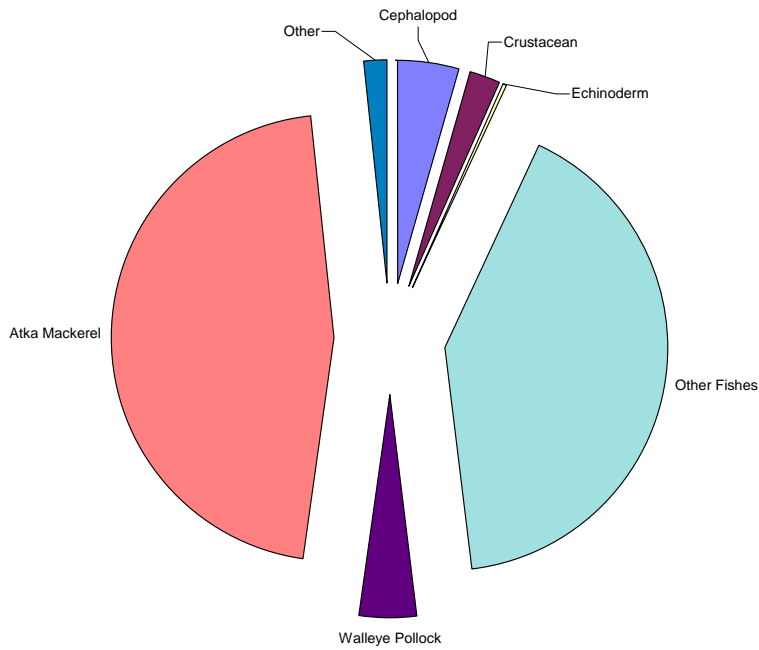
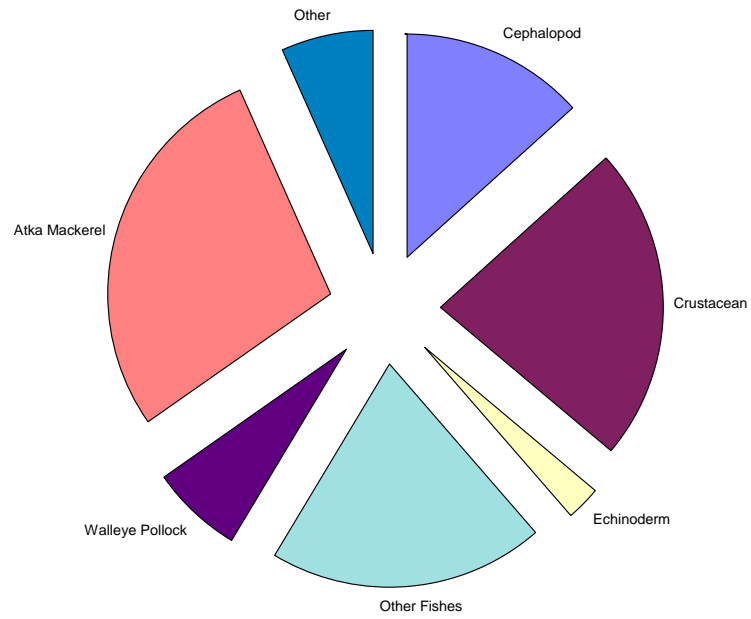


Figure 26. Percent frequency of occurrence (top) and percent total weight (bottom) of prey taken from stomach contents of Pacific cod (*Gadus macrocephalus*) caught on long-line gear near Buldir Island, Alaska in 1998 ($n = 48$ non-empty stomachs).

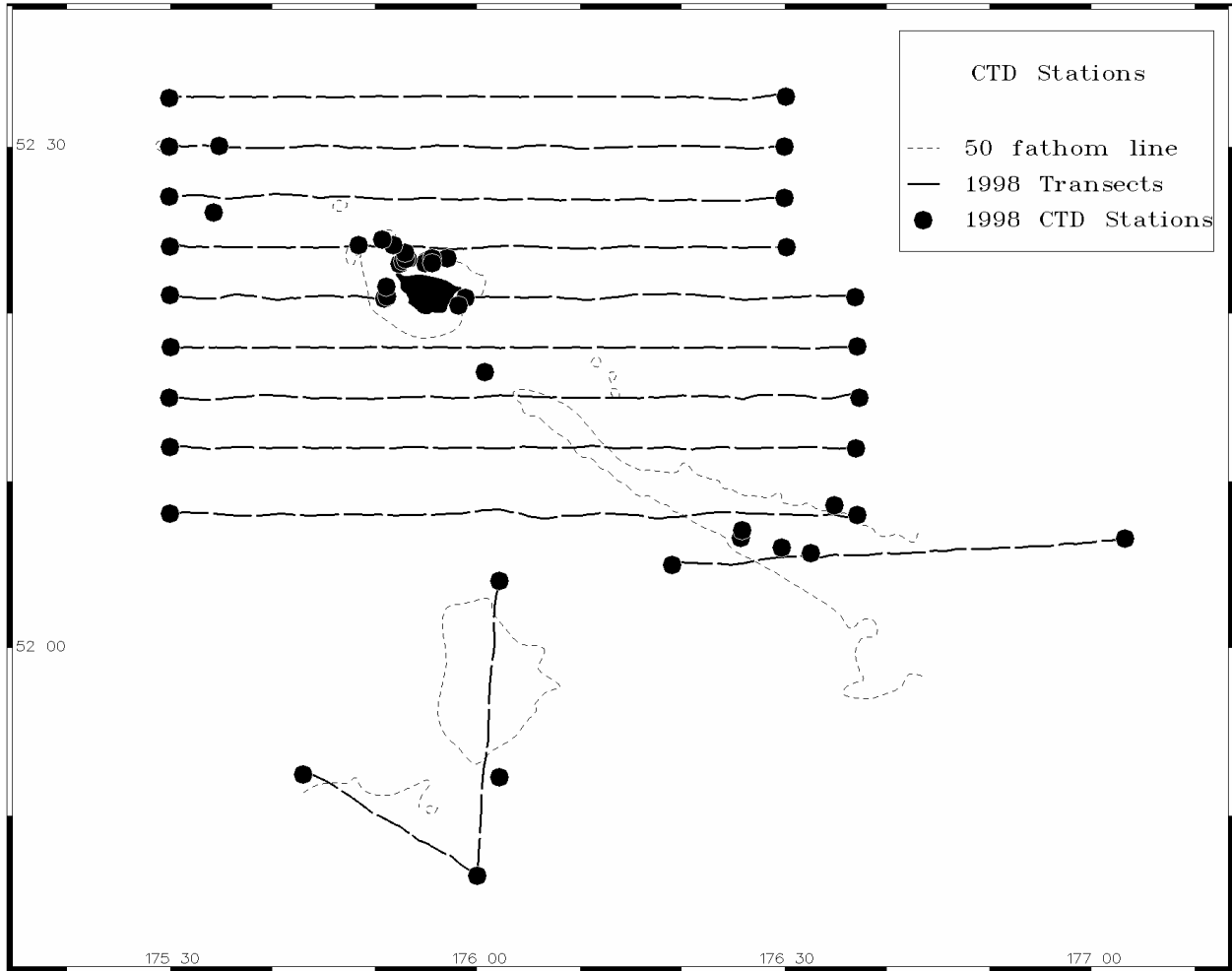


Figure 27. Locations of CTD stations sampled near Buldir Island, Alaska in 1998.

Appendix A. Transect log for SMMOCI cruise near Buldir Island, Alaska in 1998.

Date	Area	Transect No.	HydroAc File	dLog File	Time Start	Time Stop	Notes
7/25/1998	Buldir	BD4E	BD87254E.dat	BD87254E.srv	12:21	14:45	LAAL off TX, Sperm Whale off TX (SPWH) Time on dLog computer on Homer Time NOT Aleutian Time
7/26/1998	Buldir	BD09	BD872609.dat	BD872609.srv	8:11	12:31	Obs. Cond. 2&1 (Don't Use?) Time on dLog computer on Homer Time NOT Aleutian Time
7/26/1998	Buldir	BD07	BD872607.dat	BD872607.srv	13:30	17:45	
7/26/1998	Buldir	MWTR01	BDMT01.dat	BDMT01.srv	20:50	21:00	CS6 T1 10 Min. Tow
7/27/1998	Buldir	MWTR02	BDMT02.dat	BDMT02.srv	7:20	7:30	CS5 10 T1 10 Min. Tow (no catch/No CTD)
7/27/1998	Buldir	BD06	BD872706.dat	BD872706.srv	9:46	13:25	Obs. Cond. "Bad" Trans. Width 150m, False vertical spikes, Strong false bottom (deep scattering layer?)
7/27/1998	Buldir	BD05	BD872705.dat	BD872705.srv	14:18	18:58	Many false vertical spikes when water depth >300m, See false bottom log
7/30/1998	Buldir	MWTR03	BDMT03.dat	BDMT03.srv	20:41	20:44	CS18 T2, 3 Min. Tow (missed targets and ran into shallow water)
7/31/1998	Buldir	BD4W	BD87314W.dat	BD87314W.srv	8:11	9:38	False bottom
7/31/1998	Buldir	BD03	BD873103.dat	BD873103.srv	10:18	14:11	False bottom
7/31/1998	Buldir	BD02	BD873102.dat	BD873102.srv	15:10	19:02	
8/1/1998	Buldir	BD01	BD880101.dat	BD880101.srv	8:35	12:36	Run 2 OK
8/1/1998	Buldir	BD08	BD880108.dat	BD880108.srv	13:24	17:28	Mottled petrel off Tx, Poor obs. cond., 16:25-Display stalled, file was reinitiated
8/1/1998	Buldir	MWTR04	BDMT04.dat	BDMT04.srv	19:28	19:58	CS26 T1
8/2/1998	Tahoma Reef	BDT1	BD8802T1.dat	BD8802T1.srv	8:08	9:27	Start 51 52.44 N 175 43.02 E, End 51 46.50 N 176 00.00 E
8/2/1998	Tahoma Reef	BDT2	BD8802T2.dat	BD8802T2.srv	9:44	11:34	Start 51 46.50 N 17600.00 E, End 52 04.03 N 176 02.13 E
8/2/1998	S. of Buldir Reef	BDT3	BD8802T3.dat	BD8802T3.srv	13:12	15:45	Start 52 04.96 N 176019.05 E, End 52 06.50 N 177 03.00 E

Appendix B. Numbers of seabirds observed on 13 transects near Buldir Island, Alaska during July-August 1998.

Species/ Transect Number	1	2	3	4E	4W	5	6	7	8	9	T1	T2	T3
Black-footed Albatross	3	1	1	2	2	1	0	3	0	2	0	0	9
Laysan Albatross	22	23	20	17	5	27	31	58	5	31	62	22	63
Northern Fulmar	95	149	217	118	84	341	97	287	29	321	185	87	1416
Mottled Petrel	1	0	0	0	0	1	0	0	4	0	0	0	0
Sooty Shearwater	0	0	0	3	0	0	0	1	0	19	0	1	0
Short-tailed Shearwater	34	570	83	392	199	925	792	829	4	68	46	18	4999
Unidentified Shearwater	1	1	4	3	1	0	1	850	7	94	0	0	0
Fork-tailed Storm-petrel	12	1567	183	14	6	25	16	52	11	8	871	131	1553
Leach's Storm-petrel	1	0	0	0	0	0	0	1	1	1	510	18	1
Red-faced Cormorant	0	0	3	3	0	0	0	0	0	0	0	0	0
Red Phalarope	1	0	11	0	0	5	92	34	0	0	1	0	35
Unidentified Phalarope	0	0	0	0	0	0	0	0	0	0	230	15	1
Pomarine Jaeger	1	0	0	0	0	0	0	0	0	0	0	0	0
Long-tailed Jaeger	1	0	0	0	0	0	0	0	0	0	0	0	0
Slaty-backed Gull	1	0	0	0	0	0	0	0	0	0	0	0	0
Glaucous-winged Gull	31	30	40	59	58	20	36	33	4	53	38	15	44

Appendix B. Numbers of seabirds observed on 13 transects near Buldir Island, Alaska during July-August 1998 (continued).

Species/ Transect Number	1	2	3	4E	4W	5	6	7	8	9	T1	T2	T3
Black-legged Kittiwake	60	16	17	42	4	156	19	26	11	17	3	3	124
Red-legged Kittiwake	1	1	0	0	0	2	2	1	1	0	0	0	17
Unidentified Kittiwake	10	11	3	3	1	0	2	10	2	0	0	0	10
Common Murre	0	0	2	1	11	2	1	1	2	1	1	1	1
Thick-billed Murre	13	22	108	8	24	22	21	20	1	3	0	6	2
Unidentified Murre	54	12	68	14	40	12	15	13	4	4	1	1	1
Pigeon Guillemot	0	0	0	1	0	0	0	0	0	0	0	0	0
Ancient Murrelet	0	8	17	5	7	6	4	4	0	0	0	0	26
Cassin's Auklet	0	0	1	0	0	0	0	2	0	0	0	0	0
Parakeet Auklet	23	85	70	130	2	77	20	9	0	7	0	1	24
Least Auklet	2	46	691	16	4	103	5	14	2	1	0	0	5574
Whiskered Auklet	1	0	156	0	1	0	0	0	0	0	1	0	5
Crested Auklet	0	165	640	0	85	119	3	6	0	0	0	0	122
Unidentified small dark Alcid	0	37	207	0	0	26	0	2	1	0	0	0	0
Tufted Puffin	117	83	339	32	161	33	52	23	25	14	6	13	14
Horned Puffin	32	44	51	19	10	19	5	18	10	9	3	16	16
Unidentified Puffin	0	0	1	0	1	0	0	1	0	0	0	0	0

Appendix C. Numbers of marine mammals observed on 13 transects near Buldir Island, Alaska during July-August 1998.

Species/ Transect Number	1	2	3	4E	4W	5	6	7	8	9	T1	T2	T3
Minke whale	0	0	0	0	0	0	0	0	0	0	0	2	10
Killer whale	28	0	0	0	0	0	0	0	0	0	0	0	0
Dall's porpoise	3	3	4	10	4	7	0	5	11	6	0	0	0

Appendix D. Locations of fishing efforts Near Buldir Island, Alaska in 1998.

Tow Number ^a	Date	Latitude (N)	Longitude (E)
BOTR01	25 July	52° 22.86'	175° 52.71'
BORT02	26 July	52° 16.61'	175° 59.73'
BOTR03	26 July	52° 05.03'	176° 32.55'
BOTR04	27 July	52° 05.55'	176° 29.19'
BOTR05	27 July	52° 06.44'	176° 25.79'
BOTR06	27 July	52° 23.14'	175° 56.86'
BOTR07	28 July	52° 22.88'	175° 56.60'
BOTR08	30 July	52° 23.00'	175° 53.31'
BOTR09	30 July	52° 23.12'	175° 52.80'
BOTR10	30 July	52° 23.33'	175° 55.22'
BOTR11	30 July	52° 23.30'	175° 55.99'
BOTR12	30 July	52° 23.65'	175° 52.93'
BOTR13	30 July	52° 24.26'	175° 51.64'
BOTR14	30 July	52° 24.40'	175° 51.42'
BOTR 15	30 July	52° 24.79'	175° 50.86'
BOTR16	30 July	52° 24.69'	175° 50.56'
BOTR17	1 August	52° 21.14'	175° 50.93'
BOTR18	1 August	52° 21.35'	175° 51.20'
LOLI01	25 July	52° 20.10'	175° 58.26'
LOLI02	31 July	52° 24.02'	175° 48.25'
MWTR01	26 July	52° 08.34'	176° 34.70'
MWTR02	27 July	52° 08.31'	176° 34.16'
MWTR03	27 July	52° 08.31'	176° 34.16'
MWTR04	1 August	52° 27.24'	175° 38.61'

Appendix D. Locations of fishing efforts Near Buldir Island, Alaska in 1998 (continued).

Tow Number ^a	Date	Latitude (N)	Longitude (E)
NEUS01	26 July	52° 09.42'	176° 27.94'
NEUS02	26 July	52° 08.20'	176° 32.28'
NEUS03	30 July	52° 23.19'	175° 52.75'
NEUS04	31 July	52° 26.44'	175° 34.12'
NEUS05	1 August	52° 23.99'	175° 51.12'
NEUS06	2 August	52° 08.59'	176° 11.83'
NEUS07	2 August	51° 52.25'	176° 02.25'
VERT01	30 July	52° 23.01'	175° 53.07'
VERT02	30 July	52° 23.07'	175° 52.45'
VERT03	30 July	52° 23.31'	175° 53.02'
VERT04	31 July	52° 26.10'	175° 34.27'
VERT05	1 August	52° 30.03'	175° 34.71'
VERT06	2 August	51° 52.21'	176° 02.14'

^aBOTR=Bottom trawl, LOLI=Long-line set, MWTR=Mid-water trawl,
NEUS=Neuston tow, VERT=Vertical plankton tow.

Appendix E. CTD log for SMMOCI cruise near Buldir Island, Alaska in 1998.

Date	Station No.	Time ^a	Latitude (N)	Longitude (E)	Bottom Depth (m)	Download Filename	Comments
07/25/1998	01	11:59	52° 21.00'	176° 36.91'	>300	Buld-100.hex	East end of transect #4E
07/25/1998	02	14:50	52° 20.96'	175° 58.85'	60	Buld-101.hex	West end of transect #4E
07/25/1998	03	15:18	52° 20.50'	175° 58.20'	48	Buld-102.hex	Long-line set #01
07/26/1998	04	23:30	52° 23.01'	175° 52.40'	24	Buld-103.hex	Bottom trawl #01
07/26/1998	05	01:41	52° 16.52'	176° 00.74'	133	Buld-104.hex	Bottom trawl #02
07/26/1998	06	07:51	52° 07.97'	176° 37.09'	93	Buld-105.hex	East end of transect #09
07/26/1998	07	12:31	52° 08.06'	175° 30.01'	>300	Buld-106.hex	West end of transect #09
07/26/1998	08	13:13	52° 12.03'	175° 30.00'	>300	Buld-107.hex	West end of transect #07
07/26/1998	09	17:47	52° 11.98'	176° 37.00'	>300	Buld-108.hex	East end of transect #07
07/26/1998	10	21:31	52° 08.56'	176° 34.88'	124	Buld-109.hex	Mid-water trawl #01
07/27/1998	11	00:14	52° 05.69'	176° 32.58'	65	Buld-110.hex	Bottom trawl #03
07/27/1998	12	02:31	52° 06.02'	176° 29.75'	71	Buld-111.hex	Bottom trawl #04
07/27/1998	13	04:37	52° 06.60'	176° 25.70'	88	Buld-112.hex	Bottom trawl #05, tow 1
07/27/1998	14	05:42	52° 07.07'	176° 25.88'	78	Buld-113.hex	Bottom trawl #05, tow 2
07/27/1998	15	08:31	52° 15.00'	176° 37.28'	>300	Buld-115.hex	East end of transect #06
07/27/1998	16	13:25	52° 14.99'	175° 29.90'	>300	Buld-116.hex	West end of transect #06
07/27/1998	17	14:02	52° 18.04'	175° 30.09'	>300	Buld-117.hex	West end of transect #05

Appendix E. CTD log for SMMOCI cruise near Buldir Island, Alaska in 1998 (continued).

Date	Station No.	Time ^a	Latitude (N)	Longitude (E)	Bottom Depth (m)	Download Filename	Comments
07/27/1998	18	19:00	52° 18.07'	176° 37.08'	>300	Buld-118.hex	East end of transect #05
07/27/1998	19	23:03	52° 23.32'	175° 57.11'	100	Buld119.hex	Bottom trawl #06
07/28/1998	20	00:11	52° 23.06'	175° 54.92'	40	Buld-120.hex	Bottom trawl #07
07/30/1998	21	12:48	52° 23.16'	175° 52.76'	33	Buld2-00.hex	Vertical plankton tow #01 and bottom trawl #08
07/30/1998	22	14:05	52° 23.31'	175° 53.20'	44	Buld2-01.hex	Vertical plankton tow #02 and bottom trawl#09
07/30/1998	23	15:36	52° 23.32'	175° 55.58'	58	Buld2-02.hex	Bottom trawl #10
07/30/1998	24	17:14	52° 23.03'	175° 55.58'	41	Buld2-03.hex	Bottom trawl #11
07/30/1998	25	19:38	52° 23.67'	175° 52.96'	86	Buld2-05.hex	Bottom trawl #12
07/30/1998	26	21:24	52° 24.13'	175° 51.80'	82	Buld2-06.hex	Bottom trawl #13
07/30/1998	27	23:07	52° 24.45'	175° 50.69'	64	Buld2-07.hex	Bottom trawl #15
07/31/1998	28	07:56	52° 20.91'	175° 50.95'	71	Buld2-08.hex	East end of transect #4W
07/31/1998	29	09:40	52° 21.13'	175° 29.98'	>300	Buld2-09.hex	West end of transect #4W
07/31/1998	30	10:05	52° 24.05'	175° 30.02'	>300	Buld2-10.hex	West end of transect #03
07/31/1998	31	14:14	52° 23.99'	176° 30.19'	>300	Buld2-11.hex	East end of transect #03
07/31/1998	32	14:51	52° 26.94'	176° 29.99'	>300	Buld2-12.hex	East end of transect #02
07/31/1998	33	19:03	52° 27.05'	175° 29.90'	>300	Buld2-13.hex	West end of transect #02

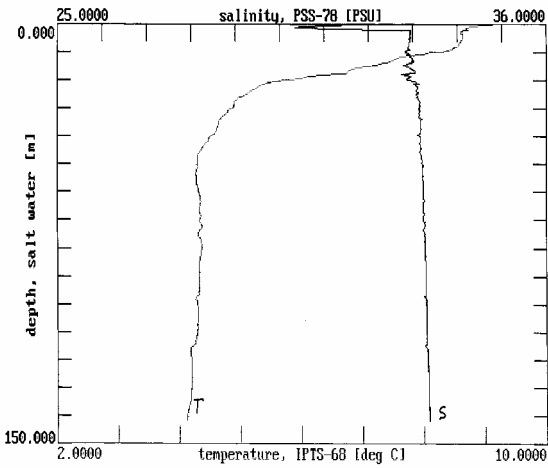
Appendix E. CTD log for SMMOCI cruise near Buldir Island, Alaska in 1998 (continued).

Date	Station No.	Time ^a	Latitude (N)	Longitude (E)	Bottom Depth (m)	Download Filename	Comments
07/31/1998	34	19:48	52° 26.08'	175° 34.28'	>300	Buld2-14.hex	Vertical plankton tow #04
07/31/1998	35	21:23	52° 24.14'	175° 48.40'	64	Buld2-15.hex	Long-line set #02
08/01/1998	36	03:22	52° 21.04'	175° 51.18'	60	Buld2-16.hex	Bottom trawl #17
08/01/1998	37	04:32	52° 21.63'	175° 51.14'	48	Buld2-17.hex	Bottom trawl #18
08/01/1998	38	08:09	52° 30.02'	175° 29.92'	>300	Buld2-18.hex	West end of transect #01
08/01/1998	39	12:38	52° 30.00'	176° 30.00'	>300	Buld2-19.hex	East end of transect #01
08/01/1998	40	13:09	52° 33.02'	176° 30.14'	>300	Buld2-20.hex	East end of transect #08
08/01/1998	41	17:29	52° 32.94'	175° 29.92'	>300	Buld2-21.hex	West end of transect #08
08/01/1998	42	18:30	52° 30.04'	175° 34.79'	>300	Buld2-22.hex	Vertical plankton tow #05
08/02/1998	43	02:50	51° 52.26'	176° 02.16'	262	Buld2-23.hex	Vertical plankton tow #06 and neuston tow # 07
08/02/1998	44	07:52	51° 52.44'	175° 43.02'	175	Buld2-24.hex	North end of transect #T01
08/02/1998	45	09:28	51° 46.40'	175° 59.98'	>300	Buld2-25.hex	South end of transects #T01 and #T02
08/02/1998	46	11:35	52° 04.05'	176° 02.19	>300	Buld2-26.hex	North end of transect #T02
08/02/1998	47	13:57	52° 04.98'	176° 19.02'	>300	Buld2-27.hex	West end of transect #T03
08/02/1996	48	15:50	52° 06.55'	177° 03.24	>300	Buld2-28.hex	East end of transect #T03

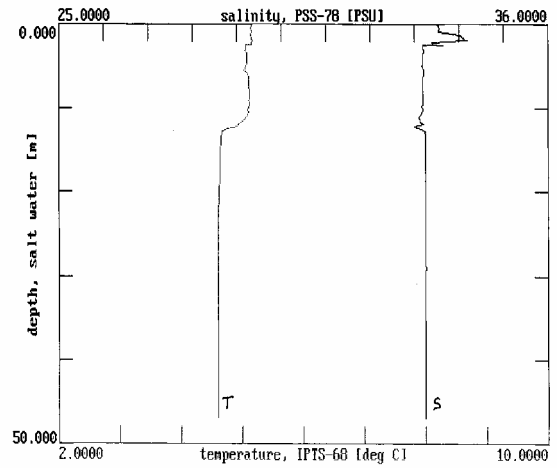
^aAll times are Aleutian Daylight.

Appendix F. Graphs of CTD casts from the SMMOCI cruise near Buldir Island, Alaska in 1998.
Vertical scale varies.

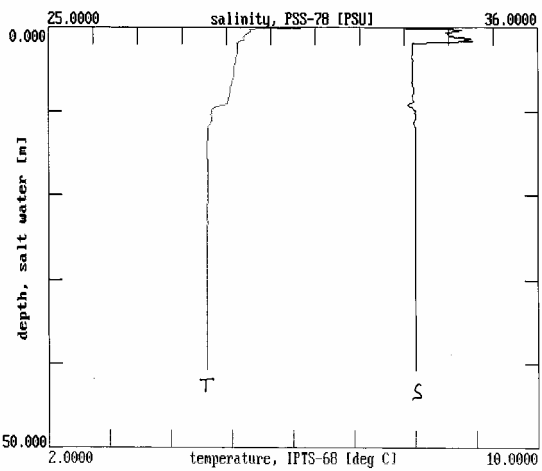
SMDCI 98-3 Buldir I. Station 01: East end of transect 4E 7/25/98



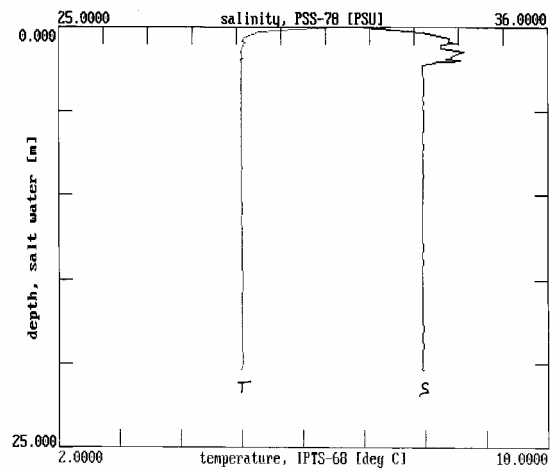
SMDCI 98-3 Buldir I. Station 02: West end of transect 4E 7/25/98



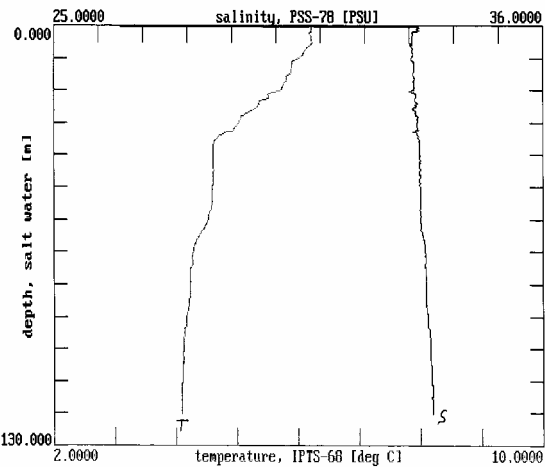
SMDCI 98-3 Buldir I. Station 03: Longline #1 7/25/98



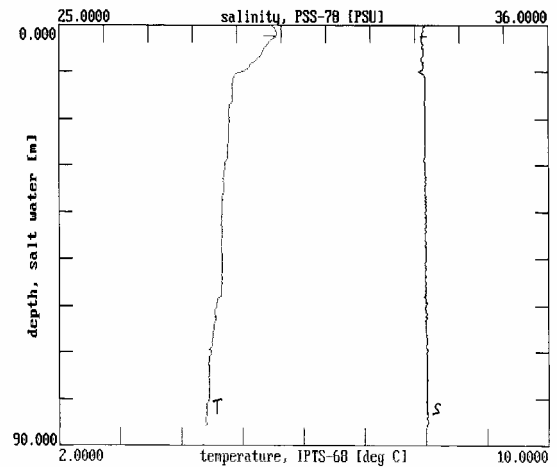
SMDCI 98-3 Buldir I. Station 04: Bottom Trawl #01 7/26/98



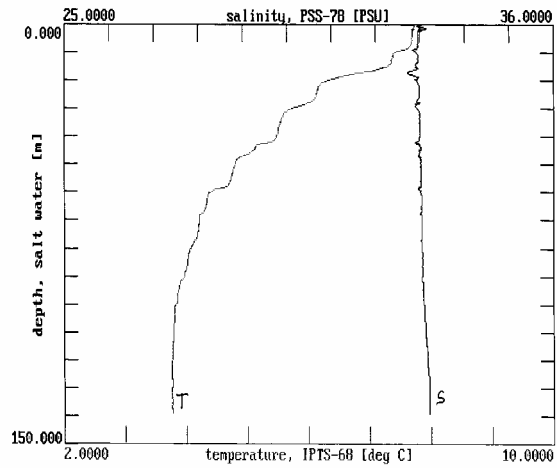
SMDCI 98-3 Buldir I. Station 05: Bottom Trawl #02 7/26/98



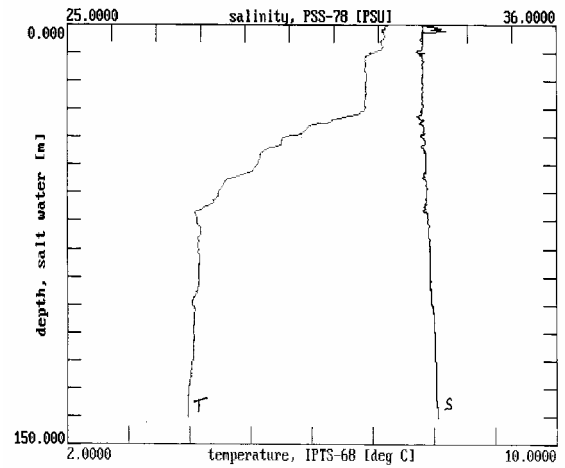
SMDCI 98-3 Buldir I. Station 06: East end of Transect 9 7/26/98



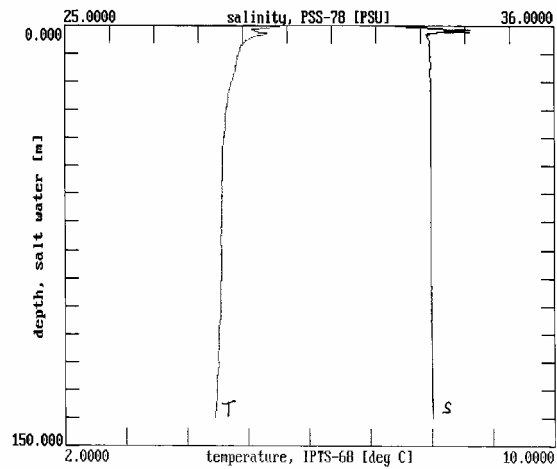
SMDCI 98-3 Buldir I. Station 07: West end of Transect 9 7/26/98



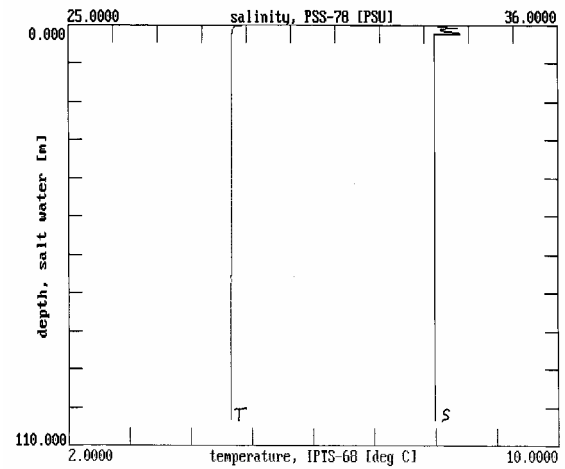
SMDCI 98-3 Buldir I. Station 08: West end of Transect 7 7/26/98



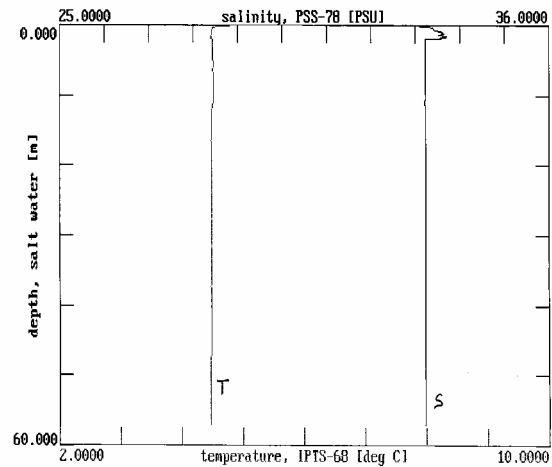
SMDCI 98-3 Buldir I. Station 09: East end of Transect 7 7/26/98



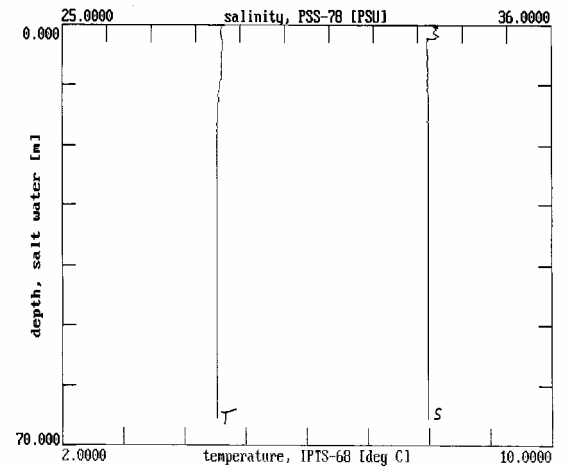
SMDCI 98-3 Buldir I. Station 10: Mid-water Trawl #1 7/26/98



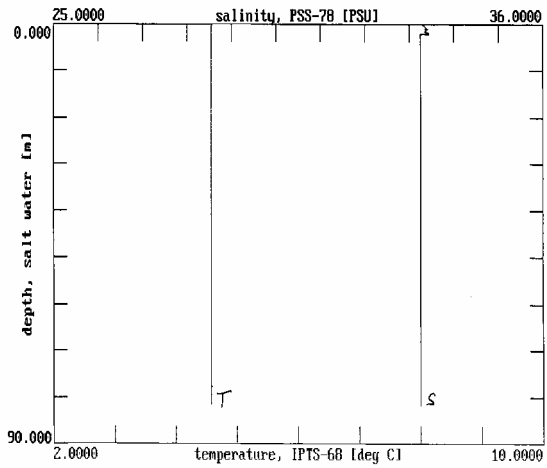
SMDCI 98-3 Buldir I. Station 11: Bottom Trawl #03 7/27/98



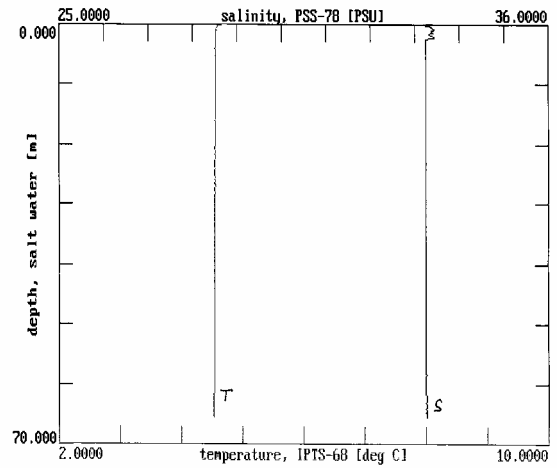
SMDCI 98-3 Buldir I. Station 12: Bottom Trawl #04 7/27/98



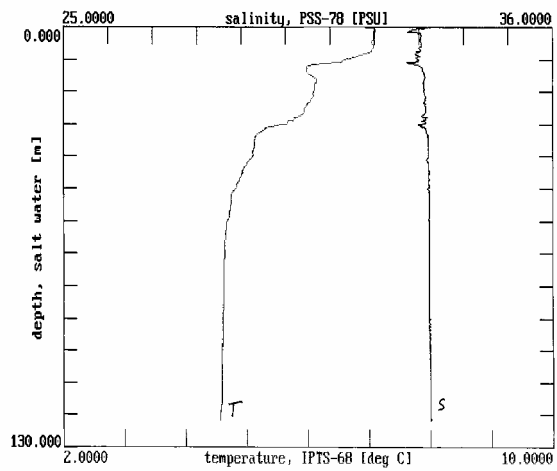
SMDCI 98-3 Buldir I. Station 13: Bottom Trawl #05 T1 7/27/98



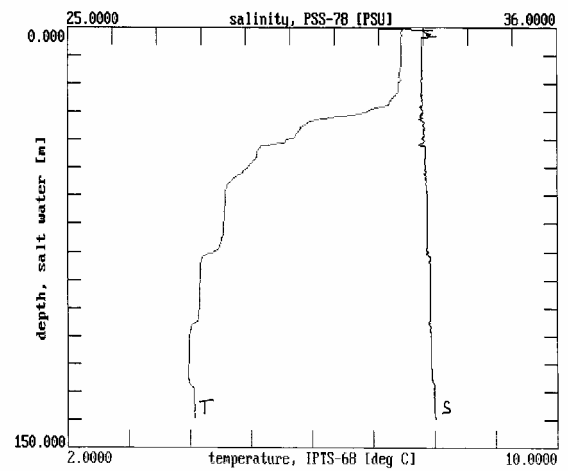
SMDCI 98-3 Buldir I. Station 14: Bottom Trawl #05 T2 7/27/98



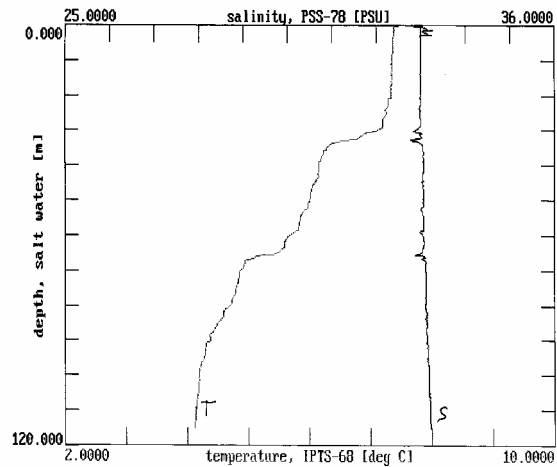
SMDCI 98-3 Buldir I. Station 15: East end of Transect 6 7/27/98



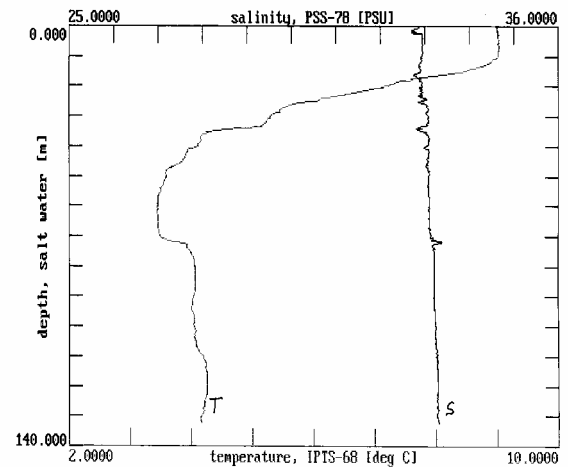
SMDCI 98-3 Buldir I. Station 16: West end of Transect 6 7/27/98



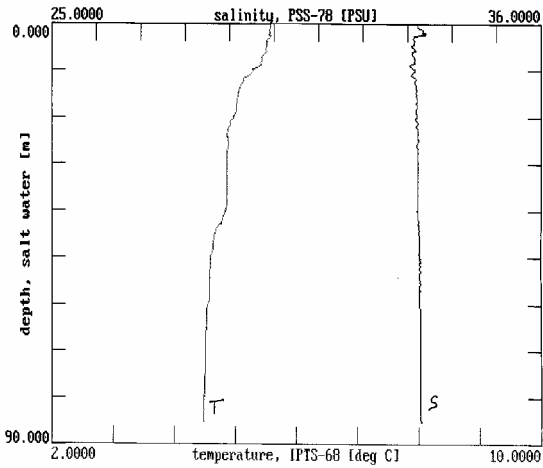
SMDCI 98-3 Buldir I. Station 17: West end of Transect 5 7/27/98



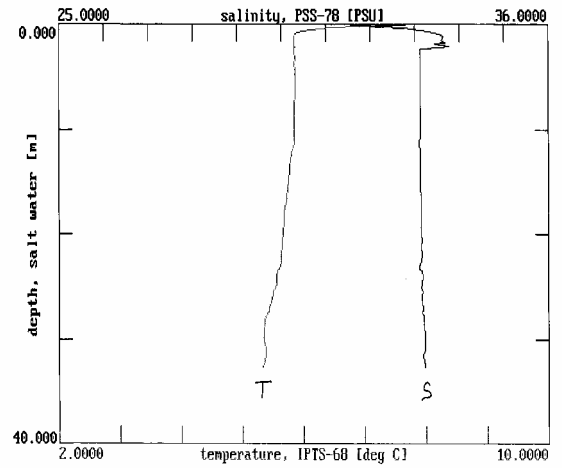
SMDCI 98-3 Buldir I. Station 18: East end of Transect 5 7/27/98



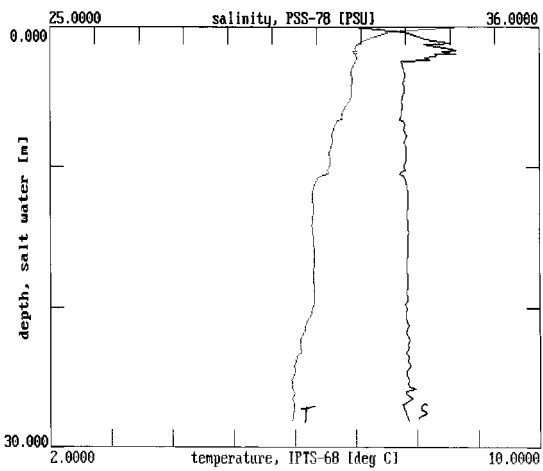
SMMOCl 98-3 Buldir I. Station 19: Bottom Trawl #06 7/27/98



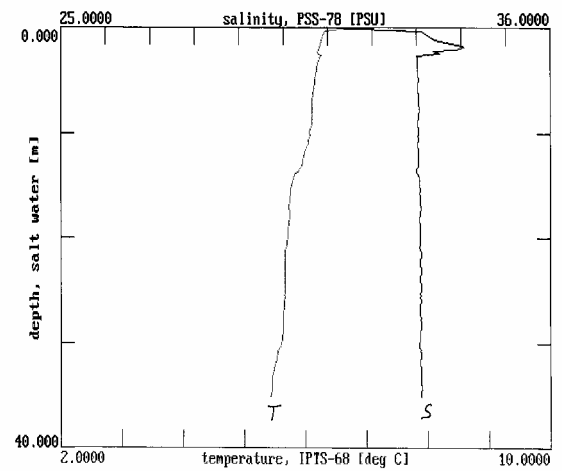
SMMOCl 98-3 Buldir I. Station 20: Bottom Trawl #07 7/28/98



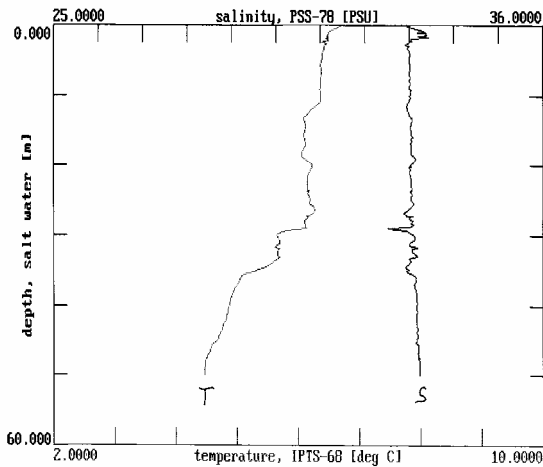
SMMOCl 98-3 Buldir I. Station 21: Bottom Trawl #08 7/30/98



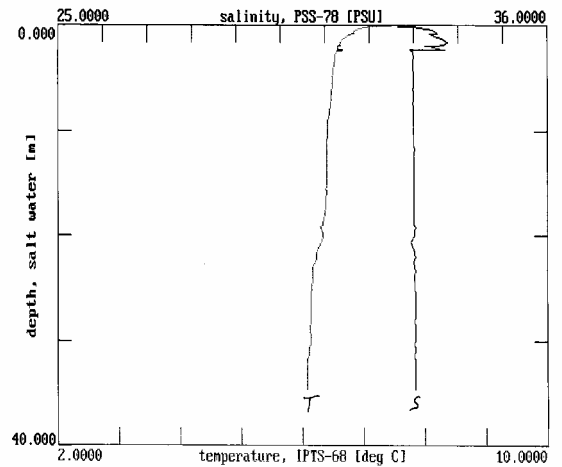
SMMOCl 98-3 Buldir I. Station 22: Bottom Trawl #09 7/30/98



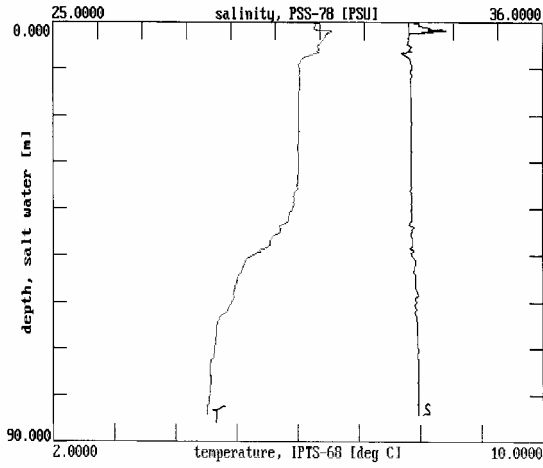
SMMOCl 98-3 Buldir I. Station 23: Bottom Trawl #10 7/30/98



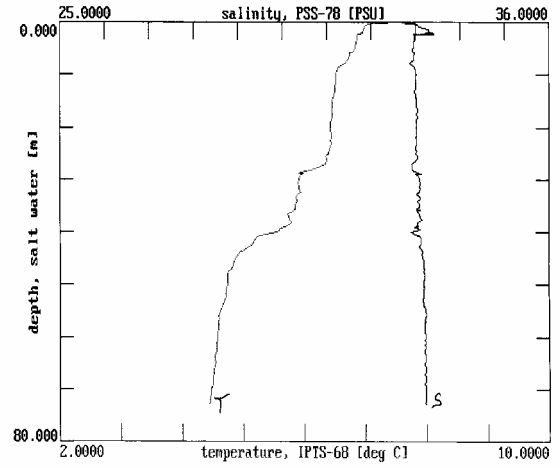
SMMOCl 98-3 Buldir I. Station 24: Bottom Trawl #11 7/30/98



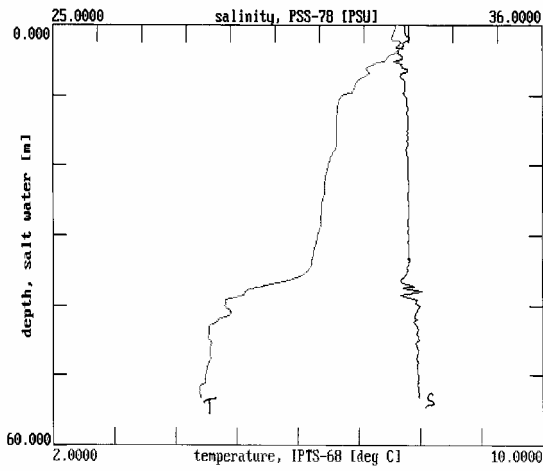
SMOICI 98-3 Buldir I. Station 25: Bottom Trawl #12 7/30/98



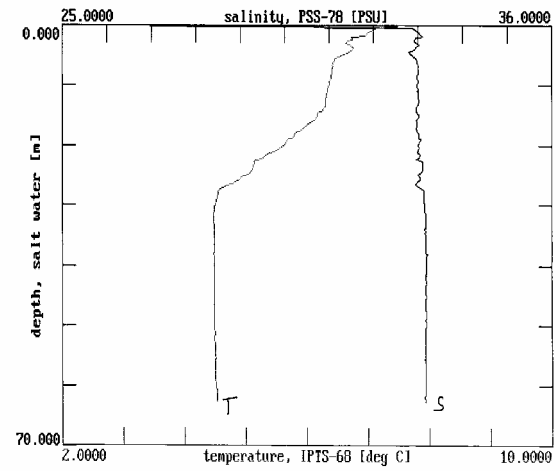
SMOICI 98-3 Buldir I. Station 26: Bottom Trawl #13 7/30/98



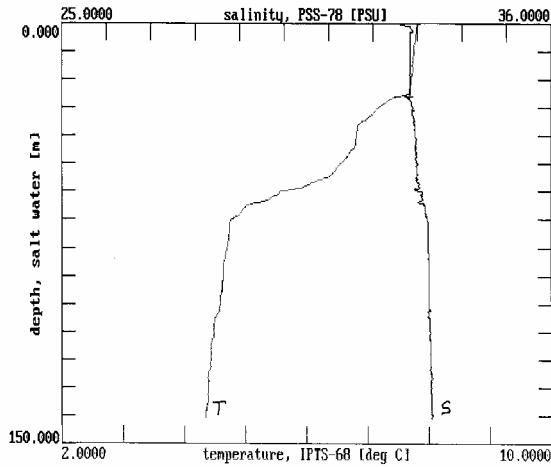
SMOICI 98-3 Buldir I. Station 27: Bottom Trawl #15 7/30/98



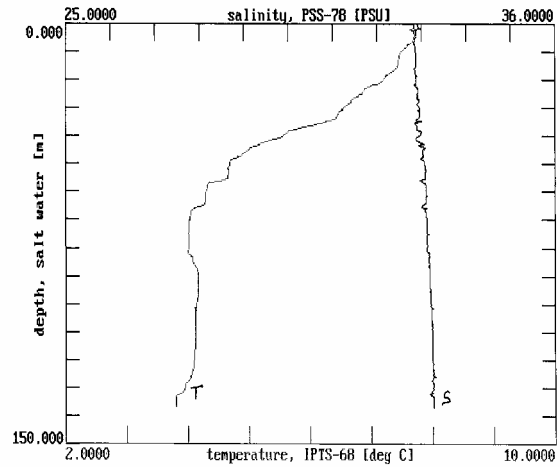
SMOICI 98-3 Buldir I. Station 28: East end of Transect 4W 7/31/98



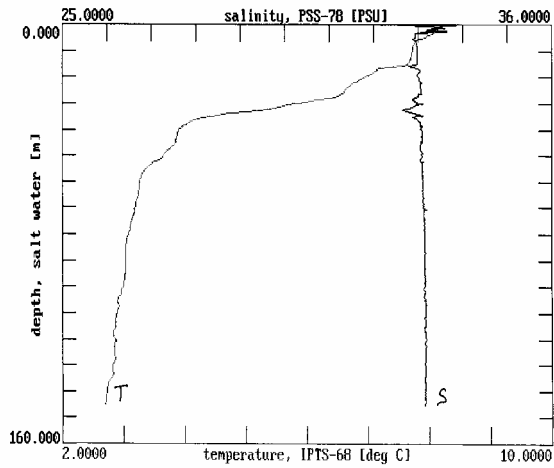
SMOICI 98-3 Buldir I. Station 29: West end of Transect 4W 7/31/98



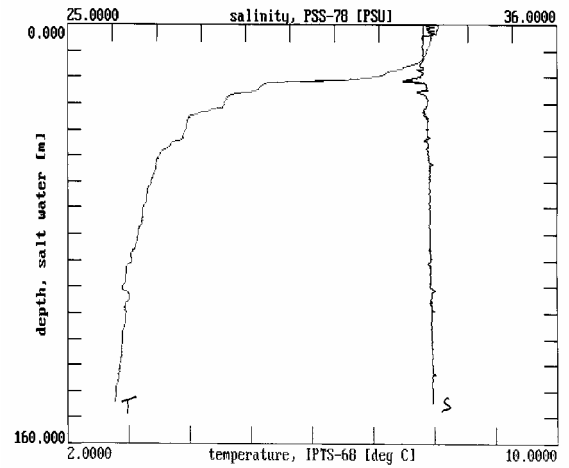
SMOICI 98-3 Buldir I. Station 30: West end of Transect 3 7/31/98



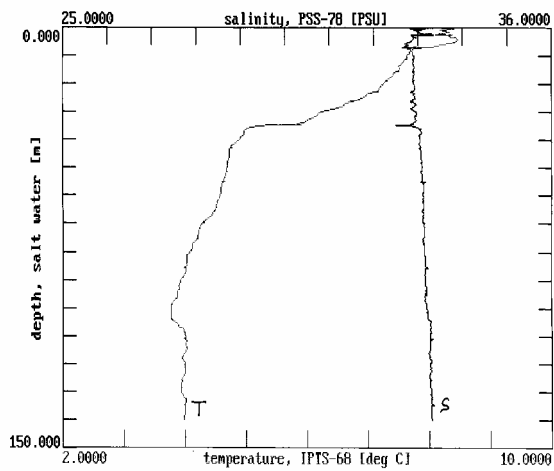
SMDCI 98-3 Buldir I. Station 31: East end of transect 3 7/31/98



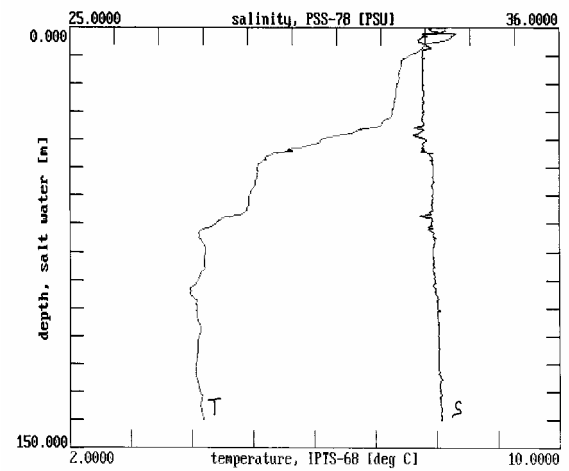
SMDCI 98-3 Buldir I. Station 32: East end of transect 2 7/31/98



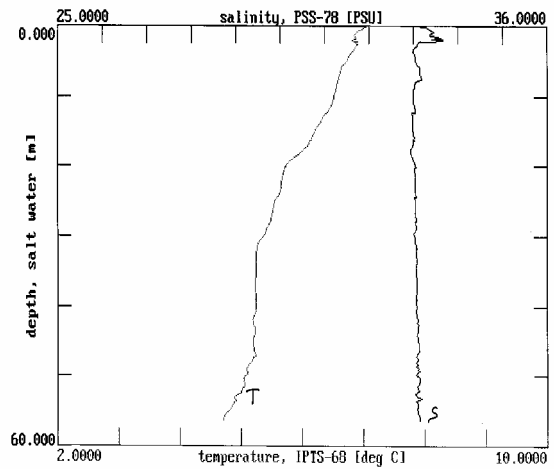
SMDCI 98-3 Buldir I. Station 33: West end of transect 2 7/31/98



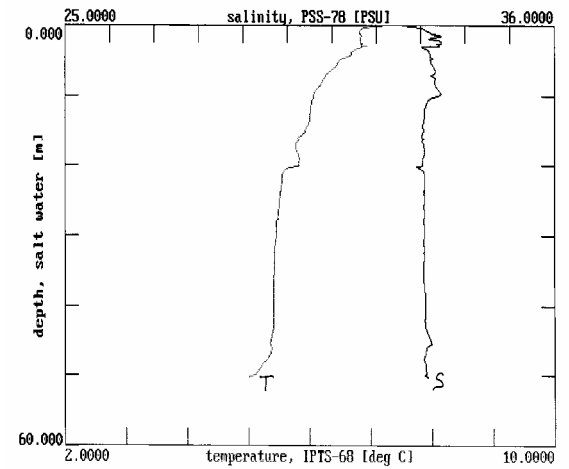
SMDCI 98-3 Buldir I. Station 34: Vertical Plankton Tow #4 7/31/98



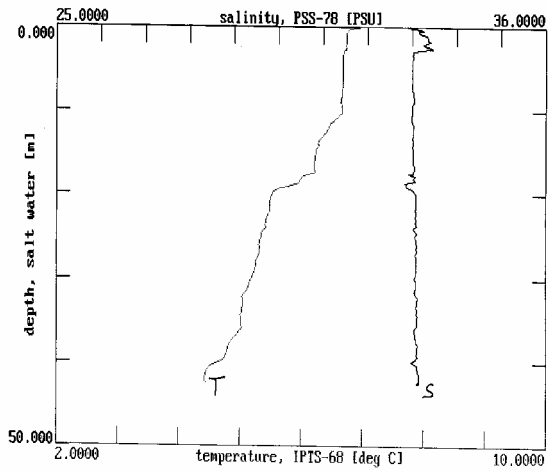
SMDCI 98-3 Buldir I. Station 35: Longline #2 7/31/98



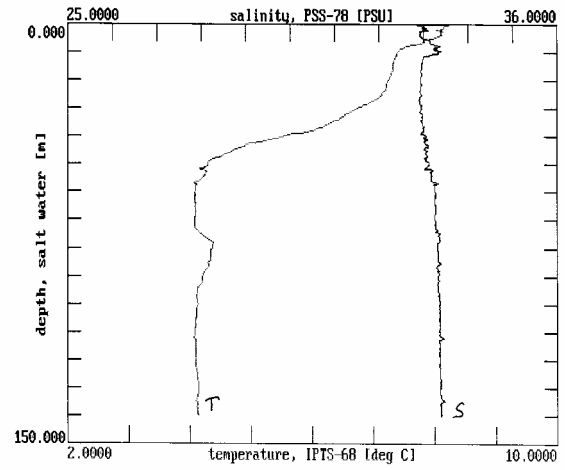
SMDCI 98-3 Buldir I. Station 36: Bottom Trawl #17 8/1/98



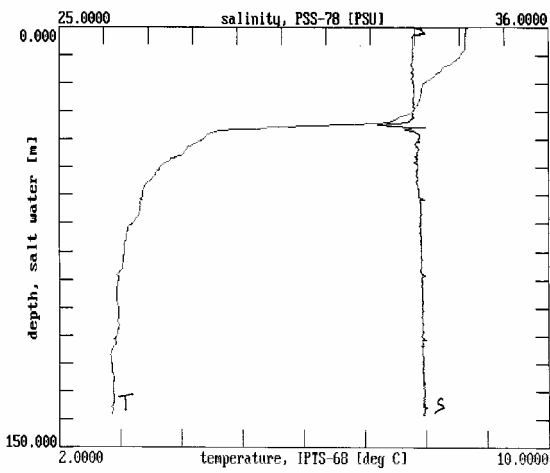
SMMOCI 98-3 Buldir I. Station 37: Bottom Trawl #18 8/1/98



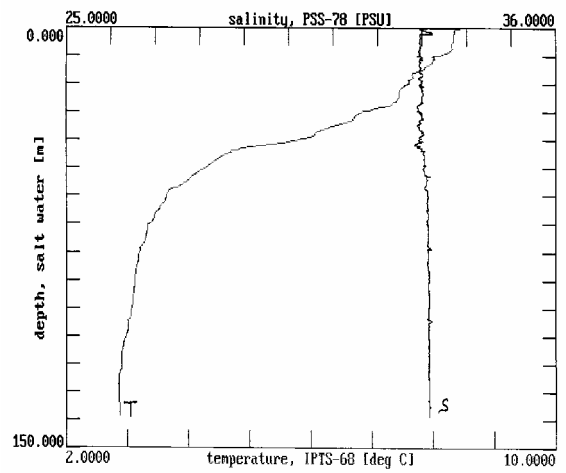
SMMOCI 98-3 Buldir I. Station 38: West end of Transect 1 8/1/98



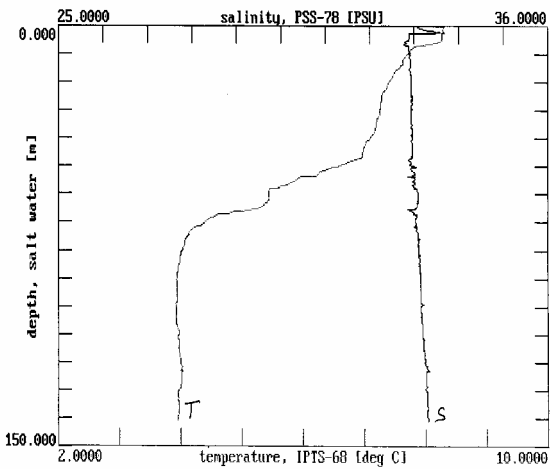
SMMOCI 98-3 Buldir I. Station 39: East end of Transect 1 8/1/98



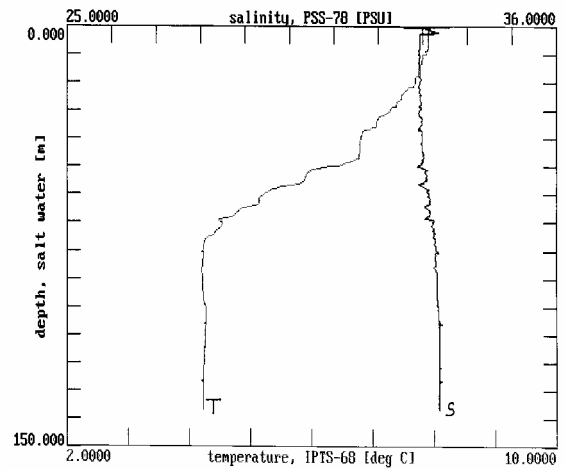
SMMOCI 98-3 Buldir I. Station 40: East end of Transect 8 8/1/98



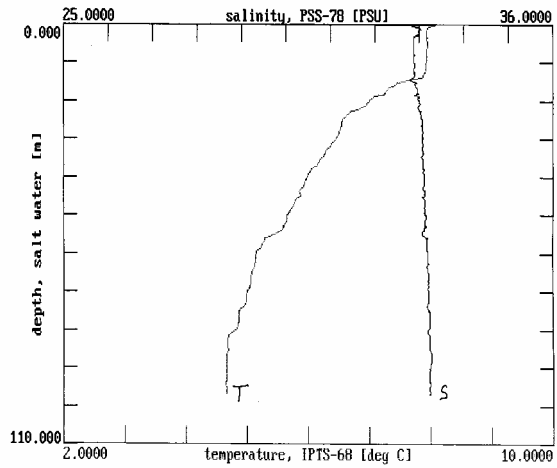
SMMOCI 98-3 Buldir I. Station 41: West end of Transect 8 8/1/98



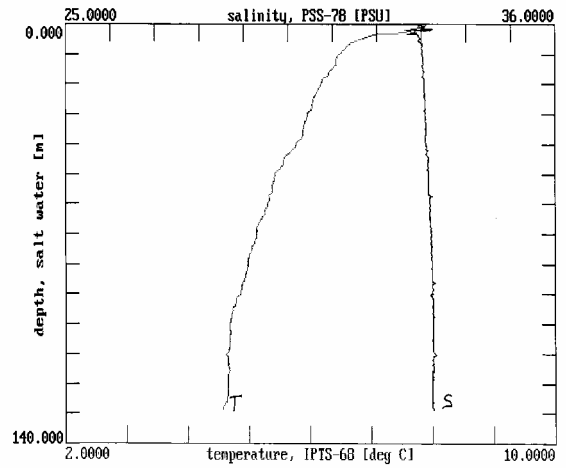
SMMOCI 98-3 Buldir I. Station 42: Vertical Plankton Tow #5 8/1/98



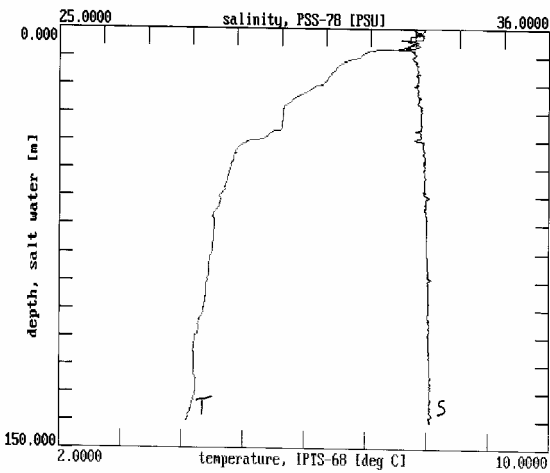
SMDCI 98-3 Buldir I. Station 43: Vertical Plankton Tow #6 8/2/98



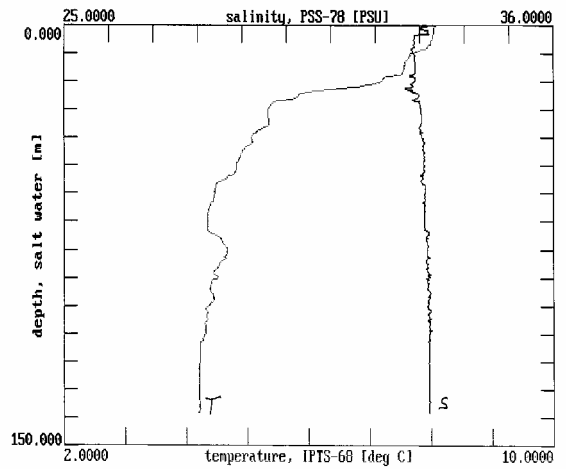
SMDCI 98-3 Buldir I. Station 44: North end of Transect T1 8/2/98



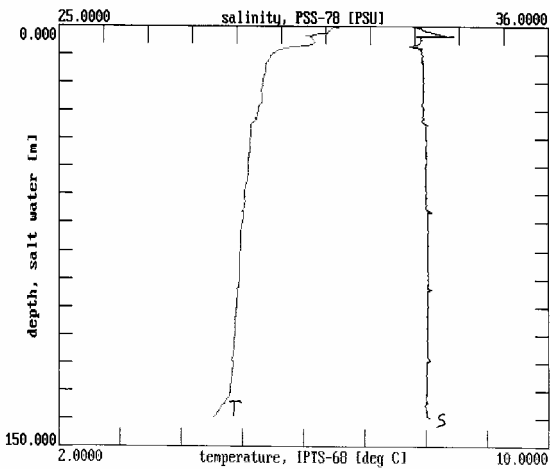
SMDCI 98-3 Buldir I. Station 45: South end of Transect T1 8/2/98



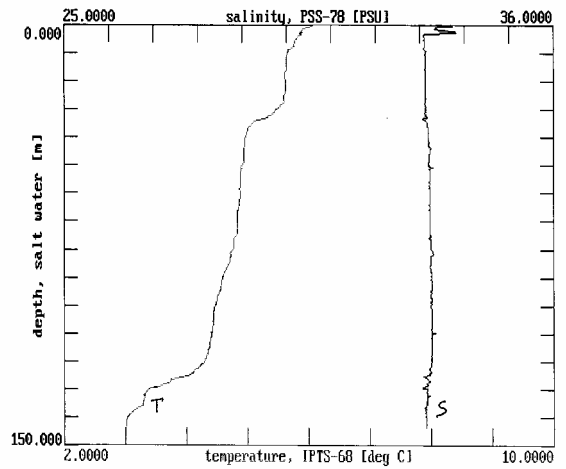
SMDCI 98-3 Buldir I. Station 46: North end of Transect T2 8/2/98



SMDCI 98-3 Buldir I. Station 47: West end of Transect T3 8/2/98

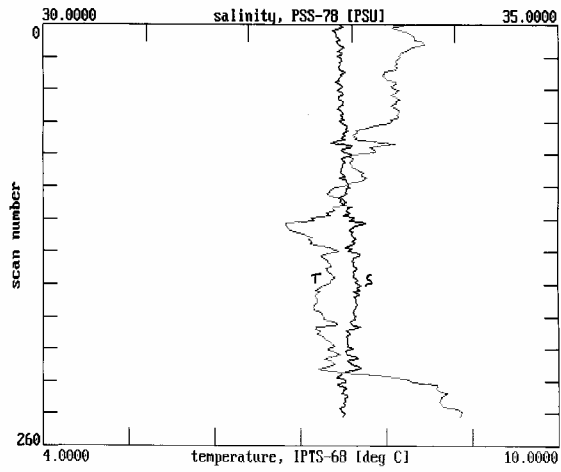


SMDCI 98-3 Buldir I. Station 48: East end of Transect T3 8/2/98

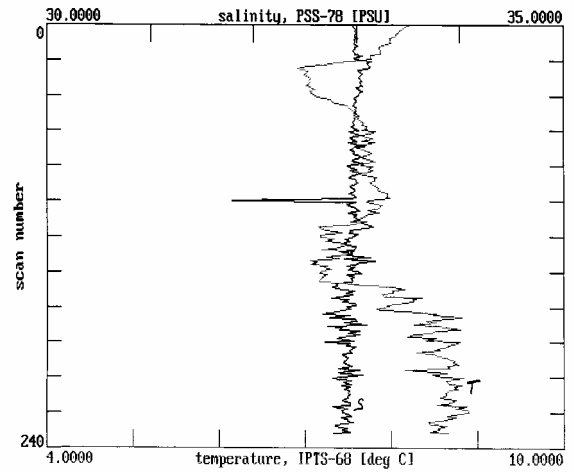


Appendix G. Graphs of thermosalinograph data from the SMMOCI cruise near Buldir Island, Alaska in 1998. Vertical scale varies.

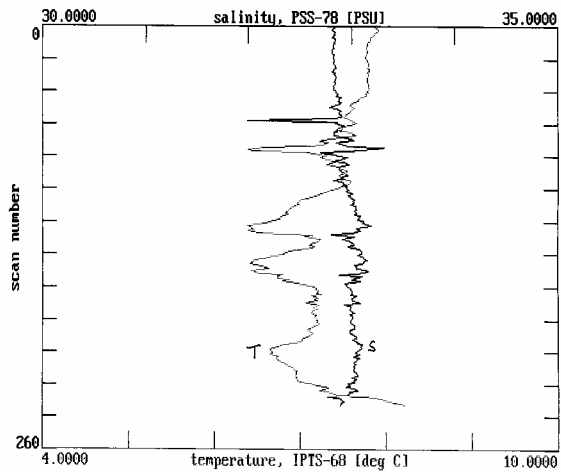
SMMOCI 98-3 Buldir I. Transect 1 (west to east) 8/01/98



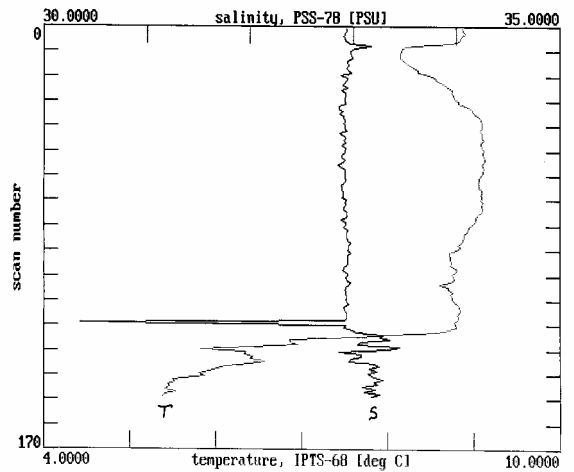
SMMOCI 98-3 Buldir I. Transect 2 (east to west) 7/31/98



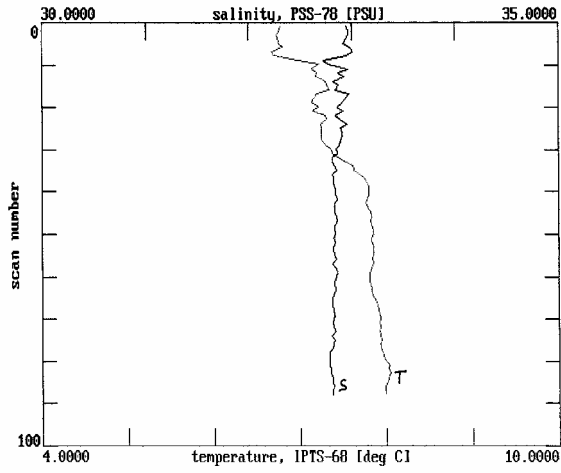
SMMOCI 98-3 Buldir I. Transect 3 (west to east) 7/31/98



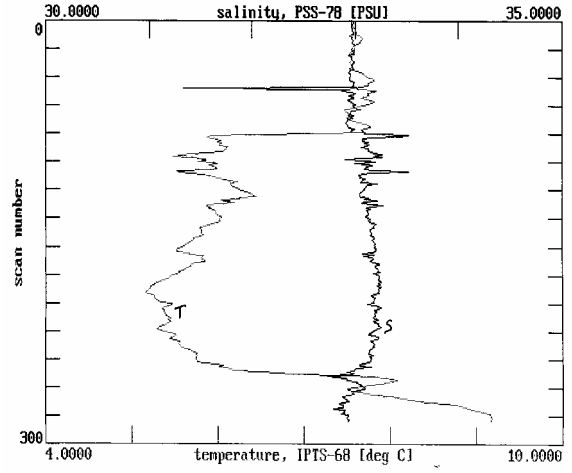
SMMOCI 98-3 Buldir I. Transect 4E (east to west) 7/25/98



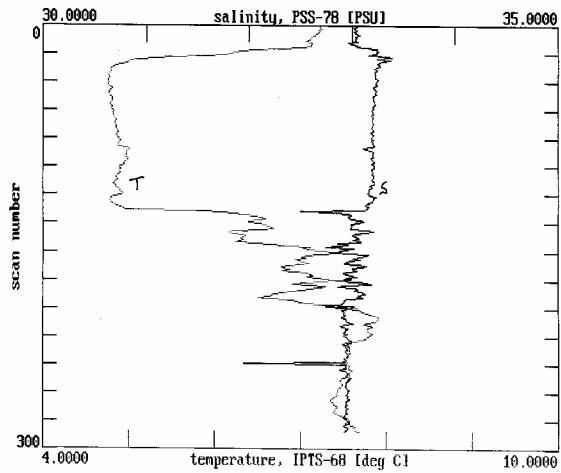
SMMOCl 98-3 Buldir I. Transect 4W (east to west) 7/31/98



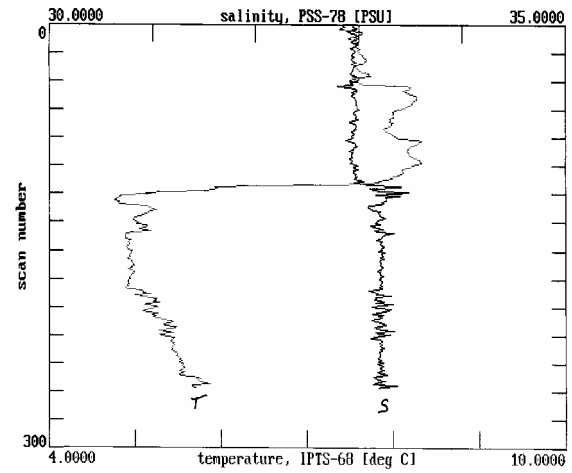
SMMOCl 98-3 Buldir I. Transect 5 (west to east) 7/27/98



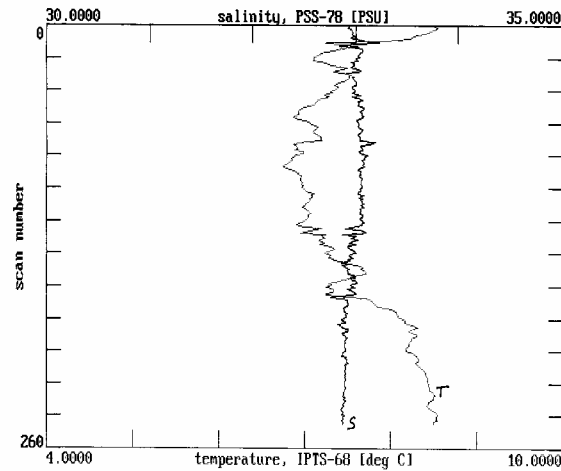
SMMOCl 98-3 Buldir I. Transect 6 (east to west) 7/27/98



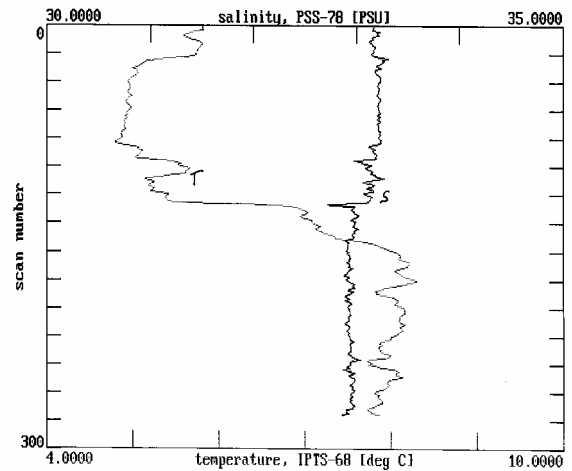
SMMOCl 98-3 Buldir I. Transect 7 (west to east) 7/26/98



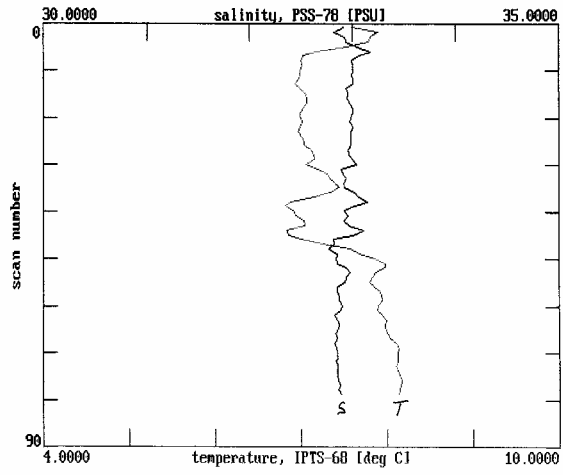
SMMOCl 98-3 Buldir I. Transect 8 (east to west) 8/01/98



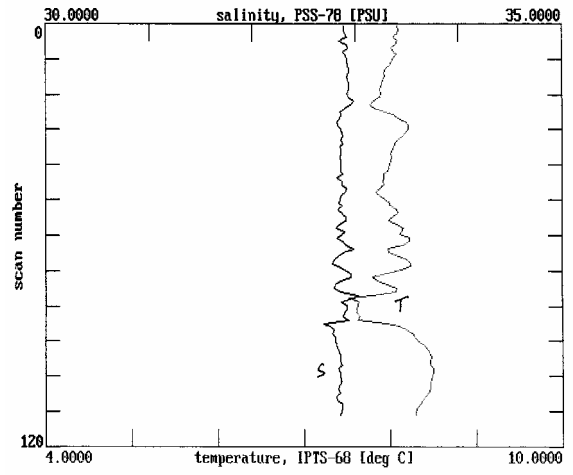
SMMOCl 98-3 Buldir I. Transect 9 (east to west) 7/26/98



SMNOCI 98-3 Buldir I. Transect T1 (north to south) 8/02/98



SMNOCI 98-3 Buldir I. Transect T2 (south to north) 8/02/98



SMNOCI 98-3 Buldir I. Transect T3 (west to east) 8/02/98

