APPENDICES

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Appendix 1

FISHERIES OCEANOGRAPHY OF THE NORTHEASTERN CHUKCHI SEA

ANNUAL REPORT 1989 SAMPLING

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INTRODUCTION

In the northeastern Chukchi Sea there is little information on the organisms, the habitats they occupy, or the interrelationship between the two. Consequently, managers can not conceptualize or predict how fishery organisms might respond to human perturbations, how various components of a system might interact to potential perturbations, or to make informed management decisions. With the interest in oil extraction from the area there has been considerable interest and effort in developing information over the past six years. This project continues these efforts in a two phase program to determine fish community structure of the northeastern Chukchi Sea and relate this to the area's geological and physical oceanographic structure. This annual report presents information developed during the first phase, the goal of which was to conduct a pilot survey of the fish fauna between Longitude 167° W and the international boundary, and north of Latitude 68° N. The overall guiding hypothesis for this phase was: The southern stratum (between 68° and approximately 70°N; Figure 1) will be dominated by Bering Sea water and the fish fauna will contain more Bering Sea species than in the northern strata. The northern stratum (north of 71° 30'N) will be dominated by Chukchi Sea Resident Water and the fish will be dominated by arctic species. The middle strata will be a mixture of the two faunas and influenced by the coarse surficial sediments emanating from Harold Shoals. There were three objectives in this phase: 1) to determine the distribution and numerical abundance of fishery organisms, emphasizing the ichthyofauna, in the study area; 2) to make a general assessment of the relationship between the fishery organisms and physical oceanographic conditions in the study area; and 3) to obtain the original data of Alverson and Wilimovsky (1966), and Quast (1972). The latter information was used to design Phase 2.

METHODS AND MATERIALS

A stratified sampling program was used in this study based on the distribution of water masses and surficial sediments. Surficial sediments of the northeastern Chukchi Sea are poorly sorted and grade from those dominated by gravels nearshore to muddy offshore, except for near Harold Shoals where it is again heavily influenced by gravel (Sharma 1979; Feder *et al.*, 1989). There are three main water masses, the Alaska Coastal Water (ACW) nearshore, and offshore the Bering Sea Water (BSW) in the southern portion and Arctic (Chukchi Resident) Water (CRW) in the northern portion of the Chukchi Sea (Coachman et al., 1975; Feder *et al.*, 1989). Based on this information the area was divided into three strata, the southern stratum was north of Latitude 68°N and south of 70°N, and northern stratum was north of 71° 30'N (Figure 1; Table 1). In both of these strata the surficial sediments are dominated by muds (Sharma 1979; Feder *et al.*, 1989). These strata, however, are dominated by different water masses; the BSW mass dominates the southern stratum whereas the CSR water mass dominates the northern stratum. The benthic/demersal fauna of the central stratum, between the northern and southern strata, will undoubtedly be strongly influenced by gravels or sand emanating from Harold Shoals. The water mass will be a mixture of BSW and CSR. Since sampling the prescribed area was completed early, additional stations were occupied in the southeastern Chukchi Sea and termed stratum 4 (Figure 1; Table 1).

Biological Sampling

At each station demersal trawling and standard physical oceanographic sampling was conducted whereas plankton sampling was conducted at specified stations (Table 1). Each station

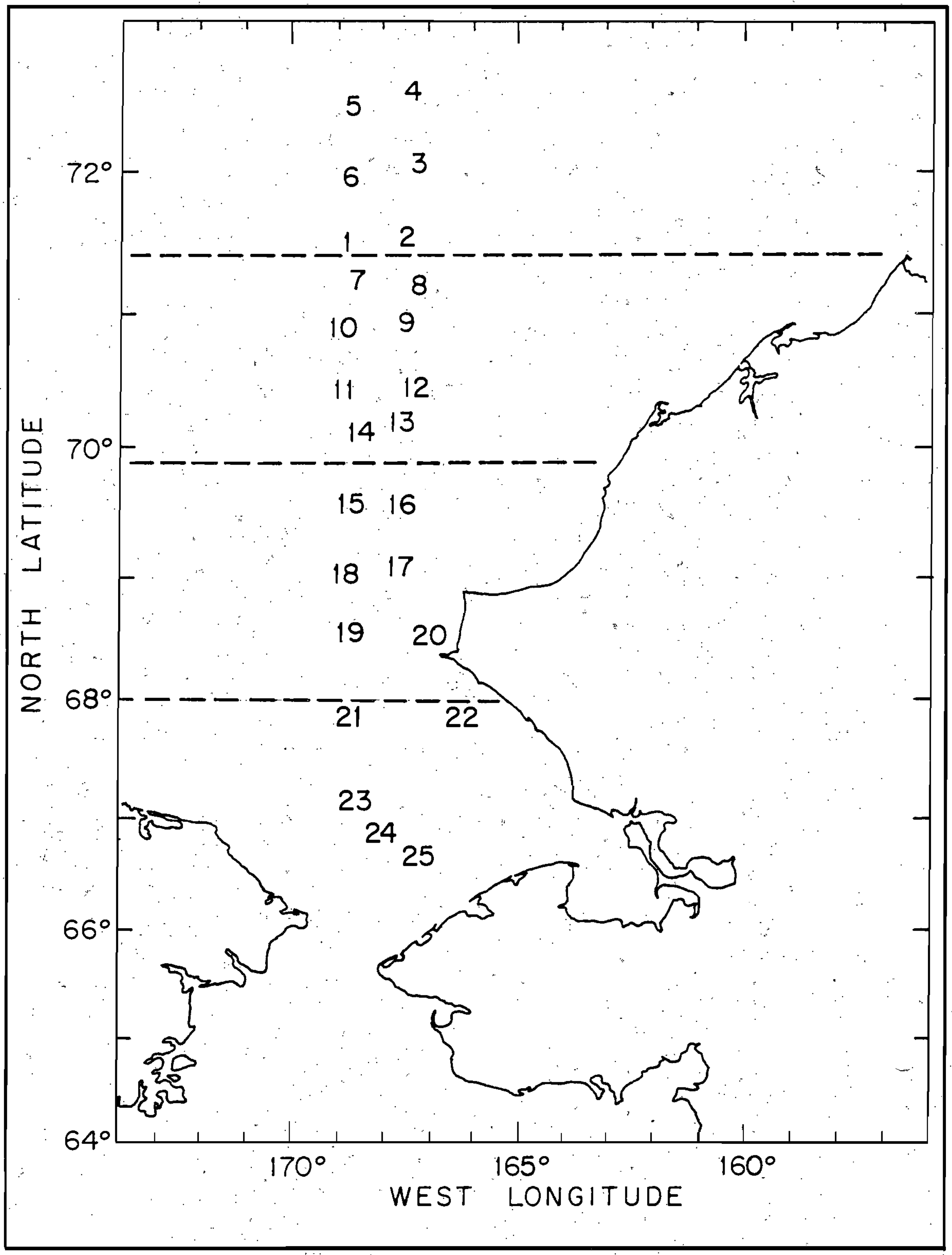


Figure 1. Station locations in the Chukchi Sea where sampling occurred 3-9 September 1989. Dashed lines separate the various strata mentioned in the text.

Table 1.—Station locations in the Chukchi Sea where biological sampling occurred from 3 - 9 September 1989 and those sampled by previous authors (their stations are in parentheses). Samples were obtained with otter and Isaacs-Kidd midwater trawls at all stations and zooplankton samples at selected stations.

Strata	Station Number	Station Location		Sampling Zooplankton	Previous Studies
Northern	5	72°30'N	168°50'W		
	6	72°30'	167°15'		
	4	72°00'	168°50'	X	
	3	72°00'	167°15'	X	
	1	71°30'	168°50'		
	2	71°30'	167°25'		
Central	7	71°15'	168°50'		
	8	71°15'	167°15'		
	10	70°45'	168°50'	X	
	9	70°45'	167°15'	X	
	11	70°15'	168°50'	X	
	12	70°15'	167°15'	X	
	14	69°56'	168°38'		2(45)
	13	69°57'	167°31'		2(41)
Southern	15	69°37'	168°52'	X	
	16	69°36'	167°36'	X	2(51)
	18	69°03'	168°50'		
	17	69°03'	167°30'		1(56)
	19	68°32'	168°52'		1(31)
	20	68°32'	166°54'		1(26)
Southeastern	21	68°03'	166°18'	X	1(30)
	22	68°03'	168°52'	X	1(19)
	23	67°04'	168°50'		
	24	66°51'	168°03'		
	25	66°39'	167°19'		

* 1 = Alverson and Wilimovsky(1966)
2 = Quast (1972)

location was determined by interpolation between satellite fixes; LORAN C could not be used for navigation due to radio propagation characteristics and the placement of the master and slave stations (Johnson 1989). Demersal fish were sampled with a 6.1-m headrope otter trawl with 35-mm meshed cod end. At each station, two 0.5 h otter trawls were conducted at speeds of approximately 2 kts. Upon landing, fish were sorted to lowest taxonomic category possible and counted. Weights were not obtained by species because of the combination of small size and low numbers. When fish were weighed, all taxa and individuals were weighed together. Total lengths (TL) were measured with dividers and a ruler. The smaller species (e.g., cottids), and those difficult to identify in the field, were preserved in 10% formaldehyde solution and returned to the laboratory for confirmatory identification. For the most common species, Arctic cod (*Boreogadus saida*) and Bering flounder (*Hippoglossoides robustus*), subsamples for otoliths, stomachs, and length measurements were obtained. In the laboratory, ages for these two species were obtained by viewing the whole otoliths on a black background with reflected light. For food habit analysis, stomachs were excised for selected species and localities, food organisms identified to the lowest taxonomic category possible and counted when possible. Estimates of total volume were also visually made.

Midwater fishes were sampled with a standard Isaacs-Kidd midwater trawl (IKMT) having a 1.8-m head bar (sampling a 2.65 m^2 area), 5-mm mesh codend, and a collecting bucket with a 1-mm mesh screen. To determine water volume sampled a flow meter was attached in the mouth of the net. The IKMT was towed obliquely, the wire let out until it was estimated to be a meter or two above the bottom and then pulled in at 1 m/sec as the boat traveled at approximately 2 kts. The samples were preserved in 5% formaldehyde solution and returned to the laboratory for identification and counting.

Invertebrates obtained in the otter trawl were sorted into broad taxonomic categories counted, and weighed when possible. Those of commercial importance were specifically identified, counted, and again, when possible, weighed. SHAB (shells and assorted biomass) was weighed without sorting and identification.

Baxter (ms) and Andriashev (1954) were used to identify adult and juvenile fish species. Larvae and post larvae were identified by Wayne A. Laroche. Species in the family Zoarcidae (eelpouts) were very difficult to identify, not only in the field but also in the laboratory. These fish were preserved in 10% formaldehyde solution and returned to the laboratory, where meristic and morphological measurements were determined following Hubbs and Lagler (1958).

Ichthyoplankton were sampled with a 1-m diameter plankton net with 1-mm mesh netting. This mesh size was chosen to facilitate larval identification. A flow meter was suspended in the net's mouth to determine volume sampled. Two samples were obtained at each designated station by hauling the net vertically through the water column. The organisms were fixed in a 10% formaldehyde and seawater solution. The ichthyoplankton were removed from the sample under a dissecting microscope, identified, counted and stored separately in a buffered 5% formaldehyde solution.

Physical Oceanography

Hydrographic information was collected with a Neil Brown conductivity temperature-depth (CTD) instrument. At each station one cast was made before and one after biological sampling. On each cast a Nansen bottle with reversing thermometers was taken for calibrating the CTD instrument. The CTD data were recorded on computer tape and averaged at one-meter depth intervals (following Johnson 1989). Calibration samples for salinity were collected at selected stations and analyzed on ship using an Autosal laboratory salinometer. The hydrographic data were stored in data banks which use the INGRES management system. Currents were determined at selected stations with an RD Instruments 300 kHz acoustic doppler current profiling system and data recorded on an IBM PC on board and processed at the Institute of Marine Science, University of Alaska.

RESULTS

Biological

The results and discussion presented in the following sections related to otter trawl sampling must be interpreted with caution; in all cases one wing or the other, or both, twisted during sampling. Attempts were made to correct this problem but were to no avail. Therefore, sampling with this gear was not as efficient as it might have been nor consistent between trawls.

Bottom trawling resulted in 28 species and 3 unknown species of fish being captured representing 8 families (Appendix Table 1). The most common species was arctic cod, making up 54% of the 1,595 specimens captured. The second most common species was the Bering founder making up 12% of the total catch followed by Arctic staghorn sculpin (*Gymnocanthus tricuspis*) with 10% of the total. Species numbers increased from north to south with 86% of 28 species found in this study occurring in the southeastern stratum (Table 2). Total number of individuals was highest in the central stratum, a reflection of Arctic cod abundance (Table 2 and Figure 2). Excluding Arctic cod, the numbers of individuals captured were about equal for the central through southeastern strata. Abundance, however, was a reflection of effort; CPUE for species other than Arctic cod was highest in the southeastern stratum (Table 2). Arctic cod was again most common in the southern stratum where 42% of total individuals were captured and the CPUE averaged 29.8/trawl. They were of about equal abundance in the northern and central strata where 28% and 26% of them were captured and the CPUE averaged 15.7 and 20.9, respectively. Bering flounder was most common in the central strata (44%) with equal abundance in the southern and southeastern strata (25% in each).

Table 2.—Total number of species and individuals and average number of species and individuals captured (with and without Arctic cod in calculations) with an otter trawl in the Chukchi Sea from 3 - 9 September 1989. Because some trawls contained no fish, one was added to determine one standard deviation (in parentheses).

	Species		**Numbers**	
	Total	**Average**	**Total**	**Average**
Northern				
With cod	10	0.63	292	19.3 (23.8)
Without cod	9	0.56	58	3.6 (2.8)
Central				
With cod	16	1.33	488	40.7 (37.3)
Without cod	15	1.25	238	19.8 (23.3)
Southern				
With cod	17	1.42	558	47.5 (39.2)
Without cod	16	1.33	212	17.7 (17.6)
Southeastern				
With cod	24	2.40	257	26.7 (18.3)
Without cod	23	2.30	248	24.8 (16.8)

Only a few fish were aged. A sample of age - 0 fish from the IKMT averaged 42 mm TL (range 27 - 67 mm). Surface ageing otoliths of Arctic cod gave the following average size

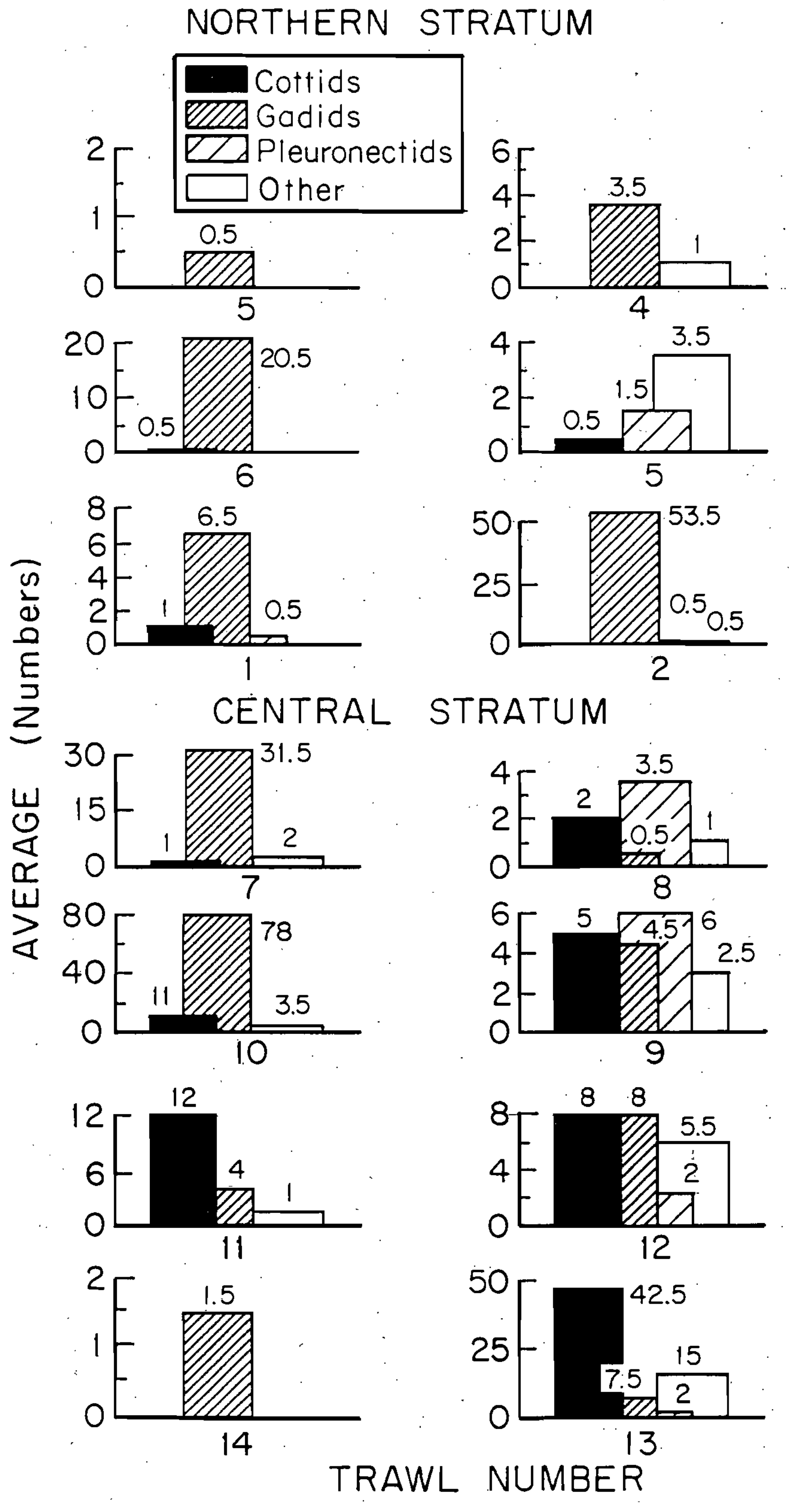
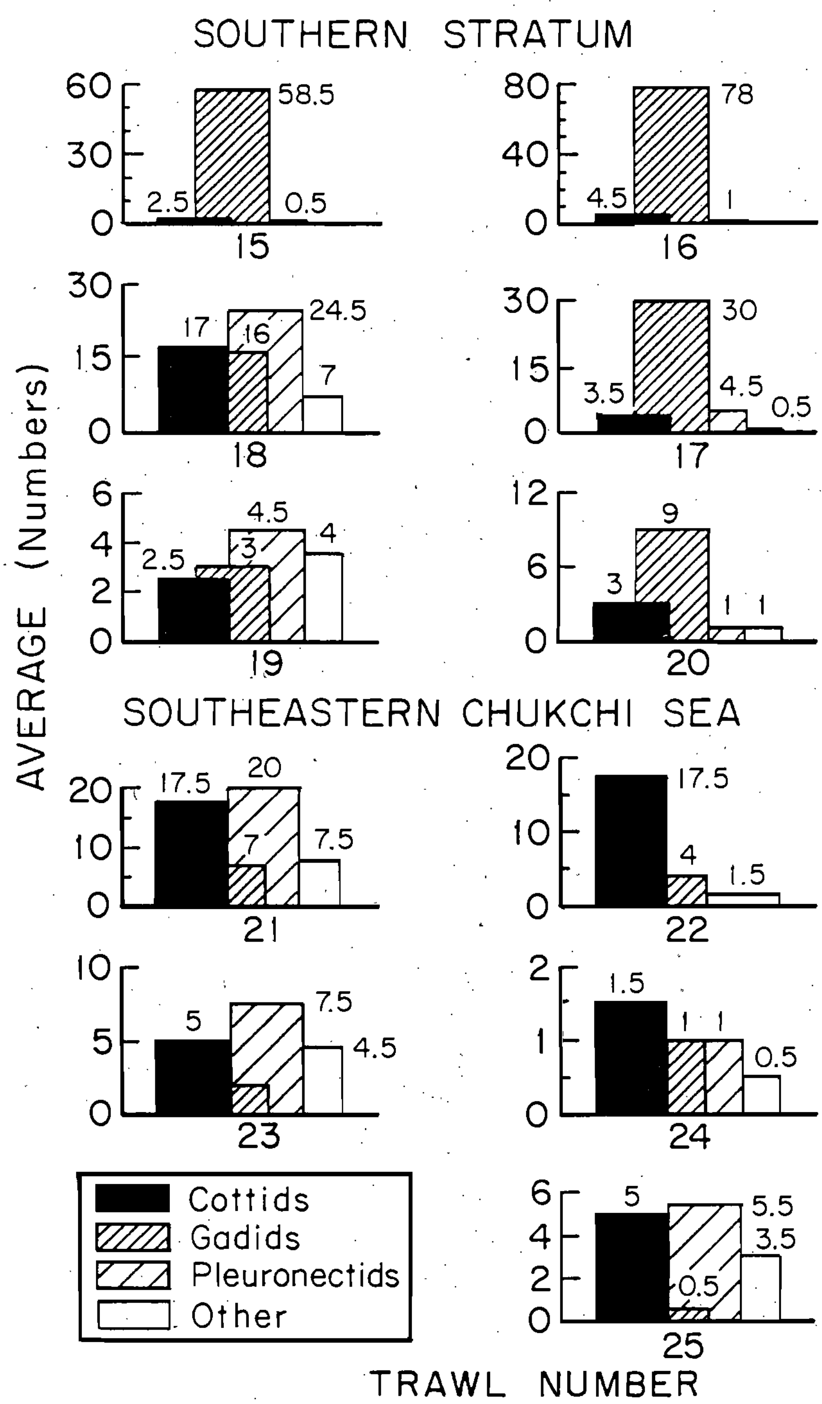


Figure 2. Average number of fish captured with two one-half hour otter trawls at each station in the four Chukchi Sea strata.

Figure 2. continued



at age:

Age	Total Length (mm) Average	Range	Sample Size
1	100	88-120	6
2	148	137-159	2
3	154	124-180	9
4	148	135-160	2
5	206	---	1
6	176	---	1

As a check on this aging, the break-and-burn technique was also attempted and gave very unsatisfactory results. There was no clear pattern of alternating light and dark bands with the otoliths being relatively uniform white with faint dark bands appearing periodically. Only four Bering flounder were aged giving an average size of 127 mm TL (range 115-143) for age - 4 fish and 130 mm TL for one fish aged six years old. The break-and-burn technique gave the same results.

Oblique trawling with the IKMT resulted in 3,506 individuals/1000 m^3 captured, averaging 73/station, representing 17 species in 8 families (Table 3; Appendix Table 2). Numbers of individuals were most abundant in the central and least in the southeastern stratum (Figure 3; Table 4). Catch in the central statum averaged 144.7/m (excluding cod, 31.6) and averaged 10.2 (excluding cod, 5.9) in the southeastern stratum. The most abundant species, juvenile Arctic cod, made up 79% of the individuals captured. The next most abundant species, Bering flounder and Arctic staghorn sculpin, made up 7% and 4.4% of the catch, respectively. Arctic cod was most abundant in the central stratum followed by the northern stratum and least abundant in the southeastern stratum (Table 4). The Bering flounder were larvae and most abundant in the central stratum where 45% of total number occurred. They were nearly as abundant in the southern stratum where 41% of the total were captured. They were least abundant in the northern stratum. Arctic staghorn sculpin were most abundant in the central stratum where the majority (about 80%) were captured. The highest number of species occurred in the southern stratum, was about equal in the northern and central strata, and least in the southeastern stratum (Table 4).

Table 3.—Average number of fish/1000 m^3 captured at each station with an Isaacs-Kidd midwater trawl obliquely in the Chukchi Sea, 3 - 9 September 1989.

Family	1	2	3	4	5	6	7	8	9	10	11	12	13
Cottidae	1.7	1.1	-	-	-	0.4	1.6	5.9	1.9	1.3	8.5	3.3	37.5
Gadidae	12.4	23.3	183	29.7	7.7	1.5	8.2	352	83	0.7	15.3	4.5	503
Pleuronectidae	-	3.5	-	-	-	-	-	-	1.7	-	-	0.7	33.5
Agonidae	-	0.8	0.4	-	-	-	0.6	-	0.7	-	-	-	1.7
Stichaeidae	2.1	0.4	1.2	0.4	2.6	3.3	1.5	1.0	0.7	13	-	-	1.2
Zoracidae	-	-	-	-	-	-	-	-	-	-	-	-	-
Ammodytidae	-	-	-	2.9	-	-	-	39.4	9.5	-	-	-	0.4
:o[arodae	-	-	0.4	-	-	-	0.4	-	-	-	-	-	-
Total x/Station=73	16.2	29.1	185	33	10.3	5.2	12.3	398.3	97.5	15	23.8	8.5	577.3

Table 3. continued

Family	Station	14	15	16	17	18	19	20	21	22	23	24
Cottidae		39.5	2.4	1.7	1.9	1.4	0.3	-	2.9	-	-	3.9
Gadidae		71.9	22.3	2.5	2.4	20.3	13.9	1.3	10.3	-	2.5	-
Pleuronectidae		29.5	9.6	0.9	6.3	23.1	18.2	1.9	4.7	10.6	1.7	-
Agonidae		0.6	0.8	-	-	0.5	0.8	-	0.5	-	-	-
Stichaeidae		16.5	0.8	-	0.5	0.9	3.0	-	0.5	-	-	-
Zoracidae		-	-	-	-	-	-	-	-	-	-	-
Ammodytidae		3.8	0.8	-	-	-	3.7	0.6	-	-	-	-
:o[arodae		-	-	-	-	-	-	-	-	-	-	-
Total x/Station=73		161.8	36.7	5.1	11.1	46.2	39.9	3.8	18.9	10.6	4.2	3.9

Table 4.—Total number of species and individuals captured and average number of species and individuals/1000 m^3 (including and excluding Arctic cod in calculations) with Isaacs-Kidd midwater trawl (IKTM) in the Chukchi Sea strata from 3 - 9 September 1989. One was added to each IKTM to determine one standard deviation (in parentheses).

	Species		Numbers	
	Total	Average	Total	Average
Northern				
With cod	11	0.69	1,394	87.1 (17.1)
Without cod	10	0.63	176	11.0 (19.7)
Central				
With cod	10	0.83	1,736	144.7 (219.4)
Without cod	9	0.76	379	31.6 (36.4)
Southern				
With cod	14	1.17	296	24.7 (20.5)
Without cod	13	1.08	170	14.2 (11.1)
Southeastern				
With cod	7	0.88	82	10.2 (8.9)
Without cod	6	0.75	59	5.9 (7.4)

Very few ichthyoplankton were captured and were at stations 21 and 22. The most abundant was the yellowfin sole (*Limanda aspera*) in which 11 (ranging from 12 to 16 mm total length) were captured. Two specimens (26 and 27 mm total length) were the longhead dab (*Lepidopsetta proboscidea*) and one 33-mm *Myoxocephalus verrucosus* were captured.

Although invertebrates were identified only to higher taxa (Table 5), there was a general impression of few species. Additionally, there were few numbers and small biomasses captured. There were two interesting features of the invertebrate catch, the abundance of opilio tanner crab and the presence of blue king crab at three stations. Opilio tanner crab occurred at all stations and were all rather small. They generally averaged less than 20 grams each; the largest average size being 76 and 50 grams at stations 4 and 18, respectively. There was no trend of increasing numbers, size, or biomass from north to south. One adult blue king crab weighing 1.4 kg was caught at station 17, and two juveniles, one 7-mm carapace length (CL) at station 12 and one individual 11-mm cl. at station 13.

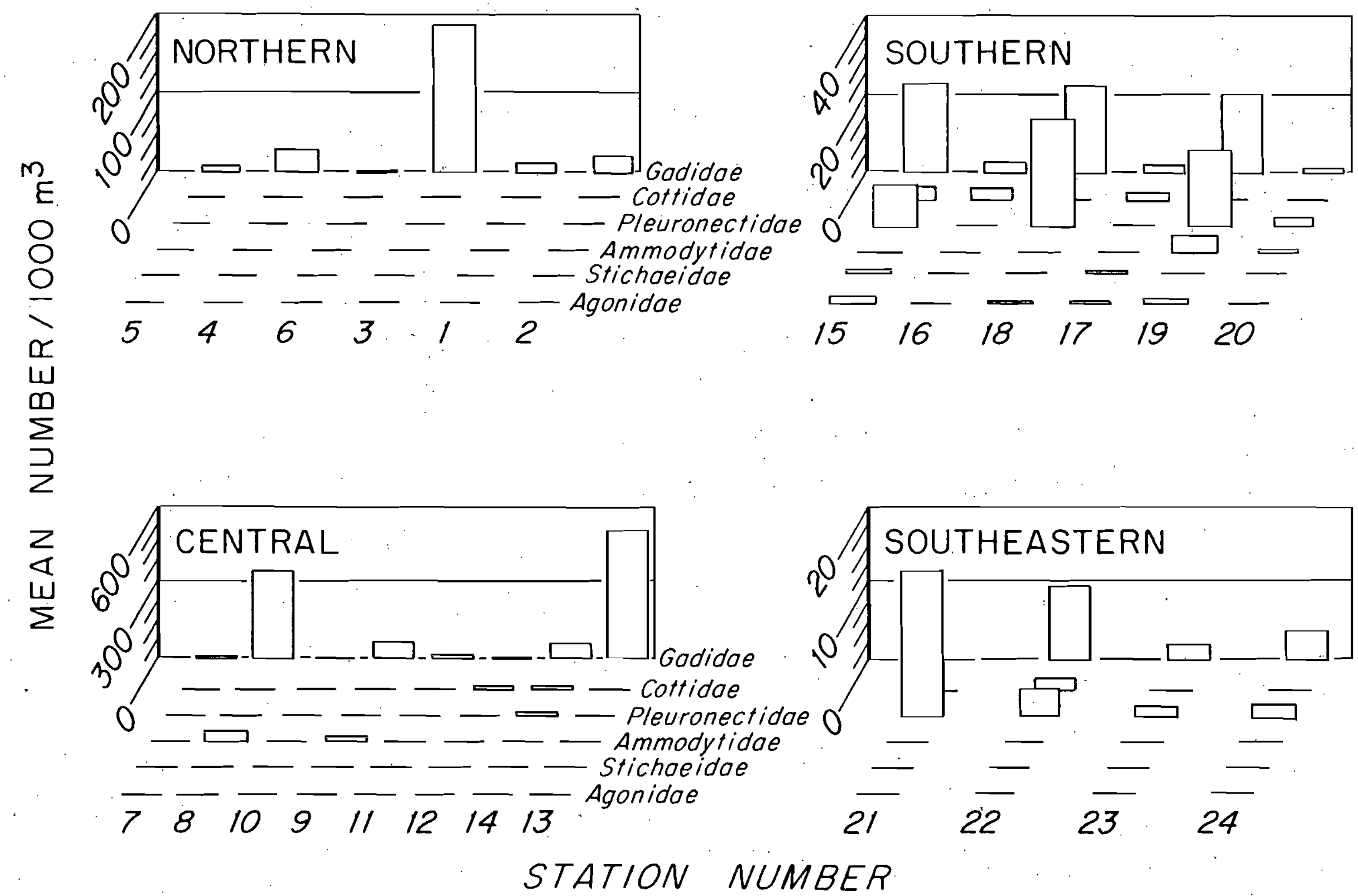


Figure 3. Average number of fish/1000 m^3 captured by two Isaacs-Kidd midwater trawls at each station in four Chukchi Sea strata.

Table 5.—Invertebrates collected with an otter trawl in the Chukchi Sea, 3 - 9 September 1989.

Shrimps		
	Crangonidae	
		Argis, Sclerocragon, Cragon, Unidentified
	Pandaliaae	
		Pandalus goniurus, Unidentified
	Hyppolytidae	
		Unidentified
Crabs		
	Atelecyclidae	
		Telmessus
	Majidae	
		Chionoecetes opilio, Hyas lyratus, Origonis sp.
	Paguridae	
		Unidentified
	Lithodidae	
		Paralithodes platypus
Echinoderms		
	Asteroidea	
		Ctenodiscus crispatus, Lepasterias groenlandica, L. polaris, Henricia sp. *Orthasterias koehleri, Pteraster obscurus*
	Ophiuroidea	
		Ophiura, Gorgonocephalus
	Echinoldea	
		Unidentified sea urchins and sand dollars
	Sponges	
		Eunephyta, Unidentified

Taxonomic

Two groups of fish have been very difficult to identify, *Lycodes* and *Myoxocephalus*; observations on the morphometrics and meristics of the four species of *Lycodes* obtained in benthic trawls are reported in Tables 6 and 7, respectively. Of the nine morphometric indices calculated, eight showed almost complete overlap in the range of values of the three species with sample size greater than one (Table 6). The fourth species, *L. mucosus*, was represented by only a single specimen; values for the eight indices of this species fell within the range for the other three species. The only character showing potential to allow some separation of these species was the proportion "interorbital width/head length". There was no overlap between *L. raridens* and either *L. palearis* or *L. polaris*. The single specimen of *L. mucosus* had an IO/HL value within the range of *L. raridens* but outside the ranges of the other two species. Four of the meristic counts, vomerine teeth, palatine teeth, upper and lower jaw teeth, exhibited considerable overlap (Table 7). The pectoral fin ray counts of *L. raridens* and *L. polaris* (16-18 and 14-16, respectively) showed little overlap and that of *L. palearis* overlapped both these species.

Table 6.—Morphometric relationships in four species of zoarcid fishes from the northeast Chukchi Sea. Abbreviations are as follows: GO = length of gill opening; HL = head length; HW = head width; IO = interorbital width; n = sample size; PA = preanal length; Pe = pectoral length; PL = pelvic length; TL = total length. Each proportion is multiplied by 100. Values are mean ± one standard deviation and range in parentheses. Length in mm.

n	*L. palearis* (15)		*L. raridens* (12)		*L. polaris* (3)		*L. mucosus* (1)
PA/TL	44.6 ±1.2	(43.4 -48.0)	49.2 ±1.1	(47.5 -50.6)	47.1±2.6	(44.2-49.2)	47.73
HL/TL	21.8 ±1.1	(20.2 -23.8)	25.9 ±1.3	(22.0 -27.2)	22.8±3.7	(18.8-26.2)	24.5
HW/TL	12.5 ±2.7	(9.3 -21.3)	14.8 ±2.1	(11.8 -19.1)	12.0±2.8	(9.6-15.1)	16.1
PL/TL	2.5 ±0.51	(1.7 - 4.0)	1.9±0.33	(1.2 - 2.2)	2.4±0.7	(2- 3.2)	1.9
OW/HL	21.9 ±2.6	(18.8 -27.8)	21.3 ±3.8	(17.3 -32.1)	21.2±2.9	(18.2-23.9)	18.4
IO/HL	5.5 ±0.5	(4.2-6.3)	7.7±0.6	(6.9 - 8.9)	5.2±0.9	(4.2- 6.0)	7.9
GO/HL	32.6 ±4.3	(27.8 -41.7)	35.2 ±4.6	(30.0 -43.9)	31.0±1.2	(30.3-32.4)	30.3
Pe/HL	55.3 ±4.5	(47.9 -62.0)	52.4 ±2.9	(48.3 -59.6)	52.7±1.6	(51.4-54.5)	57.9
Pe/TL	12.1 ±1.3	(9.8 -14.5)	13.6±1.0	(11.6-15.7)	12.0±2.4	(9.6-14.3)	14.2

Table 7.—Meristic characters in four species of zoarcids from the northeast Chukchi Sea. Abbreviations are as follows: LT = number of lower jaw teeth; PR = number of pectoral fin rays; PT = number of palatine teeth; UT = number of upper jaw teeth; VT = number of vomerine teeth.

n	*L. palearis* *(15)*		*L. raridens* *(12)*		*L. polaris* *(3)*		*L. mucosus* *(1)*
VT	3.5±1.2	(2-6)	3.9±1.3	(2-6)	3.7±1.2	(3-5)	3
PT	19.9±4.4	(15-27)	14.0±2.4	(11-19)	14.7±2.5	(12-17)	13
UT	27.9±7.6	(19-45)	20.4±2.1	(18-24)	19.0±9.2	(11-29)	20
LT	36.2±8.5	(25-53)	25.9±3.8	(17-29)	26.3±14.0	(13-41)	27
PR	15.9±0.6	(15-17)	17.1±0.6	(16-18)	15.3±1.2	(14-16)	17

The majority of *Myoxocephalus* appear to be *M. stelleri* and have been designated as this species. The characters used to identify this species were primarily descriptive and were interpreted liberally. Therefore, there may be more than one species in our "*M. stelleri*". The other nine individuals could not be "liberally" interpreted as a particular species. Because the majority of the characters used to identify this group of fish were descriptive, we did not develop any morphometric or meristic data.

Food Habits

Stomach contents of 27 Arctic cod from three different stations were examined. Fish ranged from 0.72 g to 61.2 g in weight (48-197 mm total length). Feeding habits will be reported in more detail in the final report when further analyses of this and other target species have been completed.

A listing of food organisms identified to date include: the copepods *Calanus, Pseudocalanus, Oithona, Centropages*; the amphipods *Parathemisto, Anonyx, Ampelisca, Byblis, Ischyrocerus, Melita, Oedicerotidae;* the cumaceans *Eudorella* and *Leucon;* the euphausiid *Thysanoessa*; the mysid *Neomysis*; pagurid zoea; crangonid; pandalid; polychaete; barnacle cyprid; teleosts. Thus, the diet includes planktonic (copepods, *Parathemisto*, pagurid zoea) and benthic taxa (cumaceans). It is unclear whether Arctic cod during the day are capturing euphausiids, mysids and shrimps from the water column or from the sea floor.

Teleosts occurred in 11 of the 25 fish containing food in the stomach. When present, fish dominated the stomach contents. Some of the fish prey was unidentifiable to lower taxa and when identified were gadids, usually Arctic cod. *Boreogadus* occurred in aggregations consisting of a variety of size classes. For example, fish from trawl 12 that were examined included two individuals under 1 g in weight and four weighing over 30 g. These aggregations of mixed sizes apparently promote cannibalism.

Hydrology

The CTD stations occupied are shown in Figure 4 and, with the exception of the southeastern Chukchi Sea transect, correspond to the trawl stations. This transect, bounded by stations 44 through 58, ran southwest from Cape Thompson to the international boundary, and consisted only of CTD stations. It is identical to that occupied repeatedly on the ISHTAR cruises and also by Pacific Marine Environmental Laboratory personnel (C. Pease chief scientist) in late September through October, 1989. The positions of all of these casts are shown in Figure 4 along with their consecutive station number (note only even-numbered casts are enumerated). Differences between pre-trawl and post-trawl CTD casts were small indicating that the water mass property distributions did not vary greatly at each station (or time) over which the two trawls were conducted.

The CTD results center on sets of cross-section plots of temperature, salinity, and sigma-t contoured for each transect. Two of these sets are constructed from the even numbered stations running from south to north along the 168 51'W meridian (beginning with station 42 at about 68°N and ending with station 10 at about 72.5°N, and hereafter referred to as the West Line) and on about the 16'7 35'W meridian (beginning with station 40 near Point Hope and ending with station 8 at 72.5°N, and hereafter referred to as the East Line). Since the station spacing is considerably coarse (30 to 60 km) the contoured isopleths along these transects depict a general picture of the distribution of hydrographic properties. The third set of cross-section plots is constructed from transects running southwestward from Cape Thompson and will be referred to Figure 4 (appendix 1) as the Cape Thompson Line. Station spacing here is considerably smaller (from 5 to 15 km) and therefore should fairly accurately resolve the water mass property distributions.

Figure 5a-c shows the cross-section profiles of temperature, salinity and sigma-t for the West Line. Along this line surface temperatures lie between 5° and 7°C except at the northern end of the line where surface temperatures decrease rapidly from 5°C to less than 2°C between 72°N and 72.5°N. Observed bottom water temperatures are more variable. South of 70°N bottom temperatures are relatively warm and lie between 3° and 5°C. North of 70.5°N observed bottom temperatures lie between 1° and -1.6°C. A strong bottom thermal front separates the warmer southern water south of 70°N from the colder water to the north of this position. This front appears to be continuous with the strong thermocline, found at about 25 m depth north of 70°N. In contrast, south of 70°N relatively weak thermal stratification is observed. Warmest

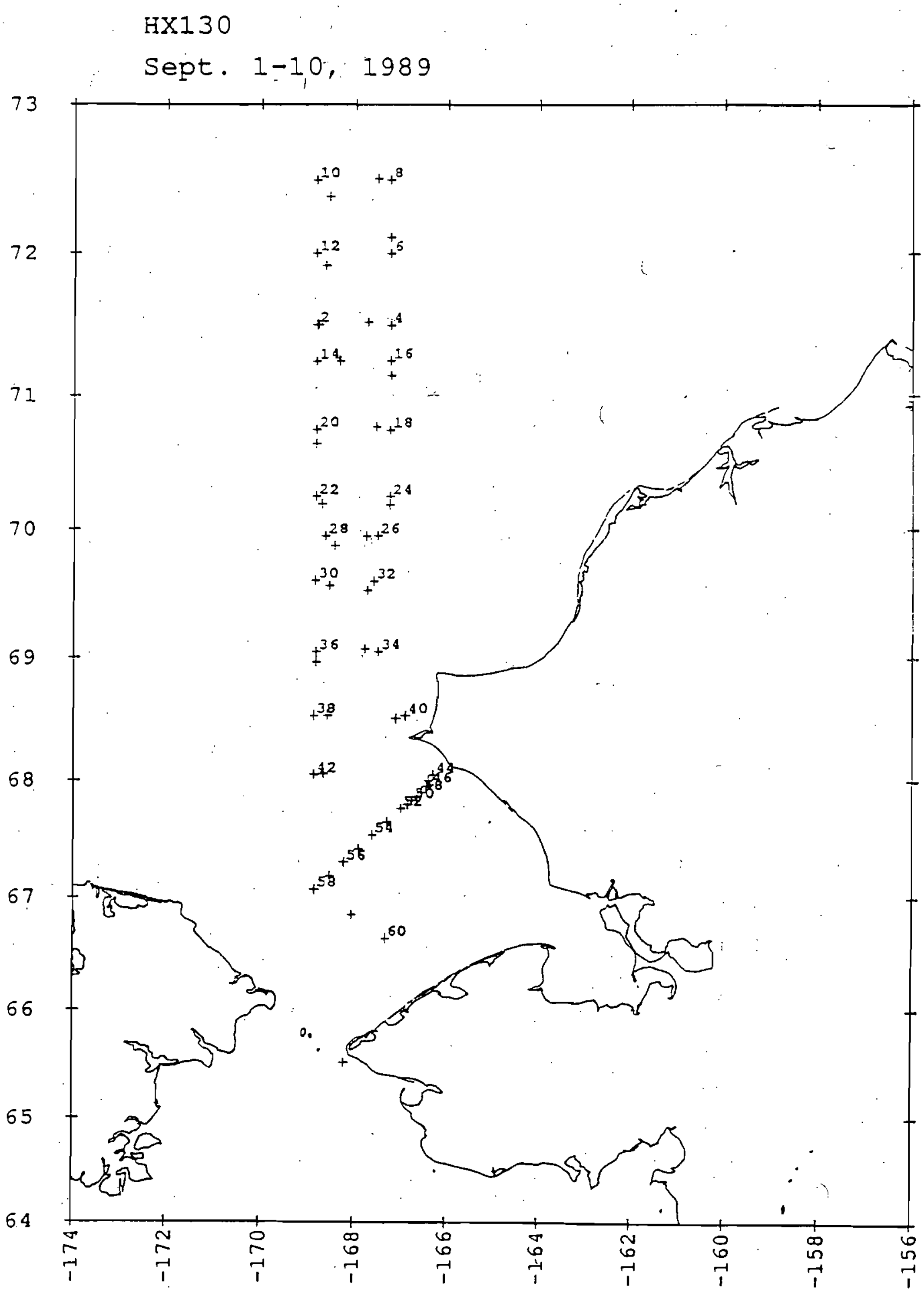


Figure 4. Sampling locations in the northeast Chukchi Sea, 1989.

waters (>7°C at the surface and >4°C at the bottom) are found at about 69°N as indicated by the deepening of the isotherms.

The isohalines demonstrate that surface salinities over most of this transect are fairly uniform and lie between 31 and 32 psu (Figure 5b). Relative minima in surface salinities are found at the southern and northernmost stations. A sharp surface salinity front is observed between 72°N and 72.5°N which separates water with salinities greater than 31 psu to the south from water with salinities less than 28 psu to the north. The low salinities (and temperatures) observed northward of this front suggest that this water mass derives from melting of the ice pack in the vicinity of 72.5°N. (Although no ice was observed throughout the cruise this may have been due to relatively poor visibility, especially in the northern portions of the study area. Nevertheless the absence of properties typical of meltwater suggests that the ice edge was not near any of the more southerly stations.) Bottom salinities are also relatively uniform over most of the domain and lie between 33 and 32 psu. Highest bottom salinities are found at the southern- and northernmost (Figure 4) stations. The salty and relatively warm waterobserved in the south is typical of that flowing into the Chukchi Sea from the Bering Sea. The salty and cold water observed in the north lies beneath a strong halocline and is characteristic of Resident Chukchi Water (RCW). The RCW water mass derives from incursions onto the Chukchi shelf of water from the upper Arctic Ocean or shelf water remnant from the previous winter. The deepening of the 32 psu isohaline at 69°N coincides with the location of warmest temperaturesalong the West Line and may be a consequence of the seaward extension of the warm, dilute water found within the Alaska Coastal Current (ACC) as this current rounds the Lisburne Peninsula. Coachman *et al.*, (1975) indicate the possibility of an anticyclonic (clockwise) meander of the ACC as it flows past Cape Lisburne. Although our data are too sparse to resolve the spatial dimensions of such a feature it may in fact represent an offshore spreading of waters with characteristics of the ACC. Isopycnal contours (Figure 5c) generally track the isohalines. Moreover, they indicate that the bottom thermal front observed at about 70°N does not coincide with a density front because the density gradients induced by the northward decrease in temperature and salinity compensate each other at this location. Instead the strongest bottom density gradients bound the core of ACC water found between 69° and 69.5°N.

Surface temperatures are considerably warmer along East Line transect than that along the West Line and range from a high of more than 9°C in the south to a low of less than 6°C to the north (Figure 6a). As was observed in the West Line the deeper waters to the north are capped by a strong thermocline at about 25 m depth. The high temperatures observed in the south, in the vicinity of Point Hope and Cape Lisburne, are reflections of the ACC.

The influence of the ACC is also seen in the salinity cross-section profile (Figure 6b). Surface salinities are more variable along the East Line than along the West Line with the lowest salinities (associated with the ACC) found at the inshore stations off Point Hope and Cape Lisburne. This low salinity water lies in the upper 10 m above a strong halocline which intersects the surface near 70°N. Near Point Hope the halocline deepens to form a near-bottom salinity front. There is no indication of the influence of sea-ice meltwater anywhere on this transect (although the lower salinity, but relatively warm water, found to the north may be a remnant of summer ice melt). As in the West Line, the isopycnal contours track the salinity contours (Figure 6c).

Figures 7a-c summarize the water property distributions along the Cape Thompson Line. Warmest temperatures and relatively low salinities are found inshore of the 40-m isobath and coincide with the weakly stratified ACC. Warm but more dilute water is also observed in the

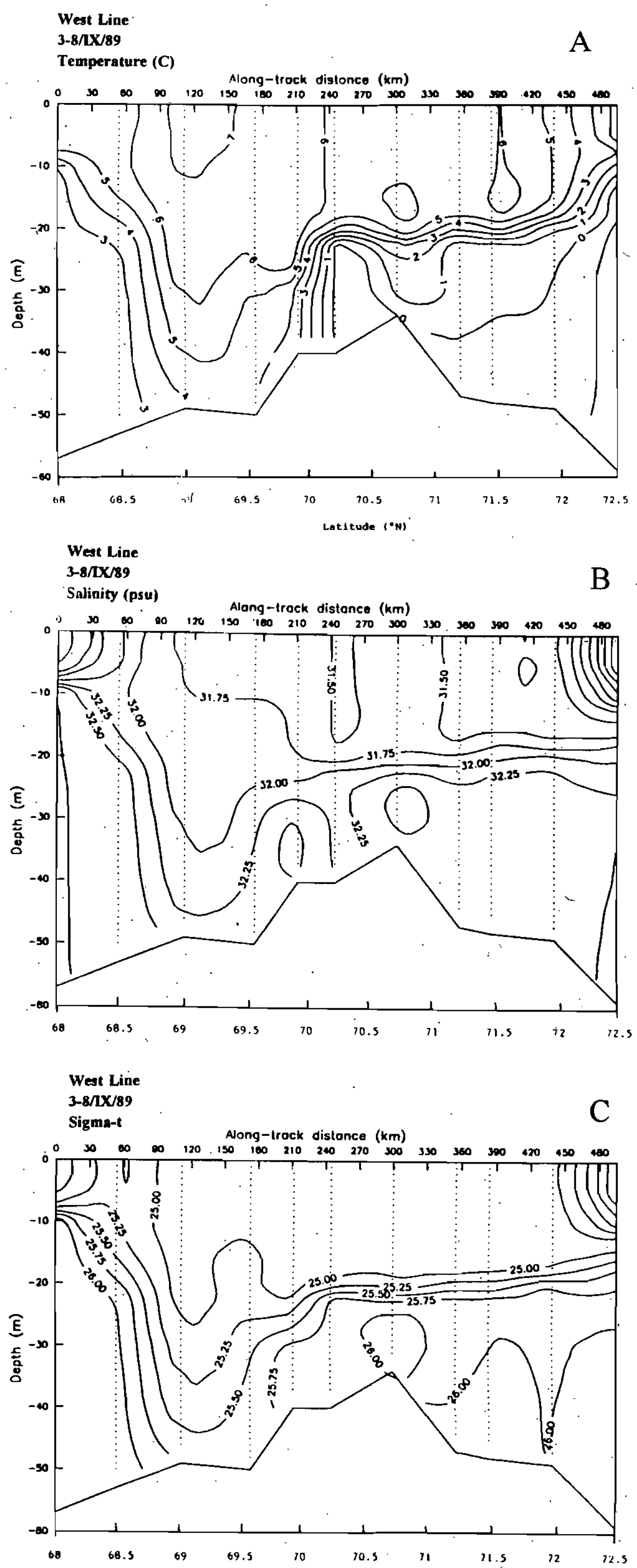


Figure 5. Contours of the (A) isotherms, (B) isohalines, and (C) isopycnals as a function of depth and meridional distance along the West Line. Dots include locations of CTD data used in constructing the contours.

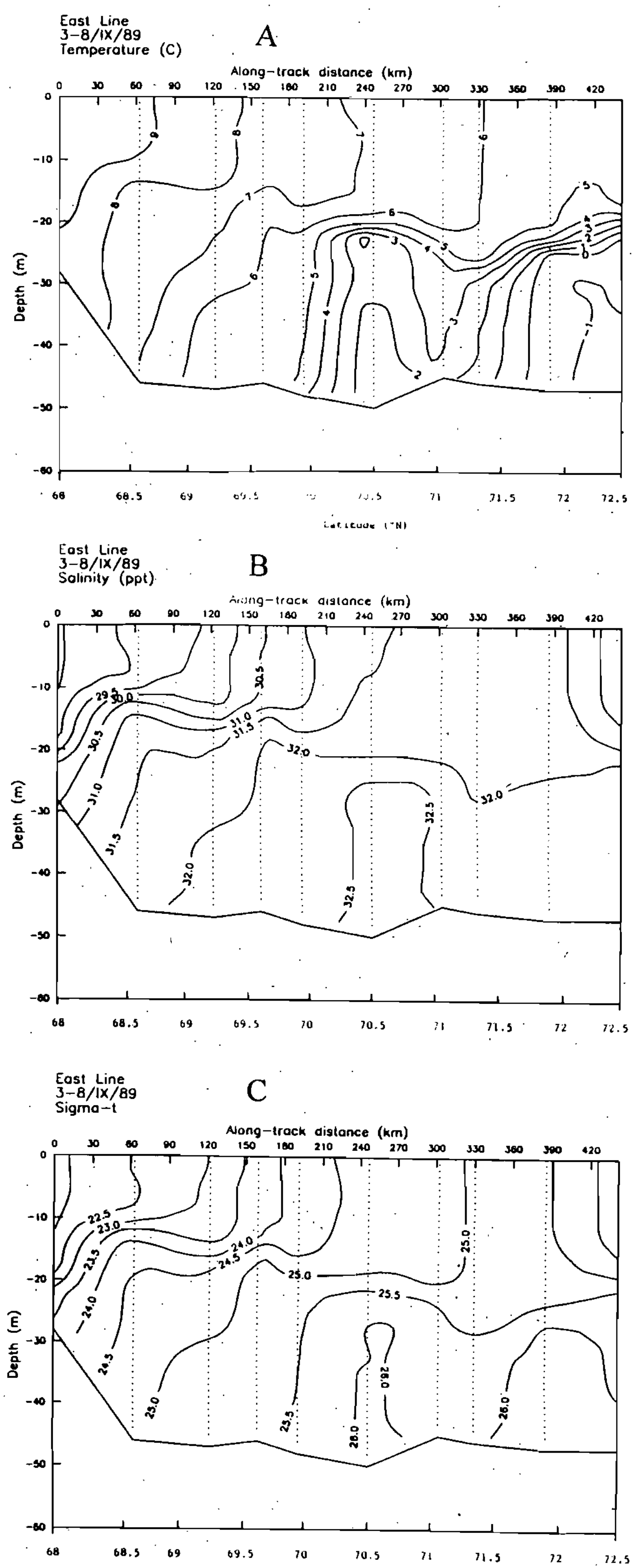


Figure 6. Contours of the (A) isotherms, (B) isohalines, and (C) isopycnals as a function of depth and meridional distance along the East Line. Dots include locations of CTD data used in constructing the contours.

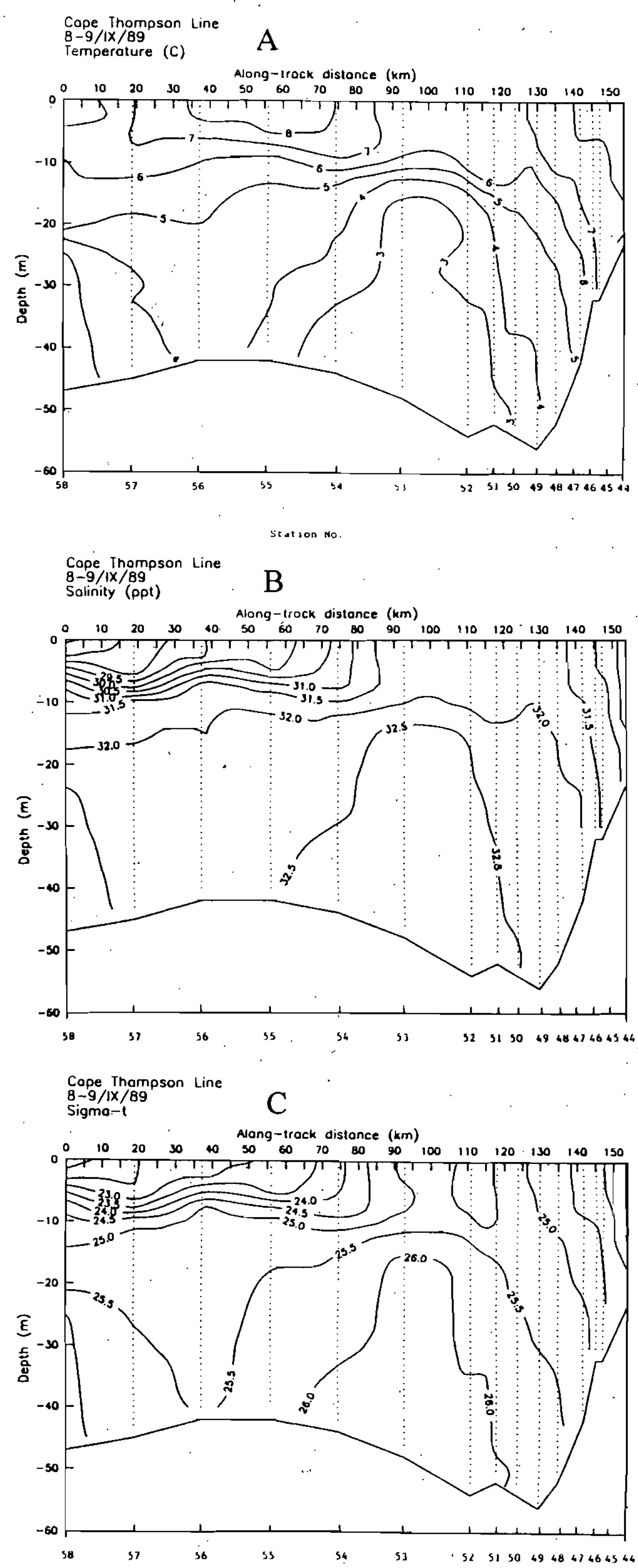


Figure 7. Contours of the (A) isotherms, (B) isohalines, and (C) isopycnals as a function of depth and distance (offshore to onshore) along the Cape Thompson Line. Dots indicate locations of CTD data used in constructing the contours.

upper 10 m seaward of station 53 where it is separated from the deeper water by a strong pycnocline. The surface layer consists of ACC water which flows northward through the Bering Strait and then spreads northeastward as it enters the Chukchi Sea. The observed doming of the isotherms and isohalines between the inshore and offshore stations is consistent with an hypothesized cyclonic gyral circulation of the southeast Chukchi Sea and Kotzebue Sound. Similar features are suggested in the cross-section profiles along this line by R. B. Tripp (personal communication, University of Washington).

DISCUSSION

Based on the results of benthic trawling, the species composition of the catches and abundance of individual taxa are highly variable over the study area (Figures 2 and 3). For example, in the northern stratum gadids dominate but are completely absent from Figure 6a station 3 (Appendix Tables 1and 2). In the central stratum pleuronectids are absent from the catch at four of the eight stations but the most abundant taxon at two of the remaining four stations. Cottids dominate the catch in two of the central stratum stations and are absent at one station. In the southern stratum gadids dominate the catch at four of the six stations; pleuronectids dominate the other two. Total number of fish per haul and per station were so highly variable that it is impossible to make any conclusions about relative abundance of fish in the four geographic areas. The northern stratum exhibited the lowest number of fish per haul, 15.5 + 20.1 fish; the southern stratum the highest, 46.0 + 28.6 fish. These numbers do not differ significantly. The variability in species composition and catch rates may be due to patchiness in the distribution and abundance of the benthic fishes or may, in part, be due to variations in fishing efficiency of the 6.1-m otter trawl employed. We expect that the commercial trawl to be used in the second year will fish much more uniformly and, thus, will allow us to make inferences about patchiness in fish distribution. Variability in species composition and abundance will be more easily addressed with the expanded number and geographic distribution of stations to be sampled in the second phase of this project. However, since replicate tows at the same station will not cover exactly the same area, a level of uncertainty about patchiness will remain.

Based on the results of the IKMT, gadids and pleuronectids dominate the pelagic and demersal fish fauna over the entire study area (Figure 3 and Table 3). The sampling procedure, repeated oblique tows to near bottom, does not allow us to fix the location of ichthyoplankton and nektonic fishes in the water column. Comparison of IKMT catch composition with that of benthic trawls at the same station, however, allows some inference about pelagic versus demersal habitat preference for the range of fish sizes captured in the IKMT. For example, station 3 in the northern stratum yielded no gadids in the benthic trawl yet the IKMT caught large numbers. We can infer that all the size classes of gadids in the IKMT station 3 catch are pelagic in habitat preference. Similarly, at station 22 in the southeastern Chukchi Sea, pleuronectids occur in the IKMT catch yet are absent from the benthic trawl catch. These inferences will add to our knowledge about the range of sizes at which some of these species adopt a benthic or demersal, as opposed to a pelagic, life history stage. Thus, early (pelagic) stages will be spared direct effects of perturbations to the benthic environment. At what size does each species become vulnerable to potential perturbations to the benthic environment such as those due to drilling activity? Hopefully, analysis of these results, those expected from phase 2 and synthesis with existing knowledge of these species will allow us to draw some conclusions.

Based on the sampling in phase 1, the Arctic cod is by far the most abundant fish species. Tentative information on its abundance and distribution are reported in Figures 2 and 3, and

Appendix Table 1. With the results we expect to obtain from the expanded sampling program of phase 2 we should be able to make a significant contribution to the understanding of the biology of the single most important fish species in the study area. Our findings will be integrated with those from several refereed publications and a growing body of unrefereed (gray) literature.

The second most abundant species is the Bering flounder. Aside from the species description and anecdotal information, virtually nothing is known about this flatfish. The Bering flounder is very similar in morphology to its congener, the flathead sole (*Hippoglossoides elassodon*). The ranges of these two species overlap in the central Bering Sea. We do not know how much overlap exists in other life history characteristics but expect to focus on this species in phase 2.

Cottids were abundant at some stations and the most abundant species was Arctic staghorn sculpin (*Gymnocanthus tricuspis*; Appendix Table 1). This species, by virtue of its abundance, will be the third species upon which we will focus attention in phase 2. We do not have a wealth of data on this species yet. Phase 1 has provided preliminary data but also has provided direction and focus for the biological studies and sampling to be conducted in phase 2. Our emphasis on these three species is part of that focus.

Our very limited results of size at age indicate that there is considerable variation in growth of Arctic cod and Bering flounder. This is similar to what other authors have found. For young-of-year (YOY) Hognestad (1968) gives a range of 2570 mm TL for fish captured in July - August in an area near Novaya Zemlya and average size varied between years, averaging 60 mm TL in 1960 and 42 mm TL in 1966. Sekerak (1982) summarizes growth of YOY from a number of sources and locations; in September they may range from as small as about 18 mm to 32 mm. Hognestad (1968) gives average sizes for other ages as: age-1 = 93 mm TL, age-2 = 149 mm TL, age-3 = 178 mm TL, age-4 = 198 mm TL. These sizes at age and ours are similar to that given by Craig *et al.*, (1982) for fish from Simpson Lagoon near Prudhoe Bay. The only information for Bering flounder is given by Pruter and Alverson (1962) who also give a picture showing an otolith which demonstrates the ease in which these fish can be aged. Pruter and Alverson did not capture any fish younger than age 6 and back calculated sizes at younger ages. For age - 4 and age - 5 fish they calculated a mean size of 116 mm TL and 125 mm TL, respectively, between which sizes of our age-4 fish fall. They back calculated age-6 fish at 135 mm and observed an average size of 179 mm TL for those captured.

In regards to the measurements made on the eelpouts, our range of values for the IO/HL character in *L. polaris* does not agree with previously derived values. It appears that this morphometric index has potential for aiding in the identification of individuals in this difficult taxonomic group. Additionally, the pectoral fin ray counts of *L. raridens* and *L. polaris* (16 - 18 and 14 - 16, respectively) may be helpful in separating these two species.

The two cross-section profiles along the East and West Line, which extend over 450 km through the northern Chukchi Sea, suggest a northward penetration at the surface of warm, relatively fresh water derived from mixing of the ACC with waters from the Bering Sea. This scenario is in agreement with the circulation schemes of Coachman *et al.*, (1975) and Aagaard (1988). In the northern half of both transects this surface water overrides a strong pycnocline which separates the surface waters from the cooler and saltier waters typical of the RCW which extend southward and eastward across the bottom of the northern Chukchi Sea. In comparison to the results presented by Johnson (1989) and Aagaard (1988) the northern Chukchi Sea in September of 1989 was uncommonly warm. Since the surface waters in the southeastern Chukchi Sea (observed on the Cape Thompson Line) do not appear to be warmer than normal

Appendix Table 1. Numbers of each species of fish captured in one-half-hour otter trawls, 3-9 September 1989 from the Chukchi Sea.

Family	Species	Station	1		2		3		4		5		6		7		8		9		10		11		12	
		Trawl	1	2	2	3	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Cottidae	*T. beani*		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	G. tricuspis		-	-	-	-	-	-	-	-	-	-	-	1	2	-	1	4	3	4	12	7	-	12	8	2
	M. stelleri		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	1	-	3	6
	A. scaber		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	1	10
	G. galeatus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	N. pribilovius		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	E. diceraus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	M. scorpius		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	I. bicornis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	H. papilio		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	H. jordani		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	M. species		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	G. species		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Unknown cottide		1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	4	-	-	1	-	2
Gadidae	*B. saida*		6	20	18	91	-	-	1	6	1	-	13	28	47	16	1	-	-	8	100	67	5	3	7	18
	T. chalcogramma		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	E. gracilis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pleuronectidae	*H. robustus*		2	-	1	-	1	2	-	-	-	-	-	-	-	-	6	1	7	5	-	-	-	-	3	2
	A. stomias		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L. sakhalinensis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agonidae	*A. olriki*		2	-	-	1	3	4	-	-	-	-	-	-	2	-	-	-	2	1	1	3	1	-	2	-
	B. nigripinnis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stichaeidae	*A. purpurescens*		-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L. medius		-	-	1	-	-	-	-	-	-	-	-	-	1	-	1	-	-	2	-	-	-	-	-	-
	L. fabricii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zoarcidae	*L. polaris*		-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L. mucosa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-
	L. raridens		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2
	G. viridis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L. polearis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ammodytidae	*A. hexapterus*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2
Liparidae	*Liparis* sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	4
	TOTAL		12	20	20	93	5	6	1	8	1	0	13	29	62	16	9	6	13	23	118	77	8	26	30	48

Family	Species	Station	13		14		15		16		17		18		19		20		21		22		23		24		25		Total
		Trawl	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
Cottidae	*T. beani*		-	-	-	-	-	-	-	-	1	-	-	2	-	-	2	-	1	-	3	-	-	-	-	-	-	-	11
	G. tricuspis		18	4	-	-	3	2	5	1	4	-	4	18	-	2	1	-	6	13	-	1	6	-	4	-	10	-	158
	M. stelleri		16	12	-	-	-	-	-	1	-	-	7	3	-	1	3	-	-	2	4	3	-	-	-	-	-	-	65
	A. scaber		19	19	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	66
	G. galeatus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	1	-	-	-	9
	N. pribilovius		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	1	-	-	-	-	-	-	7
	E. diceraus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	2	-	-	-	-	-	-	5
	M. scorpius		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-	14
	I. bicornis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-	3
	H. papilio		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
	H. jordani		-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	1	1	-	-	4
	M. species		4	3	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9
	G. species		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	3
	Unknown cottide		-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	13
Gadidae	*B. saida*		8	7	3	-	14	104	38	120	35	26	19	13	1	5	3	-	10	4	-	-	3	1	-	-	-	1	872
	T. chalcogramma		-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	E. gracilis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	-	-	-	6	2	-	-	-	-	-	-	23
Pleuronectidae	*H. robustus*		3	1	-	-	1	1	-	2	6	1	20	29	5	4	2	-	10	30	-	-	5	10	1	1	25	10	197
	A. stomias		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	L. sakhalinensis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Agonidae	*A. olriki*		9	1	-	-	-	-	-	1	-	2	1	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	39
	B. nigripinnis		-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Stichaeidae	*A. purpurescens*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	L. medius		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	1	-	8
	L. fabricii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Zoarcidae	*L. polaris*		-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	2	-	-	-	-	-	-	-	-	6
	L. mucosa		2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	5
	L. raridens		4	3	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	14
	G. viridis		1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	L. polearis		-	-	-	-	-	-	-	-	-	-	6	3	1	3	-	-	-	-	-	-	-	-	-	-	2	1	16
Ammodytidae	*A. hexapterus*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Liparidae	*Liparis* sp.		5	1	-	-	-	-	-	-	-	-	2	-	1	-	-	-	3	5	-	2	8	-	1	-	2	-	37
	TOTAL		89	63	3	0	18	107	45	127	49	30	59	71	9	16	27	0	44	60	34	14	25	16	8	2	40	14	1695

Appendix Table 2. Numbers of each species of fish captured in an Isaacs-Kidd Midwater Trawl (IKMT) in the Chukchi Sea during 3-9 September 1989.

Family	Species	Station	1		2		3		4		5		6		7		8		9		10		11		12	
		Trawl	1	2	2	3	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Cottidae	*Myoxocephalus* sp.		-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
	M. verrucosa		2	3	2	1	-	-	-	-	-	-	-	-	1	2	1	-	1	-	1	1	1	6	2	-
	G. tricuspis		-	-	-	-	-	-	-	-	-	-	-	-	1	3	2	11	2	-	-	-	4	13	3	-
Gadidae	*Boreogadus saida*		20	16	27	36	178	268	28	39	9	13	3	-	8	29	152	851	130	-	-	1	3	20	-	8
Pleuronectidae	*H. robustus*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	1	-
	Limanda sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L. aspera		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Lepidopsetta proboscidea		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agonidae	*Aspidophoroides olriki*		-	-	-	1	-	1	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-
	A. bartoni		-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
	Agonus acipenserinus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stichaeidae	*Stichaeus punctatus*		1	1	1	-	-	-	-	-	-	3	3	2	1	-	-	1	-	-	1	1	-	-	-	-
	Lumpenus sp.		4	-	-	-	-	3	1	-	-	4	2	-	2	1	2	-	1	-	-	-	-	-	-	-
	Unknown		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zoarcidae	*Lycodes* sp.		-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ammodytidae	*A. hexapterus*		-	-	-	-	-	-	7	-	-	-	-	-	-	-	10	102	15	-	-	-	-	-	-	-
Liparidae	*Liparis* sp.		-	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-

Family	Species	Station	13		14		15		16		17		18		19		20		21		22		23		24		Total Length
		Trawl	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	Range (mm)
Cottidae	*Myoxocephalus* sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22
	M. verrucosa		6	12	6	11	-	-	1	2	-	-	-	2	1	-	-	-	1	-	-	-	-	-	-	-	26-48
	G. tricuspis		30	41	19	26	6	-	1	-	3	1	1	-	-	-	-	-	2	3	-	-	-	-	-	-	28-36
Gadidae	*Boreogadus saida*		495	701	103	10	33	23	3	3	1	4	11	33	26	34	2	-	15	7	-	-	2	4	2	3	27-52
Pleuronectidae	*H. robustus*		35	42	28	18	10	12	1	-	2	9	13	35	27	27	3	-	7	3	-	-	2	1	-	-	15-34
	Limanda sp.		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
	L. aspera		-	3	-	-	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	14	-	-	-	-	12-15
	Lepidopsetta proboscidea		-	-	-	-	-	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	22-32
Agonidae	*Aspidophoroides olriki*		1	2	-	1	1	-	-	-	-	-	1	-	1	-	-	-	-	1	-	-	-	-	-	-	26-30
	A. bartoni		-	1	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	31-45
	Agonus acipenserinus		-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	27
Stichaeidae	*Stichaeus punctatus*		2	-	-	4	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21-34
	Lumpenus sp.		-	1	-	9	1	-	-	-	-	-	2	-	5	4	-	-	1	-	-	-	-	-	-	-	32-50
	Unknown		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	57
Zoarcidae	*Lycodes* sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	115
Ammodytidae	*A. hexapterus*		-	1	-	6	1	1	-	-	-	-	-	-	3	8	1	-	-	-	-	-	-	-	-	-	25-35
Liparidae	*Liparis* sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Appendix Table 3. Numbers of each species of fish 1000 m^3 captured in an Isaacs-Kidd Midwater Trawl (IKMT) in the Chukchi Sea during 3-9 September 1989.

Family	Species	1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19		20		21		22		23		24		Total Length Range (mm)
	Station / Trawl	1	2	2	3	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
Cottidae	*Myoxocephalus* sp.	-	-	-	-	-	-	-	-	-	-	-	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22
	M. verrucosus	1.4	2.0	1.4	.8	-	-	-	-	-	-	-	-	0.9	0.7	0.7	-	1.3	-	1.3	1.3	1.2	8.2	2.7	-	6.0	10.1	7.7	14.0	-	-	0.8	2.0	-	-	-	1.9	0.6	-	-	-	-	-	-	-	-	-	-	-	26-48
	G. tricuspis	-	-	-	-	-	-	-	-	-	-	-	-	0.9	1.0	1.4	7.8	2.6	-	-	-	4.8	17.7	4.0	-	25.1	34.6	24.2	33	4.7	-	0.8	-	2.8	1	0.9	-	-	-	-	-	1.8	3.2	-	-	-	-	-	-	28-36
Gadidae	*Boreogadus saida*	13.9	10.9	19.2	27.3	160	216	22.8	36.6	6.6	9.7	2.9	-	7.0	9.4	101	604	130	-	-	1.3	36	27.4	-	9.0	413	592	131	12.7	26	16.5	2.6	3	0.9	3.9	9.6	31	16.4	23.6	2.5	-	13.1	7.6	-	-	1.6	3.3	3.4	4.3	27-52
Pleuronectidae	*H. robustus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.6	-	-	-	-	-	1.3	-	29	35.4	35.7	22.8	7.8	11.3	0.8	-	1.8	8.8	11.4	33	17	18.7	3.7	-	6.1	3.2	-	-	1.6	0.8	-	-	15-34
	Limanda sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
	L. aspera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.5	-	-	-	-	-	-	-	-	1.8	-	-	0.7	-	-	-	-	-	21.1	-	-	-	-	12-15
	L. proboscidea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.6	-	-	-	-	-	0.9	-	-	-	-	-	-	-	-	-	-	-	-	22-32
Agonidae	*Aspidophoroides olriki*	-	-	-	0.7	-	0.8	-	-	-	-	-	-	-	0.3	-	-	1.3	-	-	-	-	-	-	-	0.8	1.7	-	1.3	1.6	-	-	-	-	-	0.9	-	0.6	-	-	-	-	1	-	-	-	-	-	-	26-30
	A. bartoni	-	-	-	-	-	-	-	-	-	-	-	-	0.9	-	-	-	-	-	-	-	-	-	-	-	-	0.8	-	-	1.6	-	-	-	-	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	31-45
	Agonus acipenserinus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	27
Stichaeidae	*Stichaeus punctatus*	0.7	0.7	0.7	-	-	-	-	-	-	2.2	2.9	1.8	0.9	-	-	0.7	-	-	1.3	1.3	-	-	-	-	1.6	-	-	5.1	-	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21-34
	Lumpenus sp.	2.8	-	-	-	-	2.4	0.8	-	-	3.0	1.9	-	1.7	0.3	1.3	-	1.9	-	-	-	-	-	-	-	-	0.8	-	11.4	1.6	-	-	-	-	-	1.8	-	3.2	2.8	-	-	0.9	-	-	-	-	-	-	-	32-50
	Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	57
Zoarcidae	*Lycodes* sp.	-	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	115
Ammodytidae	*A. hexapterus*	-	-	-	-	-	-	6.7	-	-	-	-	-	-	-	6.7	72	19.0	-	-	-	-	-	-	-	-	0.8	-	7.6	1.6	0.8	-	-	-	-	-	-	1.9	5.5	1.2	-	-	-	-	-	-	-	-	-	25-35
Liparidae	*Liparis* sp.	-	-	-	-	0.8	-	-	-	-	-	-	-	-	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Appendix 2

FISHERIES OCEANOGRAPHY OF THE NORTHEASTERN CHUKCHI SEA

1990 CRUISE REPORT

W. E. BARBER and R. L. SMITH

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School of Fisheries and Ocean Sciences
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Project:
Fisheries Oceanography of the northeastern Chukchi Sea

Funding Source:
NOAA, Grant No. 52ABNC900088

Cruise Dates:
9 August to 27 September 1990

Chief Scientists:
W. E. Barber and R. L. Smith
School of Fisheries and Ocean Sciences

OBJECTIVES OF CRUISE

The primary goal of this project is to determine the community structure of fishery organisms, emphasizing the ichthyofauna, and relate this to geological and physical oceanographic conditions in the northeastern Chukchi Sea. This year the National Marine Fisheries Service (NMFS) expressed interest in participating in the cruise to expand their survey information to the area. Since both this project and their intersects were similar, we integrated their bottom trawl and data gathering techniques and requirements into the sampling plan.

Objectives of this cruise were:

1) determine the distribution, abundance , and biomass of bottom organisms;
2) determine the distribution and abundance of postlarval and juvenile fish in the water column;
3) determine the distribution and abundance of ichthyoplankton and obtain plankton samples for NOAA;
4) determine the hydrographic structure of the water column at each station;
5) if time permitted, increase the number of stations in the northeast and establish stations in the southeast Chukchi Sea.

To accomplish these objectives, at each station the biological samples were obtained by pulling the NMFS 83-112 survey otter trawl at approximately 2 kt for 1/2 hour. An Isaaces-Kidd midwater trawl (1.83 m wide and a bongo plankton net (60 cm diameter openings and 1 mm mesh net) were deployed in double oblique tows from surface to near bottom to the surface at about 1.5 - 2 kt. This was done twice at each station. To determine salinity and temperature at depth, hydrographic casts were made with a Seabird S-19 automatic conductivity and temperature probe. Water samples for standards were obtained one meter from the bottom with a Nisken water sampler. The National Oceanographic and Atmospheric Administration (NOAA) required phytoplankton specimens which were obtained by Rae Baxter (NOAA representative) with a bucket from surface waters at each station.

Itinerary and Activities:

To sample 60 stations (Figure 1) the 50 charter days were divided into two cruise legs and, for planning purposes, days were allotted for various activities as follows:

12 traveling days between Dutch Harbor and Nome,
6 traveling days between Nome and sampling area,

10 weather days,
22 working days.

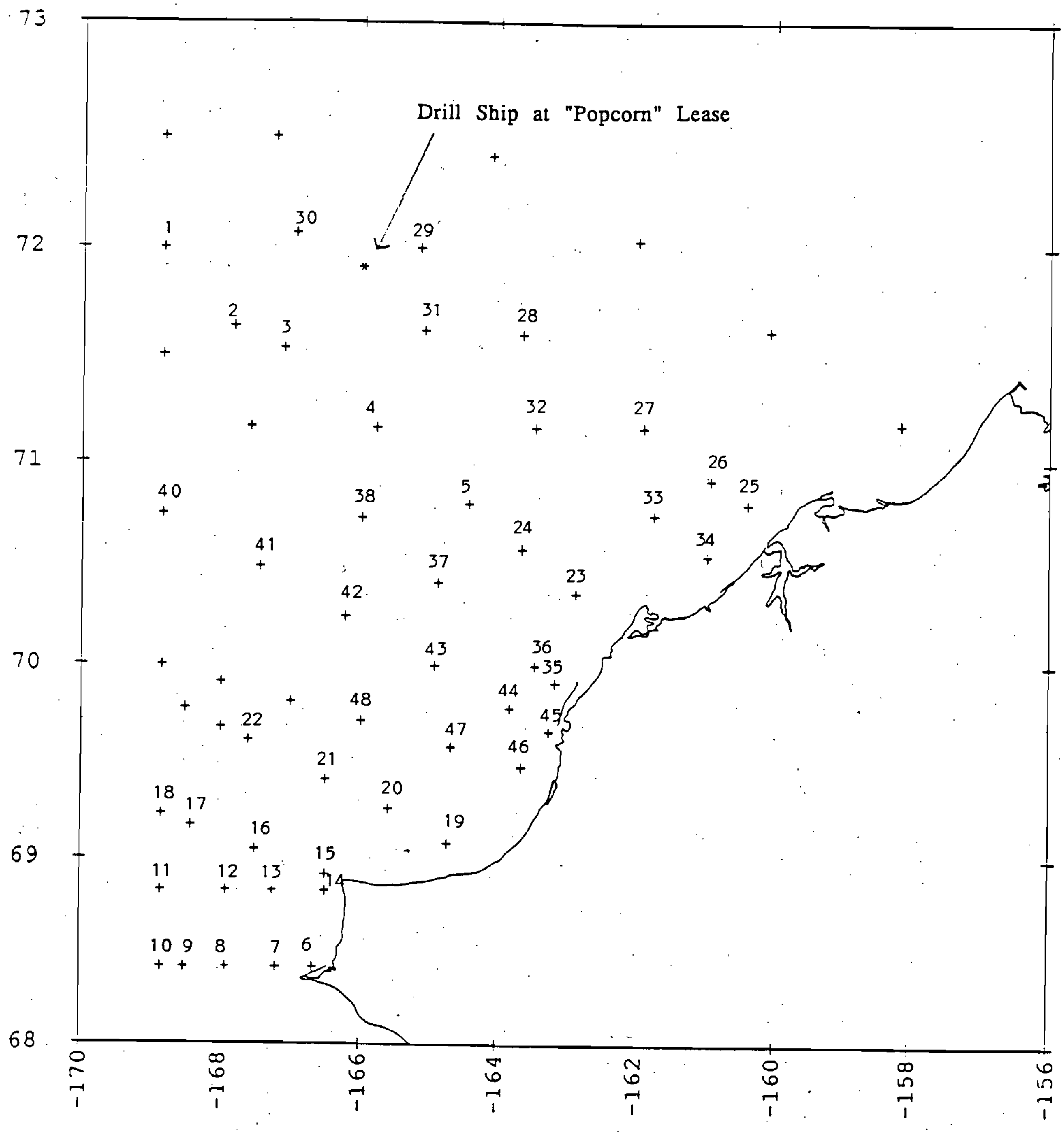

Figure 1. Pictorial presentation of stations proposed ("+") and those subsequently occupied (numbered in sequence of occupation) in the northeastern Chukchi Sea during the 1990 cruise.

The first leg was from 9 to 27 August and the second form 27 August to 27 September.

It was estimated that sampling and travelling between stations would take 13-15 days to complete all 60 stations and sampling could be expanded in the northeastern and into the southeastern Chukchi Sea. The chartered vessel, *Ocean Hope III*, was met in Dutch Harbor on 9 August to load equipment, fuel, supplies, and prepare for the cruise. The vessel departed Dutch Harbor on 12 August with the NOAA representative and a School of Fisheries and Oceanographic Sciences (SFOS) technician on board. The vessel arrived in Nome on 14 August for the first leg and to board the remaining scientific crew, Dr. R. L. Smith, chief scientist, and Mr . T. Sample (NMFS). Inclement weather required that they board at Teller in Port Clarence. Sampling was initiated 18:30, 16 August at 168°50'W and 72°00'N. Eighteen stations were occupied during this leg. The vessel left for Nome to exchange scientific parties and to resupply and refuel in Nome on 24 August. The vessel arrived on 27th, departed on the 28th, and arrived on station the 30th. An additional 26 stations were occupied before leaving northeast Chukchi Sea for safe anchorage on 16 September. We anchored off Kivalina an the 17th. We planned to return and complete transects 4 and 5 but existing and predicted weather conditions, both in the sampling and offboarding areas, dictated a more conservative approach. We departed for Nome late the 17th and arrived the afternoon 19 September. Equipment and specimens were offloaded and the vessel left that evening for Dutch Harbor to offload NMFS equipment.

Of the 11 transects established for this year's cruise only 5 were completed and 48 out of 60 stations occupied (Figure 1). During the second leg, while traversing from station 29 to 30, we located drilling ship and three support vessels at the "Popcorn" lease site. After sampling at station 30 we obtained needed water from a support vessel.

Table 1 lists the fish species captured by otter trawl this year and tentatively identified on board. Also listed are those captured by otter trawl during the 1989 cruise. For both years combined, there were a total of 64 nominal fish species captured. For the 50 nominal species captured this year, 27 were not captured during the 1989 cruise. Conversely, of the 35 species captured in 1989, 13 were not captured this year. For both years sampling 12 range extensions have been identified, 9 from this year (Table 1). There are still difficulties in identifying several species of *Myoxocephalus* and *Lycodes*.

Table 1.—Nominal list of fish species captured by otter trawl during 1989 and 1990 Chukchi Sea cruises. The 1989 cruise included sampling in the southeast Chukchi Sea whereas sampling in 1990 was only in the northeastern portion. "x" indicates year of capture.

Species	Year Captured	
	1989	**1990**
Cottidae (Sculpins)		
Artedlellus scaber (Hamecon)	x	x
Blepsias bilobus (Crested)	-	x[1]
Enophrys diceraus (Antlered)	x	x
Eurymen gyrinus (smooth cheeked)	-	x[1]
Gymnocanthus galeatus (Armorhead)	x	-[2]
G. tricuspis (Arctic staghorn)	x	x
G. species	x	-
Hemilepidotus jordani (Yellow Irish lord)	x	-

Table 1. continued

Species	Year Captured	
	1989	1990
H papilio (Butterfly)	x	x
Icelus bicornis (Two·horn)	x	-
I. spatula (Spatulate)	-	x[1]
Megalocottus platycephalus (Belligerent)	-	x
Microcottus sellaris (Brightbelly)	-	x
Myoxcephalus polyancanthocephalus	-	x[3]
M. quadricornis (Fourhorn)	-	x
M. scorpius	x	-[3]
M. stelleri (Shorthorn)	x	-[3]
M. verrucosus	-	x[3]
N. pribilovius (Eyeshade)	x	x
Triglops pingeli (Ribbed)	x	x
T. forficata (Scissortail)	-	x[1]
Agonidae (Poachers)		
Agonus acipenserinus (Sturgeon)	-	x
Aspidophoroides bartoni (Aleutian Alligatorfish)	-	x[1]
A. olriki (Arctic alligatorfish)	x	x
Bathyagonus nigripinnis (Blackfin)	x	-[4]
Ammodytidae (Sandlances)		
Ammodytes hexapterus (Pacific)	x	x
Anarhichadidae (Wolffishes)		
Anarhichas orientalis (Bering)	-	x[1]
Zoarcidae (Eelpouts)		
Gymnelus hemifasciatus	-	x
G. viridis (Fish doctor)	x	x
Lycodes mucosus	x	-[2]
L. palearis (Wattled)	x	x
L. polaris (Canadian)	x	x
L. raridens	-	x
L. cf. rossi (Threespot)	x	x
Cycloptaridae (Lumpsuckers)		
Eumicrotremus andriashevi	-	x[1]
E. birulai (Spiny)	-	x[1]
E. orbis (Pacific spiny)	-	x[1]
Liparidae (Piparids)		
Liparis gibbus (Dusky)	x	x[1]

Table 1. continued

Species	Year Captured	
	1989	1990
L. tunicatus (Kelp)	x	x
L. sp (Bronze)	x	x
Stichaeidae (Pricklebacks)		
Anoplarchus purpuresens (Highcockscomb)	x	-[4]
Lumpenus fabricii (Slinder eelbleny)	x	x
L. medius (Stout eelblenny)	x	x
Stichaeus punctatus (Arctic shanny)	x	x
Chirolophis snyderi (Wendal's warbonnet)[1]	-	x
Gadidae (Cod)		
Boreogadus saida (Arctic)	x	x
Eleginus gracilis (Saffron)	x	x
Gadus macrocephalus (Pacific)	x	x[1]
Theragra chalcogramma (Pollock)	x	x
Hexagramidae (Greenlings)		
Hexagrammus stelleri (Whitespotted)	-	x
Pleuronectidae (Flounders)		
Atheresthes stomias (Arrowtooth)	x	-[5]
Hippoglosoides robustus (Bering)	x	x
H. stenolepis (Pacific halibut)	-	x
Limanda aspera (Yellowfin sole)	-	x
L. proboscidea (Longhead dab)	-	x
L. sakhalinensis (Sakhalin flounder)	x	x[1]
Platichthys stellatus (Starry flounder)	-	x
Pleuronectes quadrituberculatus (Alaska plaice)	-	x
Reinhardtius hippoglosoides (Greenland turbot)	-	x
Clupeidae (Herring)		
Clupea harengus (Pacific herring)	-	x
Osmeridae (Smelts)		
Mallotus villosus (capelin)	-	x
Osmerus eperlanus (Boreal)	-	x

[1] Range extension
[2] Tentative identification
[3] Complex of several species for which identifications at this time are tentative
[4] May have been missidentified in the field

[5] Postlarva identified in the field

Table 2 lists the invertebrate species captured by otter trawl. They were identified and provided by Rae Baxter.

Table 2.—List of mollusk species captured in the Chukchi Sea during 1989 and 1990. The 1989 cruise included sampling in the northeast and southeast Chukchi Sea and were captured by otter trawl to which a small dredge was attached on an otter board. They were captured only by otter trawl in the northeast Chukchi Sea in 1990. They were identified by Rae Baxter.

			1989	1990
BIVALVIA				
	1153	*Astarte montagui*	+	+
	1219	*Axinopsida orbiculata*	+	+
	1077	*Chlamys wainwrightensis*	+	+
	1051	*Clinocardium californiense*		+
	1004	*Clinocardium ciliatum*	+	+
	1035	*Crassicardia crassidens*	+	+
	1083	*Cyclocardia crebricostata*	+	+
	1073	*Cyclocardia ventricosa*		+
	1010	*Hiatella arctica*	+	+
	1020	*Liocyma fluctuosa*	+	+
	1217	*Lyonsia arenosa*	+	+
	1091	*Macoma brota*	+	+
	1095	*Macoma calcarea*	+	+
	1202	*Macoma crassula*	+	+
	1044	*Macoma lama*		+
	1031	*Macoma middendorffi*		+
	1008	*Musculus discors*	+	+
	1009	*Musculus niger*	+	+
	1168	*Mya pseudoarenaria*		+
	1016	*Mya truncata*		+
	1025	*Mytilus edulis*		+
		Musculus corrugatus	+	+
		Mysella aleutica	+	
	1130	*Mysella beringensis*		+
		Mysella planata	+	
		Mytilus edulis	+	
		Nearomya compressa	+	
	1034	*Nucula tenuis*	+	+
	1194	*Nuculana buccata*	+	+

Table 2. continued

			1989	1990
	1005	*Nuculana fossa*		+
		Nuculana minuta	+	
		Nuculana radiata	+	
	1021	*Pandora filosa*		+
		Pandora gracialis	+	
		Periploma aleuticum	+	
	1022	*Pododesma macrochisma*	+	+
		Portlandia frigida	+	
	1001	*Serripes groenlandicus*	+	+
	1002	*Serripes laperousi*		+
	1017	*Spisula polynyma*		+
		Thyasira equalis	+	+
	1069	*Tridonta borealis*	+	+
	1048	*Voldia hyperborea*	+	+
	1078	*Yoldia myalis*		+
	1185	*Yoldia scissurata*	+	+
CEPHALOPODA				
	C 2	*Octopus leioderma*	+	+
GASTROPODA				
	111	*Admete couthouyi*	+	+
	339	*Admete laevior*		+
	459	*Admete regina*	+	+
		Admete sp.	+	+
	681	*Aquilonaria turneri*	+	
	546	*Asterophila japonica*	+	+
	187	*Beringius behringi*		+
	403	*Beringius stimpsoni*		+
	292	*Boreoscala greenlandica*		+
	296	*Boreotrophon clathratus*	+	+
	517	*Boreotrophon muriciformis*	+	+
	251	*Boreotrophon pacificus*		+
	198	*Baccinum angulosum*		+
	294	*Baccinum glaciale*		+
	313	*Baccinum plectrum*	+	+
	516	*Buccinum polare*	+	+
	538	*Buccinum scalariforme*	+	+
	233	*Buccinum solenum*	+	+
	188	*Buccinum tenellum*		+
	879	*Buccinum* sp.		+
	880	*Buccinum* sp.		+
	881	*Buccinum* sp.		+
	883	*Buccinum* sp.		+

Table 2. continued

		1989	1990
194	*Bulbus fragilis*		+
174	*Capulacmaea commodum*	+	+
239	*Clinopegma magna*	+	+
279	*Colus cf. aphelus*	+	+
307	*Colus capponius*	+	+
302	*Colus dautzenbergi*	+	+
683	*Colus esychus*		+
298	*Colus ombronius*	+	+
883	*Colus cf. roseus*		+
66	*Colus spitsbergensis*		+
387	*Crepidula grandis*	+	+
285	*Cylichna alba*		+
	Cylichna attonsa	+	
	Dendronotus sp. (orange)		+
	Dendronotus sp. (purple)	+	+
286	*Diaphana brunnea*		+
	Diaphana minuta	+	
755	*Diaphana* sp.		+
	Frigidoalvania		+
159	*Lepeta caeca*	+	+
	Lmacina helicina	+	
291	*Liomesus ooides*		+
127	*Margarites argentatus*		+
343	*Margarites costalis*	+	+
	Margarites giganteus	+	
126	*Margarites vorticifera*		+
	Marsenina sp.	+	+
293	*Natica aleutica*	+	+
496	*Nepturea borealis*	+	+
148	*Neptunea heros*	+	+
149	*Neptunea middendorffi*		+
147	*Neptunea ventricosa*	+	+
	Odostomia castanea	+	
	Odenopota bicarinata	+	
	Oenopota decussata	+	
74	*Oenopota elegans*		+
141	*Oenopota harpa*	+	+
522	*Oenopota incisula*	+	+
322	*Oenopota murdochiana*		+
	Oenopota rosea	+	
310	*Oenopota simplex*		+
320	*Oenopota tenuicostata*		+
334	*Oenopota turricula*		+
	Oenopota viridula	+	

Table 2. continued

		1989	1990
205	*Oenopota* sp.		+
	Onchidiopsis sp. (brown)		+
	Onchidiopsis sp. (small brown)		+
	Onchidiopsis sp. (orange)		+
	Onchidiopsis sp. (purple)		+
	Onchidiopsis sp. (black)		+
634	*Philinadae Gn.* sp.		+
	Plicifusus brunneus	+	
389	*Plicifusus callorhinus*	+	+
151	*Plicifusus kroeyeri*	+	+
882	*Plicifusus* sp.		+
353	*Polinices pallida*	+	+
	Ptychatractus occidentalis	+	
31	*Solariella obscura*	+	+
574	*Solariella varicosa*	+	+
105	*Tachyrhynchus erosus*	+	+
115	*Tachyrhynchus reticulatus*	+	+
255	*Tochuina tetraquatra*	+	+
197	*Trichotropis bicarinata*	+	+
446	*Trichotropis borealis*	+	+
119	*Trichotropis coronata*	+	+
189	*Trichotropis kroeyeri*	+	+
	Turridae Gn. sp.	+	
360	*Velutina plicatilis*	+	+
212	*Velutina undata*	+	+
242	*Velutina velutina*	+	+
55a	*Volutopsius attenuatus*		+
521	*Volutopsius deformis*	+	+
225	*Volutopsius fragilis*		+
237	*Volutopsius stefanssoni*		+
POLYPLACOPHORA			
A30	*Amicula vestita*	+	+
A7	*Stenosemus albus*	+	+

We did not complete all stations because, quite simply, the weather was atrocious. For example, on the second leg we arrived on station at 02:00 on 30 August and completed 4 stations before 40-50 kt winds and 15 - 20 foot seas on the 31st required us to seek shelter. The next seven days were spent seeking protection, attempting to sample inshore stations, or riding the weather out on anchor. Sampling was resumed the late afternoon of 6 September. Significantly for this study, all stations not occupied were either in the last transect or offshore stations (Figure 1). The distribution of stations from this incomplete sampling will make the associations tentative at best.

Participants:

First Leg

Ronald L. Smith, Professor, UAF;
Terry Sample, Technician, NMFS;
Rae Baxter, NOAA Representative;
Franz Mueter, SFOS Graduate Student.

Second Leg

Willard E. Barber, Associate Professor, UAF;
Rae Baxter, NOAA representative;
Claire Armistead, NMFS Technician;
Loren Tuttle, SFOS Graduate Student.

Appendix 3

FISHERIES OCEANOGRAPHY OF THE NORTHEASTERN CHUKCHI SEA

1991 CRUISE REPORT

WILLARD E. BARBER, R. L. SMITH,
and T. J. WEINGARTNER

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PROJECT

Fisheries Oceanography of the northeastern Chukchi Sea

FUNDING SOURCE

Minerals management Service

Contract umber 14-35-0056-30559

CRUISE DATES

Oshoro Maru	17 July - 4 August
Ocean Hope III	4-25 September
Responder	23-29 July; 12-18 August; 27 September - 1 October
Surveyor	22 September - 11 October

OBJECTIVE OF CRUISES

The primary goal of this project is to determine the community structure of fishery organisms, emphasizing the ichthyofauna, and relate this to geological, physical and biological oceanographic conditions in the northeastern Chukchi Sea. Objectives of this year's cruises were to:

1. Occupy stations not sampled in 1990 to (a) determine the distribution, abundance and biomass of bottom organisms; (b) determine the distribution and abundance of ichthyoplankton and juvenile fish;
2. Occupy selected stations sampled in 1990 to determine interannual variability in abundance and biomass of bottom fishes;
3. Determine the hydrographic structure of the water column at each station;
4. Determine the abundance and distribution of bottom and midwater juvenile fishes near the oil drill ship;
5. Determine the differences in catches between the *Oshoro Maru* and the *Ocean Hope III* at stations sampled from both vessels;
6. Deploy five current meters.

To accomplish these objectives, biological samples were obtained and CTD casts made from the Japanese research vessel *Oshoro Maru,* the chartered fishin vessel *Ocean Hope III*, a launch deployed from the oil company barge *Responder*, and current meters deployed from the NOAA vessel *Surveyor*. Stations occupied while aboard the *Oshoro Maru* and *Ocean Hope III* are listed in Table 1 and shown in Figure 1. Current meter locations are shown in Figure 1 and listed in Table 2. From the *Oshoro Maru* bottom fish and invertebrates were obtained with an otter trawl

Table 1.—Station locations in the northeastern Chukchi Sea occupied from the *Oshoro Maru* (OM) on 25-31 July and from the *Ocean Hope III* on 14-23 September 1991.

Station	Latitude	Longitude	Vessel
Otter Trawling			
91-24	69°02'	166°44'	OM
90-16	69°01'	167°27'	OM & OH[1,2]
91-2	69°09'	168°21'	OM
90-21	69°21'	166°25'	OH[1]
91-25	69°31'	166°00'	OM
91-26	69°27'	165°01'	OM
90-47	69°13'	164°43'	OM[4]
90-46	69°28'	163°53'	OM[4]
91-X	69°52'	168°39'	OM
91-18	70°11'	167°05'	OM
91-8	70°32'	166°08'	OM
91-7	70°53'	166°17'	OM
91-14	70°28'	163°45'	OM
91-13	70°58'	163°36'	OM
90-22	69°37'	167°43'	OM & OH[2]
91-28	69°47'	167°03'	OH[3]
91-22	69°40'	168°34'	OM & OH[3]
91-29	69°51'	168°00'	OH[3]
91-27	69°59'	168°34'	OH[3]
91-16	70°32'	162°22'	OM
91-17	70°56'	162°36'	OM
90-27	71°10'	161°55'	OH[2,3]
91-31			OH[5]
91-32	71°37'	159°00'	OH[3]
91-33	71°15'	158°43'	OH[1,3]
91-34	71°07'	158°35'	OH[1,3]
91-35	71°00'	159°21'	OH[1,3]
90-23	70°22'	162°52'	OH
90-36	70°02'	163°23'	OM & OH[2,3]
90-43	69°59'	164°51'	OM & OH[2,3]
90-06	68°26'	166°38'	OH[2,3]

1 One otter trawl conducted.
2 Sampled in 1990.
3 Sampled with the Bongo net, lost IKMT at station 91-28.
4 Identified as 1990 stations, but wrong location.
5 Lost otter trawl.

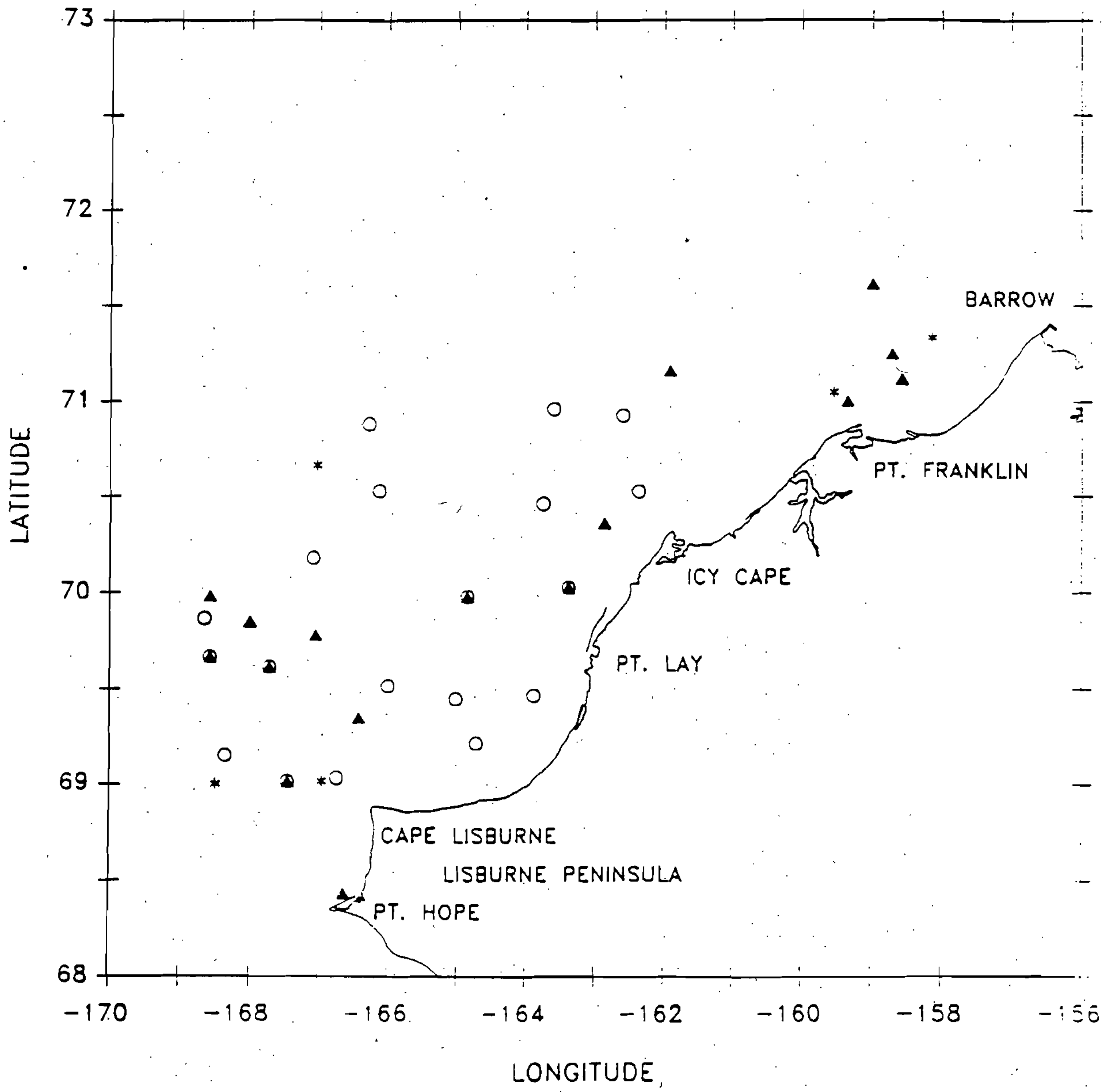

Figure 1. Station locations occupied during the 1991 northeastern Chukchi Sea field season. Circles are stations occupied from the *Oshoro Maru*, triangles are stations occupied from the *Ocean Hope III*, and asterisks are locations of current meter moorings.

having a 43.3 m headrope and 48.6 m footrope, and a 90 mm codend mesh. Juvenile and larval fishes were obtained with the Hokkaido University's standard beam trawl which had a 2 x 2.5 m square mouth and a 17 m long net having a mesh grading from 6.5 mm to a 4 mm square mesh; the codend had a 1 mm lining. CTD measurements were obtained from their standard hydrographic casts.

Sampling from the *Ocean Hope III* was identical to that of last year. At each station the biological samples were obtained by pulling the NMFS 83-112 survey otter trawl at approximately 2 kts for 1/2 hour. An Isaacs-Kidd midwater trawl (IKMT; 1.83 m wide headrope with a 5 mm stretched mesh net with a 1 mm screened bucket) and a bongo plankton net (60 cm diameter openings and 1 mm mesh net with 0.5 mm screened buckets) were deployed in double oblique tows from surface to near bottom at about 1.5 - 2 kts. To determine salinity and temperature at depth, hydrographic casts were made with a Seabird S-19 automatic conductivity and temperature probe. In addition to this sampling, microzooplankton was obtained at the surface, 5, 10, and 15 m depths by sampling with a 30 l Nisken bottle with the water filtered through a 0.046 mm net for copepod nauplii (potential food for larval fishes). Microzooplankton also was obtained by pulling a Calvet net (0.165 mm mesh) vertically from the bottom to the surface to sample potential food (copepods) for juvenile fishes. Hydrographic casts for CTD were made with a portable Seabird.

Sampling near the drill ship was done from a 10.9 m launch deployed from the *Responder*. The launch was equipped with a detachable A-frame and diesel powered

Table 2.—Proposed and actual locations of current meter moorings deployed in the northeastern Chukchi Sea in September and October 1991.

Planned		Deployed	
69°01'N	166°58'W	69°01'N	166°58'W
71°03'N	159°33'W	71°03'N	159°33'W
71°28'N	156°53'W	71°20'N	158°10'W
71°45'N	166°00'W		
72°27'N	164°00'W		
		69°00'N	168°29'W
		70°40'N	167°02'W

winch system to deploy and retrieve a 4.9 m otter trawl (5 mm mesh), the IKMT and bongo net. Additionally, microzooplankton was sampled and CTD casts made as previously described.

Itinerary and Activities:

Oshoro Maru

Barber and McDonald met the *Oshoro Maru* and loaded equipment aboard on 16 July, departing the following day. We arrived at St. Lawrence Island on the 20th to occupy stations for several Japanese scientists then proceeded to the northeastern Chukchi Sea on the evening of the 22nd. A number of hydrographic stations were occupied on the way to the northeastern Chukchi Sea. We arrived off Cape Lisburne on the 25th and the first trawl was made at 13:27. Several stations were occupied along the international border up to 71°00'; ice prevented sampling further north. Twenty stations were sampled with the otter and beam trawls; a number of other stations were established for hydrographic casts and plankton sampling for Japanese scientists. The last otter trawl was made at 06:36 on the 31st and we departed for Dutch Harbor. We arrived in Dutch Harbor on the morning of 4 August and offloaded equipment and samples, departing for Fairbanks that evening.

Ocean Hope III

The vessel was met and equipment loaded in Dutch Harbor on 3 September. The vessel departed on the 4th with Foster and McDonald on board; Barber returned to Fairbanks. Barber and Okkonen met the vessel in Nome at 23:30 on the 7th. Departing early on the 8th we arrived at Pt. Hope on the 10th and, because of high seas, anchored to wait more favorable conditions. On the 14th we arrived at station 90-16 and attempted a hydrographic cast but because of high seas (3 - 4 m) attempts were discontinued. We accomplished one trawl and proceeded to Cape Lisburne to sort the catch. This pattern was repeated at station 90-21 on the 15th. Weather broke on the 16th and we proceeded back to station 90-21 and completed hydrographic and plankton sampling. Otter trawling could not be completed; the cod-end rope broke on the first attempt and on the second attempt we had approximately 5,500 kg of jellyfish. We then completed four stations in the southwestern area before losing the IKMT at station 91-28. We proceeded to and sampled station 90-27 (71°36'N 163°40'W, about 20 mi from the drill ship) on the 19th then proceeded further north into the ice and established station 91-31. All sampling was completed except trawling; the otter trawl hung up and we lost the latter half of the net. Because of the probability of further hang-ups, we proceeded to the next station. Station 91-32 was located in heavy ice, it was snowing and there was slush ice forming. We next established a station (91-33) in the Barrow Canyon. Besides biological organisms being in the trawl, there were large rocks which broke through the sorting table and the wooden portion of the deck; we did no further otter trawling here. Large rocks were also present at station 91-34 and, because of the possibility of losing the spare net, we proceeded further south in hopes of sampling areas with less chance of losing the net. We sampled two stations established last year (36 and 43) on the 22nd and, because of building seas, we headed for and anchored behind Cape Lisburne. The following day we proceeded to station 6 (established in 1990), conducted two trawls and spent the day beind Pt. Hope sorting the catch. Hydrographic and plankton sampling could not be done because of high seas. Weather predictions were for several days of similar conditions and we departed for Nome that night. Arriving in Nome on the morning of the 25th, we off-loaded specimens and equipment and departed that night.

Table 3 lists the fish species captured by otter trawl from charter vesselsfor the three years of sampling. For years combined, there were a total of 64 nominal fish species captured. For those captured this year the tubenose poacher (*Pallasina barbata*) was not captured during previous cruises. For the three years sampling 13 range extensions have been identified. There are still difficulties in identifying several species of *Myoxocephalus* and *Lycodes*.

The taxonomy of *M. verrucosus* has been discussed with Dr. Alex Peden (B.C. Provincial Museum, Victoria) and is open to question. Dr. Peden is currently conducting a genetic study using protein patterns formed in electrophoretic gells of another closely related species of *Myoxocephalus*. He requested 50 specimens of *M. verrucosus* preserved and separately tagged with the hearts frozen in separate vials. We were only able to obtain 35 specimens that were large enough.

Invertebrates collected by otter trawl and identified are listed in Table 4.

Responder

There were three cruises on the barge *Responder*; three personnel participated during the first two cruises and two the last. Sampling was limited to daylight hours only, between 07:00 and 17:00, by the barge supervisor.

The otter trawl collected predominantly Arctic cod and sculpins during all three cruises. Although the IKMT was deployed several times in various ways, it caught few or no fish. Visual inspection in the field indicated that the Bongo net samples

Table 3.—List of fish species captured by otter trawl in the northeastern Chukchi Sea in 1989 and nominal species of those captured in 1990 and 1991 ("x" indicates year).

Species	Year Captured		
	1989	1990	1991
Cottidae (Sculpins)			
Artediellus scaber (Hamecon)	x	x	x
Blepsias bilobus (Crested)[1]	-	x	-
Enophrys diceraus (Antlered)	x	x	x
Eurymen gyrinus (smooth cheeked)[1]	-	x	x
Gymnocanthus tricuspis (Arctic staghorn)	x	x	x
G. species	x	-	-
Hemilepidotus jordani (Yellow Irish lord)	x	-	-
H. papilio (Butterfly)	x	x	x
Icelus bicornis (Two horn)	x	-	-
I. spatula (Spatulate)[1]	x	-	-
I. spiniger (Thorny)[1]	x	-	-
Megalocottus platycephalus (Belligerent)	-	x	-
Microcottus sellarus (Brightbelly)	-	x	-
Myoxocephalus polyacanthocephalus[2]	-	x	-
M. quadricornis (Fourhorn)	-	x	-
M. scorpius[2]	x	-	-
M. stelleri (Shorthorn)[2]	x	-	-
M. verrucosus[2]	-	x	x
Nautichthys oculofaciatus (Sailfin)[1]	x	-	-
N. pribilovius (Eyeshade)	x	x	x
Triglops beani	x	x	x
T. forficata (Scissortail)[1]	-	x	-
Agonidae (Poachers)			
Agonus acipenserinus (Sturgeon)	x	x	x
Aspidophoroides bartoni (Aleutian alligatorfish)[1]	-	x	-
A. olriki (Arctic alligatorfish)	x	x	-
Bathyagonus nigripinnis (Blackfin)[1]	x	-	-
Pallasina barbata (tubenose)[1]	-	-	x
Ammodytidae (Sandlances)			
Ammodytes hexapterus (Pacific)	x	x	x
Anarhichadidae (Wolffishes)			
Anarhichas orientalis (Bering)[1]	-	x	-
Zoarcidae (Eelpouts)			
Gymnelus hemifasciatus	-	x	-
G. viridis (Fish doctor)	x	x	x
Lycodes mucosus	x	-	-
L. palearis (Wattled)	x	x	x
L. polaris (Canadian)	x	x	-
L. raridens	-	x	x
L. cf. rossi (threespot)	x	x	-

Table 3. continued

Species	Year Captured		
	1989	1990	1991
Cycloptaridae (Lumpsuckers)			
Eumicrotremus andriashevi[1]	-	x	x
E. birulai (Spiny)	-	x	-
E. orbis (Pacific spiny)[1]	-	x	-
Liparidae (Liparids)			
Liparis gibbus (Dusky)[1]	x	x	x
L. tunicatus (Kelp)	-	x	x
L. sp. (Bronze)	x	x	x
Stichaeidae (Pricklebacks)			
Anoplarchus purpuresens (High cockscomb)	x	-	-
Lumpenus fabricii (Slender eelbleny)	x	x	x
L. medius (Stout eelblenny)	x	x	-
Stichaeus punctatus (Arctic shanny)	x	x	x
Chirolophis snyderi (Wendal's warbonnet)[1]	-	x	x
Eumesogrammus praecisus	-	-	x
Gadidae (Cod)			
Boreogadus saida (Arctic)	x	x	x
Eleginus gracilis (Saffron)	x	x	x
Gadus macrocephalus (Pacific)[1]	x	x	-
Theragra chalcogramma (Pollock)	x	x	-
Hexagrammidae (Greenlings)			
Hexagramus stelleri (Whitespotted)[1]	-	x	-
Pleuronectidae (Flounders)			
Atheresthes stomias (Arrowtooth)	x	-	-
Hippoglosoides robustus (Bering)	x	x	x
H. stenolepis (Pacific halibut)	-	x	-
Limanda aspera (Yellowfin sole)	-	x	x
L. proboscidea (Longhead dab)	-	x	-
L. sakhalinensis (Sakhalin founder)[1]	x	x	-
Platichthys stellatus (Starry flounder)	-	x	-
Pleuronectes quadrituberculatus (Alaska plaice)	-	x	x
Reinhardtius hippoglosoides (Greenland turbot)	-	x	-
Clupeidae (Herring)			
Clupea harengus (Pacific herring)	-	x	x
Osmeridae (Smelts)			
Mallotus villosus (capelin)	-	x	x
Osmerus eperlanus (Boreal)	-	x	x

[1] Range extension.
[2] Complex of several species for which identifications at this time are tentative.

Table 4.—List of invertebrates captured by otter trawl in the northeastern Chukchi Sea in 1991 from the *Ocean Hope III.*

Mollusca
- *Lepeta caeca*
- *Margarites costalis*
- *Crepidula grandis*
- *Boreoscala groenlandica*
- *Trichotropis bicarinata*
- *Velutina plicatilis*
- *Capulacmaea commondum*
- *Onchidiopsis* spp.
- *Marsenina glabra*
- *Natica clausa*
- *Polinices pallidus*
- *Boreotrophon muriciformis*
- *Boreotrophon beringi*
- *Buccinum polare*
- *Buccinum angulosum*
- *Buccinum glaciale*
- *Buccinum plectrum*
- *Buccinum solenum*
- *Buccinum tenellum*
- *Buccinum fringillium*
- *Buccinum* sp.
- *Beringius beringi*
- *Beringius stimpsoni*
- *Clinopegma magna*
- *Colus spitzbergensis*
- *Colus hypolispus*
- *Colus* sp.
- *Neptunea borealis*
- *Neptunea heros*
- *Neptinea ventricosa*
- *Plicifusus kroyeri*
- *Volutopsius fragilis*
- *Volutopsius castaneus*
- *Volutopsius steffansoni*
- *Volutopsius castaneus*
- *Volutopsius difformis*
- *Admete regina*
- *Oenopota* sp.
- *Trocuina tetraquetra*
- *Calycidoris geuntheri*
- *Nucula tenuis*
- *Yoldia amygdalea*
- *Musculus niger*
- *Musculus discors*
- *Chlamys islandica*
- *Pododesmus macroschisma*
- *Cyclocardia crassidens*
- *Cyclocardia crebricostata*
- *Clinocardium ciliatum*
- *Clinocardium californiense*
- *Serripes laperousi*
- *Serripes groenlandicus*
- *Macoma moesta*
- *Hiatella arctica*
- *Panomya* sp.
- *Pandora glacialis*
- *Liocyma fluctuosa*
- *Amicula vestita*
- *Stenonemus albus*

Porifera
- Several unidentified species

Coelenterat
- *Eunephtya* sp.
- Unidentified hydroids
- Unidentified scyphozoan
- Unidentified anemones

Annelida
- *Eunoe nodosa*
- *Eunoe depressa*
- *Nereis* sp.
- Opheliidae (*Brada* sp.)?)
- Polynoidae

Arthropoda
- *Balanus* sp.
- *Balanus rostratus*
- *Labidochirus splendescens*
- *Pagurus* sp.
- *Sclerocrangon boreas*
- *Crangon communis*
- *Lebbeus groenlandicus*
- Pandalidae
- *Paralithodes platypus*

Bryozoa
- Several unidentified species

Sipunculida
- Unidentified sipunculid

Table 4. continued

Echinodermata	Ascidiacea
Asterias amurensis	Several unidentified species
Crossaster borealis	*Petalonia corrugata*
Crossaster papposus	
Ctenodiscus crispatus	
Evasterias echinosoma	
Henricia spp.	
Letasterias nanimensis	
Leptasterias sp.	
Leptasterias arctica or *L. groenlandica*	
Orthasterias koehleri	
Pteraster obscurus	
Solaster sp.	
Cucumaria sp.	
Myriotrochus rinkii	
Psolus peronii	
Psolus sp.	
Ophiura sarsi	
Ophiopholis aculeata	

appeared to contain primarily gadids, particularly in the first cruise. The CTD data for the first two cruises indicated a two layered water column with a salinity-temperature discontinuity layer between the 10 and 20 m depths. Only the otter trawl was deployed during the last cruise; after the first day of sampling weather conditions deteriorated and by the time conditions improved personnel were required to leave the barge.

Surveyor

Activities aboard the *Surveyor* met with partial success, primarily because of sea ice protruding southward over much of the area of focus to about 70° 30' between 163° and 168°. All five current meter moorings were deployed but the ice conditions required that three of the mooring positions be changed from those proposed (Table 2 and Figure 2). The mooring locations are such that four of the five are at locations previously occupied by Pacific Marine Environmental Laboratory's moorings. This deployment will not allow measuring currents in regions previously unexplored as proposed; it will, however, allow developing an understanding of interannual variability of currents in the northeastern Chukchi Sea.

A preliminary examination of the CTD data suggests hydrographic conditions in the Chukchi Sea were quite different this year as compared to 1990. Salinities were generally higher and temperatures colder throughout the region. Extremely cold and salty bottom water was observed northwest of Pt. Franklin. A CTD survey in the Bering Strait also indicated colder and saltier water on the east side of the straight.

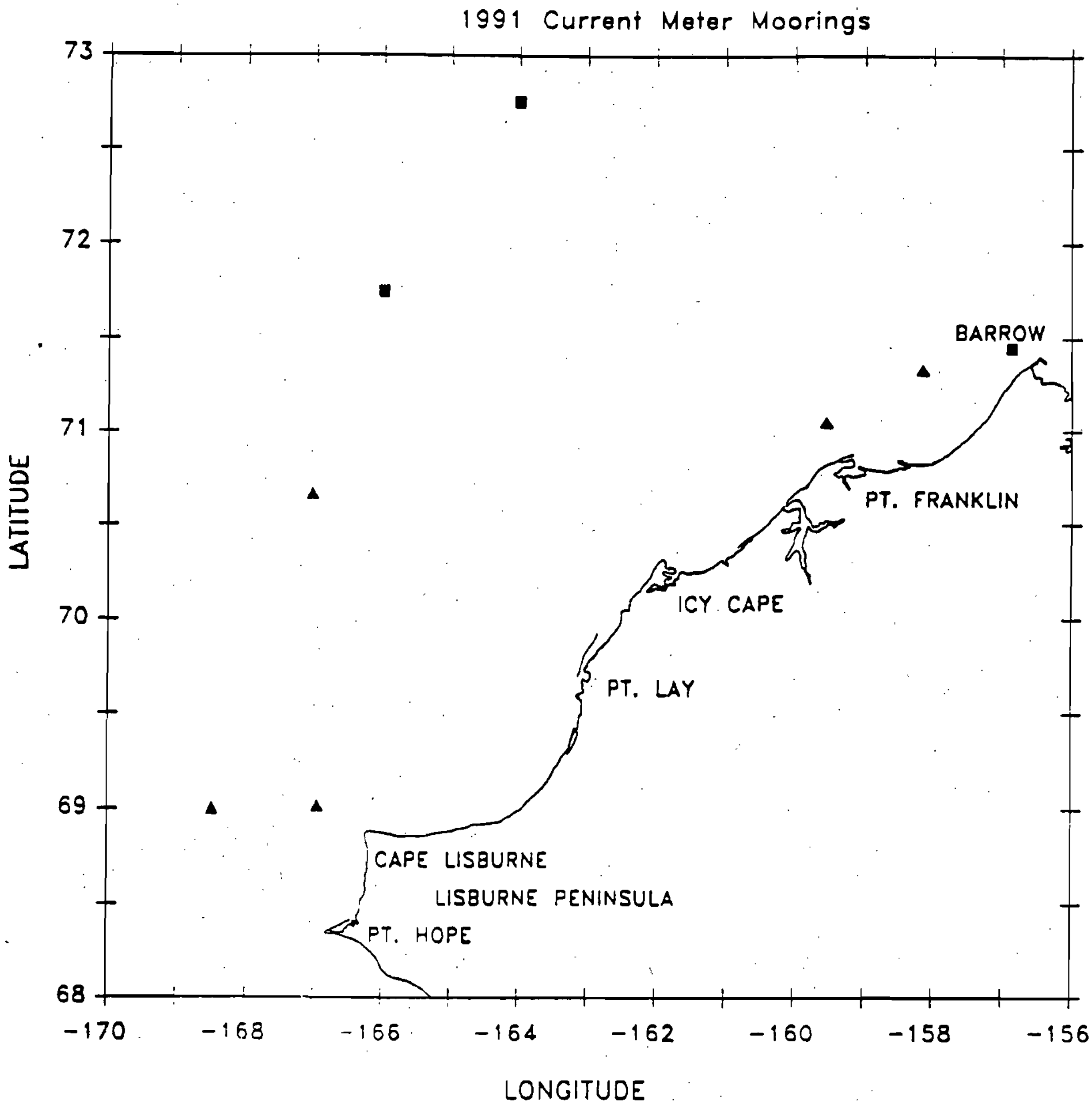

Figure 2. Locations proposed for current meter moorings (squares) in the northeastern Chukchi Sea during the 1991 field season shown in relation to where current meters were moored (triangles) because of heavy ice conditions in proposed areas.

Waters on this side are typically warm and fresh, and provide the source waters for the Alaskan Coastal Water (ACW). The observations suggest a marked decrease in the volume of ACW in 1991 compared to previous years. While detailed analysis remains to be done, the summer of 1991 was characterized by consistent northerly winds and undoubtedly responsible for the southward extent of the icepack. These winds would also tend to decrease the northward transport through the Bering Strait and hence will prolong the time required to flush the Chukchi Sea of the cold, salty winter water remnant on the shelf.

Paticipants:

Oshoro Maru - W. E. Barber, Judy McDonald

Ocean Hope III - W. E. Barber, Judy McDonald, Nora Foster, Steve Okkonen

Responder - Ken Coyle (Cruise Leader), Mark Vallarino, Beth Bergeron, Juli Gillispie

Surveyor - T. J. Weingartner and J. R. Smithhisler

Appendix 4

FISHERIES OCEANOGRAPHY OF THE NORTHEASTERN CHUKCHI SEA

OSHORO MARU REPORT

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INTRODUCTION

The *Oshoro Maru* was used as an opportunity for expanding the sampling area in the northeast Chukchi Sea. It also provided a means of comparing the efficiency of different otter trawl configurations (between *Oshoro Maru* and *Ocean Hope III*). In addition, the *Alpha Helix* and *Surveyor* were utilized for collecting physical oceanographic information.

METHODS AND MATERIALS

Sampling was conducted from the *Oshoro Maru* on 25 July to 31 August 1991 and 11 July-4 August 1992 (Figure 1; Table 1). In 1991 fishes and snow crab were collected with an otter trawl. The trawl had a 43.3 m headrope and 48.6 m footrope fitted with rollers, and a 90 mm mesh codend. Larval and YOY fishes were sampled with the University of Hokkaido's standard beam trawl - a 2 x 2.5 m square mouth and a net 17 m long with mesh grading from 6.5 mm to 4 mm, the codend had a 1 mm lining. In 1992 sampling was conducted the same as in 1991, however, the codend of the otter trawl had a 45 mm mesh liner. The numbers of fish caught per trawl in 1991 were compared between the *Oshoro Maru* and *Ocean Hope III* where the sampling areas overlapped (north of 69° N latitude and east of 161° 50' W longitude). Numbers of fish caught were also compared where stations were sampled by both vessels. A description of the gear used and station locations sampled from the *Ocean Hope III* may be found in Chapter 2.

Sampling was conducted from the *Surveyor* from 22 September - 11 October 1991. Five current meters were deployed and CTD collected. Specific station locations can be found in Chapter 2 and Appendix 3.

In 1992 the *Alpha Helix* was used from 14 September -9 October. The five current meters deployed in 1991 were recovered and re-deployed. In addition, CTD data was collected. Station locations for current meters and CTD are located in Chapter 3 and Appendix 5.

RESULTS AND DISCUSSION

Information obtained during the *Oshoro Maru* and *Ocean Hope III* cruises can be found in Chapter 4 for ichthyoplankton and Chapter 11 for snow crab. The number of fish captured from the *Oshoro Maru* in 1992 was much greater than in 1991 (Tables 2 and 3). This is undoubtedly due to the addition of the codend liner. The average number of fish captured in 1991 by the *Oshoro Maru* was 10.6 fish/trawl and 521.5 fish/trawl by the *Ocean Hope III*. The number of fish per trawl at stations sampled by both vessels was much larger from the *Ocean Hope III* than the *Oshoro Maru* (Table 4). This difference is most likely due to differences in gear type. The net used aboard the Oshoro Maru had a 90 mm mesh net and the footrope had rollers. The net used aboard the Ocean Hope III had a 45 mm meshed codend liner and a tickler chain on the foot rope.

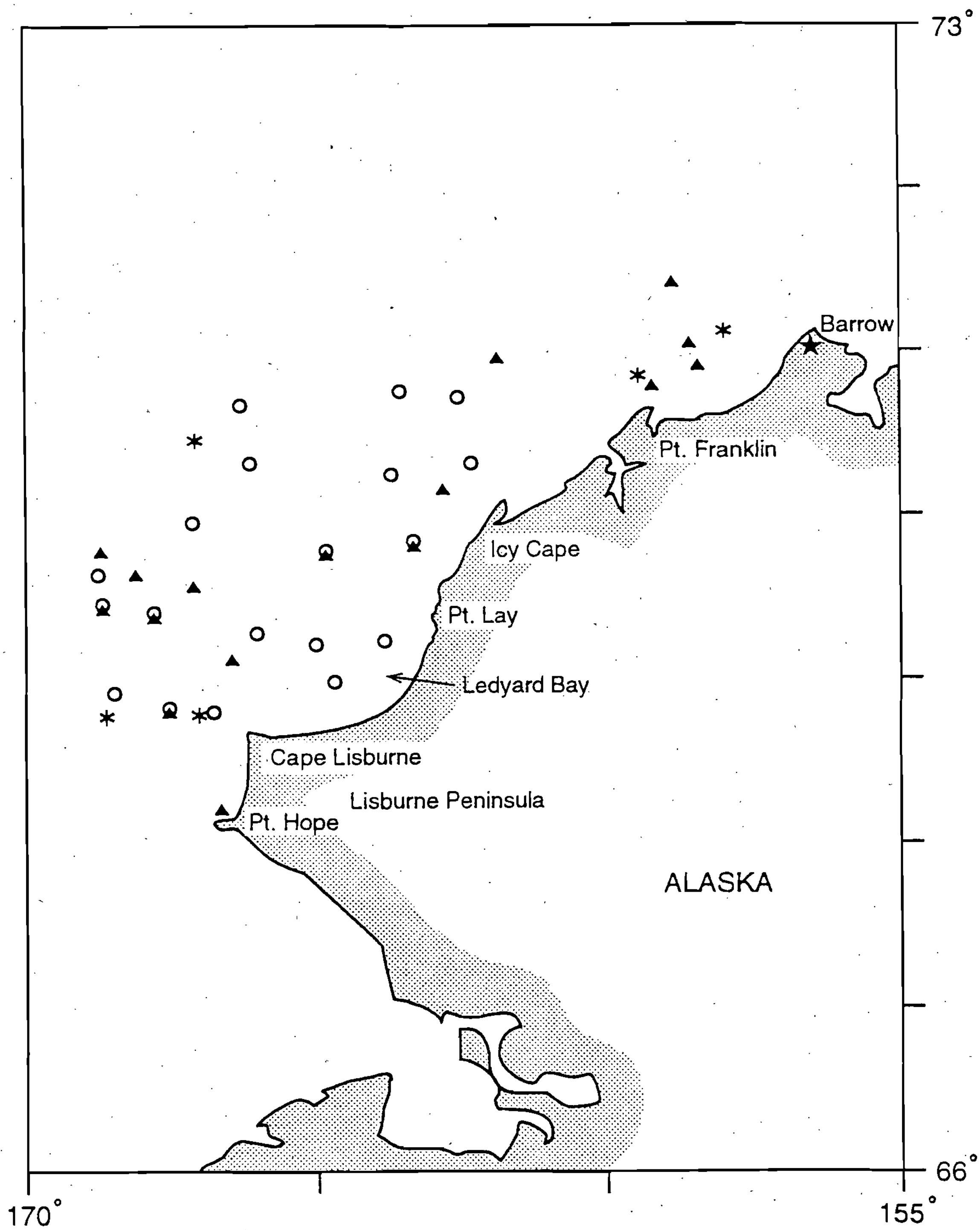

Figure 1. General stations locations occupied by the *Ocean Hope III* (triangles) and the *Oshoro Maru* (circles) in the northeast Chukchi sea during 1991. Specific locations for *Ocean Hope III* stations are given in Smith *et al.*, Chapter 5. Open circles indicate stations sampled from the *Oshoro Maru*, triangles stations sampled from *Ocean Hope III*, and asterisks current meter moorings.

Table 1.—Station locations sampled in 1991 and 1992 in the northeast Chukchi Sea by the *Oshoro Maru*.

Station #	Date (d/m/y)	Latitude ° 'N		Longitude ° 'W	
		1991			
9105	25071991	60	02	167	38
9106	25071991	69	06	168	23
9107	26071991	69	53	168	42
9108	26071991	69	40	168	42
9109	26071991	69	38	167	48
9110	27071991	70	12	167	04
9111	27071991	70	31	166	08
9112	27071991	70	52	166	16
9113	28071991	69	59	165	03
9114	28071991	69	59	163	39
9115	28071991	70	28	163	47
9116	29071991	70	57	163	38
9117	29071991	70	57	162	34
9118	29071991	70	32	162	20
9119	30071991	69	29	163	52
9120	30071991	69	14	164	42
9121	30071991	69	27	165	00
9122	30071991	69	31	165	59
9123	31071991	69	03	166	43
		1992			
9216	25071992	68	00	168	34
9217	25071992	68	30	168	34
9218	25071992	68	55	168	15
9219	26071992	70	00	166	59
9220	26071992	70	28	167	28
9221	26071992	71	00	167	40
9222	27071992	70	49	165	34
9223	27071992	70	37	163	21
9224	28071992	70	34	162	08
9225	28071992	69	59	164	57
9226	29071992	69	34	165	15
9227	29071992	69	29	163	59
9228	29071992	69	12	165	09
9229	30071992	69	29	166	59
9230	30071992	69	30	168	34
9231	30071992	68	43	167	06
9232	31071992	68	02	166	59

Table 2. Number of each species caught from the *Oshoro Maru* by otter trawl in the northeast Chukchi Sea in 1991.

Species	Station 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Clupea pallasii																			
Mallotus villosus	2		1																
Gadus macrocephalus																	7		
Eleginus gracilis	1																		
Theagra chalcogramma																			
Boreogadus saida	18	36		16	19	16	3	8	1	13	2	13	1				1		
Lumpenus fabricii	1																		
Stichaeus punctatus																	1		
Lycodes turneri		1																	
Lycodes raridens																			
Lycodes palearis						2													
Hemilepidotus papilio																			
Enophrys diceraus															1	1	2		
Myoxochephalus jaok																			
Artediellus scaber					1		1												
Myoxocephalus polyacanthocephalus																			
Myoxocephalus verrucosus		1	3		11		2								4	1			
Gymnocanthus tricuspis	1			1					1					1					
Podothecus scipenserinus														1					
Liparis gibbus																			
Hippoglossoides robustus	8	16		1															
Pleuronectis asper	1								2	1									
Pleuronectis quadrituberculatus		2					1												
Pleuronectes mochigarei																			
Pleuronectes proboscidea																			
Hippoglosus stenolepis																			
Eumicrotremus taranetzi															2				

Table 3. Number of fish captured from the *Oshoro Maru* by otter trawl in the northeast Chukchi Sea in 1992.

Species	Station 16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Osmerus mordax dentex		1															
Clupea pallasii			1													4	1
Mallotus villosus	30	10	7						1		2	31	8			10	3
Eleginus gracilis		1	2				1									3	
Boreogadus saida	268	130	137	124	76	129	773	67	35	29	178	50	43	20	2624	92	187
Ammodytes hexapterus	8							1									
Lumpenus fabricii	14	13															16
Stichaeus punctatus																	3
Stichaeus sp.																	2
Lycodes turneri	16	11															
Lycodes raridens		1		2						2	1						10

Table 3. continued

Species	Station 16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Lycodes palearis	1	17			2										1	4	21
Gymnelus sp.																	9
Hemilepidotus papilio																	1
Icelus spiniger													1				
Icelus bicornis																	6
Triglops beni																	15
Triglops pingeli									2								
Myoxocephalus verrucosus	1			1	1				4	2	1	1	5	1	2	1	66
Enophrys deceraus													14				2
Artediellus scaber				23			7			1				1			
Gymnocanthus tricuspis	227	10	2	5	48	12	8	11	30	3	59	62	63			2	48
Podothecus acipenserinus	1	1									1	1	1				38
Aspidophoroides bartoni											1						
Ulcina olriki					1	1	1				1						
Liparis ochotensis				1													4
Liparis gibbus	16	1			8		1	1		1	1	1	1	1		1	
Liparis megacephalus	1																
Hippoglossoides robustus	866	341	140	7	3	37	1			9	1			1	2	41	37
Pleuronectis asper											3	4					
Pleuronectis quadrituberculatus											1				1	2	
Pleuronectes proboscidea												3					

Table 4. The total number of fish captured at each station in the northeast Chukchi Sea by otter trawl from two different vessels in 1991. The total from the *Ocean Hope III* is the sum of two 30 min hauls while the total from *Oshoro Maru* is the sum from one 60 min haul.

Ocean Hope III Station	Total	***Oshoro Maru*** Station	Total
91-22OH	729	9	28
91-22OH	1266	8	21
91-16	186	5	32
90-43	532	13	16
90-36	356	14	3

FISHERIES OCEANOGRAPHY OF THE NORTHEASTERN CHUKCHI SEA

1992 CRUISE REPORT

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PROJECT

Fisheries Oceanography of the Northeastern Chukchi Sea

FUNDING SOURCE

Minerals Management Service

Contract umber 14-35-0056-30559

CRUISE DATES

Oshoro Maru	11 July - 4 August 1992
Alpha Helix	14 September - 9 October 1992

OBJECTIVE OF CRUISES

The primary goal of this project is to determine the community structure of fishery organisms, emphasizing the ichthyofauna, and relate this to geological, physical and biological oceanographic conditions in the northeastern Chukchi Sea. Objectives of this year's cruises were to:

1. Obtain specimens of what is believed to be *Myoxocephalus verrucosus* from the study area, this species and *M. polyacanthocephasus* from the St. Lawrence Island area for taxonomic comparisons.
2. Monitor the species present and their abundance from a ship of opportunity.
3. Recover the five current meters deployed last year.
4. To obtain conductivity, temperature, and depth data for describing the circulation and water mass property distribution for the Russian and U.S. waters of the northern Chukchi Sea.

The biological objectives were accomplished by using an otter trawl from the *Oshoro Maru*. The physical oceanographic objectives were accomplished from the *Alpha Helix*. Additionally, objective four was a cooperative effort between our project and Russian and Japanese scientists.

ITINERARY AND ACTIVITIES

Biological Objectives

The *Oshoro Maru* was met in Juneau on 9 July and departed on 11 July for the St. Lawrence Island area. Sampling began on 18 July and was conducted the same manner as last year while aboard the *Oshoro Maru*. This year, however, the otter trawl had a 45-mm cod-end liner. Several specimens of *M. polyacanthocephalu* and two *M. verrucosus* were obtained. We departed for the northeastern Chukchi Sea on

22 July and reached the first station on 25 July. Stations occuped are listed in Table 1. The last trawl sample was obtained on 31 July after which we departed for and arrived at Dutch Harbor on 4 August.

Physical Objectives

The major scientific activities planned for this year were to:

1. Occupy a series of conductivity-temperature-depth-fluorometry (CTDF) transects between Bering Strait and the northern Chukchi Sea to better define the water mass property distribution and circulation pattern of the Chukchi Sea.
2. Collect dissolved oxygen (DO) at selected depths at each CTDF station.
3. Recover five current meter moorings deployed by the University of Alaska Fairbanks (UAF) and three current meter moorings deployed by NOAA's Pacific Marine Environmental Laboratory (NOAA-PMEL) in fall of 1991.
4. Occupy a series of stations within the sea-ice for purposes of making atmospheric boundary layer measurements and radiative properties of sea ice.
5. Re-deploy five current meter moorings in Bering Strait and Barrow Canyon for the purposes of monitoring interannual variability of the circulation and water mass properties of the Chukchi Sea.

These activities, however, were augmented by several factors:

1. We were able to take advantage of an NSF-funded cruise, previous to the one currently being reported, to the northern Chukchi Sea in early September to recover two UAF moorings in Barrow Canyon. This allowed us to retrieve these moorings under favorable ice conditions.
2. We were able to collect water samples for the analysis of nutrients by J. Grebemeier (University of Tennessee), stable isotopes of oxygen by L. Cooper (Oak Ridge National Laboratory), and dissolved barium by K. Kenison-Falkner (Oregon State University). The analysis of these samples is being paid for by existing grants to these investigators. All of these results, however, will be pooled to describe water mass sources, characteristics, and mixing regions.
3. Mr. J. C. George, of the North Slope Borough Department of Wildlife Management, joined the cruise to conduct marine mammal and bird surveys, with particular focus on the distribution and abundance of bowhead whales.
4. At the request of our Russian colleagues, we attempted to recover a current meter mooring which they had deployed in the fall of 1991.
5. Due to concerns related to discharge of radioactive wastes in the seas, the Department of Energy requested that we obtain seawater samples for the analysis of radioactivity.

The *Alpha Helix* was met by the cruise leader and Japanese scientists on 14 September, loaded and departed on 16 September for Provideniya to meet the

Table 1.—Stations sampled from the *Oshoro Maru* with an otter trawl in the northeastern Chukchi Sea in July 1992. Station location is the latitutde and longitiude when the otter trawl reached bottom. Distance is the distance trawled. Previous sampling column indicates year and from which ship (OM=*Ocean Hope III*) at locations near where previous sampling occurred.

Station Number	Latitude	Longitude	Location Date	Distance (km)	Previous Sampling
OS92130	68° 00.5'	168° 34.4'	7/25/92	6.49	
OS92131	68° 31.6'	168° 39.0'	7/25/92	8.21	
OS92132	68° 56.1'	168° 13.9'	7/25/92	5.84	1991 (OM)
OS92134	70° 00.9'	167° 00.0'	7/26/92	6.57	1991 (OM)
OS92135	70° 29.4'	167° 27.5'	7/26/92	6.05	
OS92136	71° 01.2'	167° 42.7'	7/26/92	6.17	
OS92143	70° 48.9'	165° 34.0'	7/27/92	5.93	
OS92144	70° 38.2'	163° 20.7'	7/27/92	4.72	
OS92145	70° 33.7'	162° 11.1'	7/28/92	6.47	1991 (OM)
OS92147	69° 59.0'	165° 00.4'	7/28/92	6.24	1990 (OH) 1991 (OM)
OS92150	69° 34.6'	165° 13.2'	7/29/92	5.01	
OS92151	69° 29.1'	164° 01.5'	7/29/92	6.50	1991 (OM)
OS92152	69° 11.8'	165° 12.6'	7/29/92	6.49	
OS92154	69° 29.1'	167° 00.1'	7/30/92	2.87	1990/1991 (OH)
OS92155	69° 30.0'	168° 36.7'	7/30/92	6.63	1991 (OM & OH)
OS92156	68° 42.2'	167° 05.1'	7/30/92	6.09	
OS92158	68° 01.7'	167° 00.7'	7/31/92	5.86	

Russian scientists. Provideniya was left on 19 September and recovery of first mooring was done on the 20th. Samplings and mooring recoveries were completed by 5 October and Dutch Harbor was reached on 9 October.

All of the originally planned objectives and ancillary sampling programs were attained. A total of 108 CTDF stations were occupied with samples for DO, nutrients, oxygen isotopes, and dissolved barium taken at most of these stations. The general cruise track is shown in Figure 1 and a complete listing of station locations and activities is given in Appendix I. With the exception of the Russian mooring, all planned mooring recoveries and deployments were successfully made. Preliminary inspection of the data records from the five UA moorings, which are funded through MMS, indicate a nearly 100% data return.

A detailed description of the cruise, including the participating scientists, the cruise track, station and mooring locations, and a daily narrative of events is attached as Appendix I. This appendix is included as it is, because it is the cruise report required by and submitted to the U.S. Department of State and Russian Foreign Ministry Office under the conditions of the R/V *Alpha Helix'* clearance to operate in the Russian EEZ. Appendix II contains a preliminary report describing the marine mammal and bird surveys made by J. C. George of the Department of Wildlife Management, North Slope Borough.

PARTICIPANTS

Oshoro Maru

Dr. W. E. Barber	University of Alaska Fairbanks
Ms. P. Croom	University of Alaska Fairbanks
Dr. H. Miyake (cruise leader)	Hokkaido University
Dr. Y. Sakurai	Hokkaido University

Alpha Helix

T. J. Weingartner(chief scientist)	UAF
Y. Sasaki (co-chief scientist)	Japan Marine Science Technology Center (JAMSTEC)
Sergey Barshanov	Representing the Chief of Naval Administration for Navigation and Oceanography, Russia
Clark Darnell	National Oceanographic and Atmospheric Administration, Pacific Marine Environmental Laboratory, USA
John Craig George	North Slope Borough, Alaska
Kiyoshi Hatakeyama	JAMSTEC, Japan
Haruo Ishii	JAMSTEC, Japan
Nobori Koyama	JAMSTEC, Japan
Mikhail Kulakov	Arctic and Antarctic Research Institute (AARI), Russia
Hideomi Nakamura	JAMSTEC, Japan
Toru Nakamura	JAMSTEC, Japan
Vladimir Pavlov	AARI
John Smithhiusler	UAF, USA

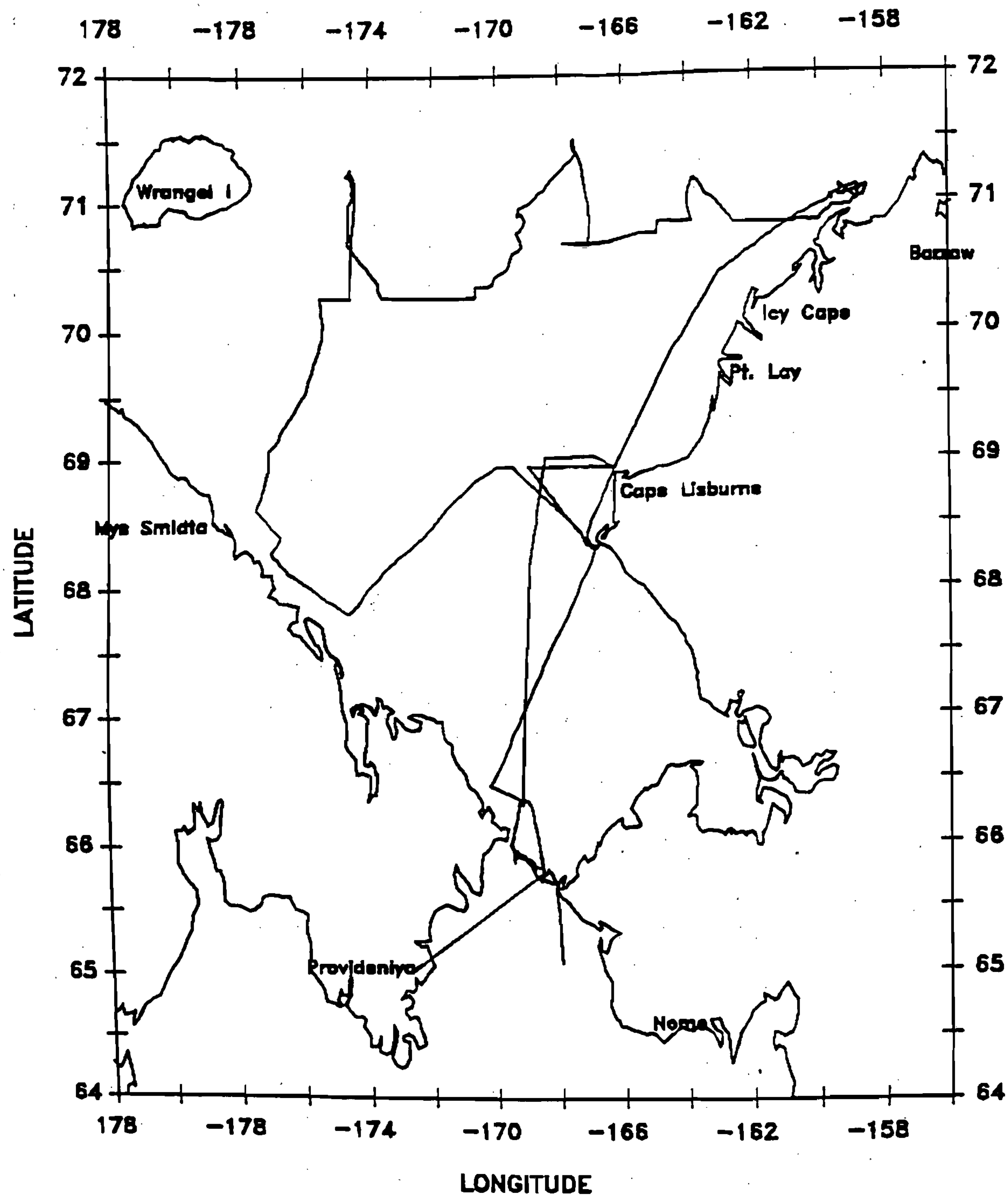

Figure 1. Track of *Alpha Helix* during the physical oceanographic cruise of September and October 1992.

APPENDIX I

Japanese/Russian/American Chukchi Sea Circulation Study

Alpha Helix Cruise #166 (HX166)
September 16 - October 8, 1992

U.S. Department of State Reference:
Cruise No. 92-024, R/V *Alpha Hellx*, 9/16-10/8/92

Funding Sources:
Japan Marine Science and Technology Center (JAMSTEC)
United States Dept. Interior, Minerals Management Service

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Science Party:

Sergey Barshanov	Representing the Chief of Naval Administration for Navigation and Oceanography, Russia
Clark Darnell	National Oceanographic and Atmospheric Administration, Pacific Marine Environmental Laboratory, USA
John Craig George	North Slope Borough, Alaska
Kiyoshi Hatakeyama	JAMSTEC, Japan
Haruo Ishii	JAMSTEC, Japan
Nobori Koyama	JAMSTEC, Japan
Mikhail Kulakov	Arctic and Antarctic research Institute (AARI), Russia
Hideomi Nakamura	JAMSTEC, Japan
Toru Nakamura	JAMSTEC, Japan
Vladimir Pavlov	Arctic and Antarctic Research Institute (AARI), Russia
John Smithhisler	UAF, USA

SCIENTIFIC PURPOSE

The northward flow of Pacific Ocean water through the Bering Strait and the Chukchi Sea exerts a profound influence on the regional oceanography and the Arctic Ocean. This throughflow is modified by physical and biological processes occurring on the Chukchi Sea shelf.

Both the throughflow and the modification processes are characterized by large temporal variability occurring at time scales ranging from the synoptic to the interdecadal. Such variability needs to be understood because these processes have broad implications on global climate as well as regional ecosystem dynamics. The objective of the Japanese/Russian/American 1992 Chukchi Sea cruise is to understand better ocean and ice circulation and sea-ice and water mass properties. In addition to these studies, the North Slope Borough, headquartered in Barrow, Alaska sent a marine mammal observer, Mr. J. C. George, to document the distribution of these animals in relation to oceanographic and sea-ice features.

Data collected during this cruise included: Conductivity temperature-depth-fluorometry (CTDF) profiles, surface and bottom nutrient, oxygen isotope, and barium samples, dissolved oxygen at selected stations (see Table 1). The CTDF data were supplemented by expendable bathythermograph (XBT) profiles at selected stations in the USA EEZ. In addition, moored current meters were recovered at locations indicated in Table 2 and deployed at locations shown in Table 3. Throughout the cruise meteorological parameters (wind velocity, humidity, pressure, temperature), sea surface temperature and salinity, and current velocity (obtained using an Acoustic Doppler Current Profiler [ADCP]) were obtained along the cruise track (Figure 1). Marine mammal observations were made along this track as well. Scientists were deployed on the ice at several locations in order to obtain sea-ice samples and measure ice-drift rates and estimate the wind-stress. The locations of these stations and the activities conducted there are shown in Table 4.

Table 1.—HX166 CTDF Station list.

CS#	Name	Date 1992	Time (GMT)	Latitude N	Longitude W<0	Depth m	02	Ba	018	Nuts
1	SA2	09-21	02:57	65.78	-168.61	50	X	X	X	X
2	A10	09-21	05:10	65.68	-168.18	25	X			
3	A9	09-21	05:40	65.69	-168.32	48	X		X	X
4	A8	09-21	06:25	65.71	-168.47	49	X		X	X
5	A7	09-21	07:10	65.73	-168.62	51	X		X	X
6	A6	09-21	07:58	65.74	-168.75	51	X		X	X
7	A5	09-21	08:54	65.76	-168.87	45	X	X	X	X
8	A4	09-21	10:13	65.87	-169.12	44	X	X	X	X
9	A3	09-21	11:19	65.90	-169.31	46	X	X	X	X
10	A2	09-21	12:35	65.94	-169.49	50	X	X	X	X
11	A1	09-21	13:29	65.99	-169.64	49	X	X	X	X
12	E-MOOR	09-23	02:01	65.02	-166.96	NR	X			
13	C16	09-23	03:35	68.94	-166.33	27	X	X	X	X
14	C15	09-23	05:01	68.94	-166.99	44	X	X	X	X
15	C14	09-23	06:11	68.94	-167.49	45	X	X	X	X
16	C13	09-23	07:21	68.94	-167.99	48	X	X	X	X
17	C12	09-23	08:31	68.94	-167.49	50	X	X	X	X
18	C11	09-23	09:41	68.94	-168.99	52	X	X	X	X
19	B92	09-24	19:08	71.02	-159.57	73	X	X	X	X
20	PF1	09-24	21:46	71.11	-159.34	84	X			

Table 1. continued

CS#	Name	Date 1992	Time (GMT)	Latitude N	Longitude W‹0	Depth m	02	Ba	018	Nuts
21	PF2	09-24	22:12	71.10	-159.30	81				
22	PF3	09-24	22:42	71.09	-159.25	81	X	X	X	X
23	PF4	09-24	23:15	71.08	-159.20	86				
24	PF5	09-24	23:38	71.08	-159.16	78	X	X	X	X
25	PF6	09-25	00:12	71.07	-159.11	65				
26	PF7	09-25	00:33	71.06	-159.06	61	X	X	X	X
27	PF8	09-25	00:59	71.05	-159.02	51				
28	PF9	09-25	01:19	71.04	-158.97	45	X	X	X	X
29	PF10	09-25	01:43	71.02	-158.92	35				
30	PF11	09-25	02:00	71.01	-158.88	30	X	X	X	X
31	PF12	09-25	02:21	71.00	-158.85	28				
32	PF13	09-25	02:40	70.98	-158.82	25	X	X	X	X
33	FW1	09-26	04:07	70.95	-159.24	32	X	X	X	X
34	FW2	09-26	05:03	70.95	-159.57	53	X	X	X	X
35	FW3	09-26	06:45	70.83	-160.00	44	X	X	X	X
36	FW4	09-26	08:26	70.83	-160.51	50	X	X	X	X
37	FW5	09-26	10:03	70.82	-161.02	44	X	X	X	X
38	FW6	09-26	11:34	70.82	-161.52	43	X	X	X	X
39	FW7	09-26	13:01	70.82	-162.04	41	X	X	X	X
40	FW8	09-26	14:42	70.82	-162.55	42	X	X	X	X
41	FW9	09-27	03:53	70.83	-163.84	43	X	X	X	X
42	FW10	09-27	05:58	70.84	-164.86	36	X	X	X	X
43	FW11	09-27	09:04	70.72	-165.83	40	X	X	X	X
44	FW12	09-27	11:55	70.67	-166.84	46	X	X	X	X
45	FW13	09-27	14:42	70.66	-167.85	47	X	X	X	X
46	C-MOOR	09-27	17:11	70.66	-167.03	49	X	X	X	X
47	FW14	09-28	22:38	71.00	-168.83	42	X	X	X	X
48	FW14	09-28	22:42	71.00	-168.83	42	X	X	X	X
49	FW15	09-29	01:24	70.43	-169.24	31	X	X	X	X
50	FW16	09-29	04:08	70.46	-169.69	31	X	X	X	X
51	FW17	09-29	06:30	70.33	-170.62	27	X	X	X	X
52	DKTEST	09-29	06:51	70.00	-170.00	DECK				
53	FW18	09-29	09:55	70.25	-171.57	35	X	X	X	X
54	FW19	09-29	12:50	70.25	-172.57	40	X	X	X	X
55	FW20	09-29	15:47	70.25	-173.56	45	X	X	X	X
56	HV1	10-01	23:21	71.08	-174.49	71	X	X	X	X
57	HV2	10-01	00:13	71.00	-174.39	66	X	X	X	X
58	HV3	10-01	00:54	70.92	-174.43	68	X	X	X	X
59	HV4	10-01	01:37	70.83	-174.44	63	X	X	X	X
60	HV5	10-01	02:30	70.75	-174.48	60	X	X	X	X
61	HV6	10-01	03:31	70.66	-174.50	56	X	X	X	X
62	HV7	10-01	04:15	70.58	-174.52	54	X	X	X	X
63	HV8	10-01	04:58	70.50	-174:52	52	X	X	X	X

Table 1. continued

CS#	Name	Date 1992	Time (GMT)	Latitude N	Longitude W‹0	Depth m	02	Ba	018	Nuts
64	HV9	10-01	05:40	70.42	-174.55	52	X			
65	HV10	10-01	06:19	70.33	-174.56	52	X	X	X	X
66	FW21	10-01	07:08	70.25	-174.57	51	X	X	X	X
67	FW22	10-01	08:48	70.25	-175.08	51	X	X	X	X
68	FW23	10-01	10:09	70.25	-175.48	57	X	X	X	X
69	MS7	10-01	12:52	69.92	-175.43	56	X	X	X	X
70	MS6	10-01	16:07	69.53	-175.93	52	X	X	X	X
71	MS5	10-01	17:54	69.32	-176.43	51	X	X	X	X
72	MS4	10-01	19:44	69.10	-176.92	48	X	X	X	X
73	MS3	10-01	21:03	68.94	-177.07	49	X	X	X	X
74	MS2	10-01	22:13	68.78	-177.21	49	X	X	X	X
75	MS1	10-01	23:30	68.62	-177.43	42	X	X	X	X
76	C1	10-02	09:16	67.79	-174.60	40	X	X	X	X
77	C2	10-02	10:27	67.89	-174.22	45	X	X	X	X
78	C3	10-02	11:26	67.99	-173.99	46	X	X	X	X
79	C4	10-02	12:43	68.10	-173.60	48	X	X	X	X
80	C5	10-02	13:58	68.20	-173.20	47	X	X	X	X
81	C6	10-02	16:38	68.41	-172.25	50	X	X	X	X
82	C7	10-02	18:39	68.61	-171.60	53	X	X	X	X
83	C8	10-02	21:06	68.82	-170.71	53	X	X	X	X
84	C9	10-02	23:03	68.94	-169.99	53	X	X	X	X
85	C10	10-03	00:18	68.94	-169.49	53	X	X	X	X
86	PH1	10-03	02:05	68.78	-168.86	51	X			
87	PH2	10-03	03:58	68.63	-168.17	50	X			
88	PH3	10-03	05:44	68.48	-167.55	48	X			
89	B9	10-03	07:50	68.32	-166.87	28	X	X	X	X
90	B8	10-03	08:48	68.19	-167.04	42	X			
91	B7	10-03	09:58	68.05	-167.33	50	X			
92	B6	10-03	11:48	67.79	-167.75	52	X			
93	B5	10-03	13:40	67.55	-168.25	46	X			
94	B4	10-03	15:29	67.31	-168.67	46	X			
95	B3	10-03	17:26	67.05	-169.14	47	X			
96	B2	10-03	18:53	66.87	-169.49	46	X			
97	B1	10-03	20:29	66.65	-169.83	45	X	X	X	X
98	B0	10-03	21:50	66.48	-170.17	43	X	X	X	X
99	A1	10-04	13:04	65.99	-169.63	47				
100	A2	10-04	13:36	65.94	-169.48	50				
101	A3	10-04	14:09	65.90	-169.31	46				
102	A4	10-04	14:45	65.87	-169.12	45				
103	A5	10-04	15:59	65.76	-168.87	46				
104	A6	10-04	16:26	65.74	-168.75	51				
105	A7	10-04	16:53	65.73	-168.61	49				
106	A8	10-04	17:21	65.71	-168.47	50				

Table 1. continued

CS#	Name	Date 1992	Time (GMT)	Latitude N	Longitude W‹0	Depth m	02	Ba	018	Nuts
107	A9	10-04	17:50	65.69	-168.32	49				
108	A10	10-04	18:17	65.68	-168.18	20				

Table 2.—Current Meter Moorings Recovered.

Name	Date 1992	Latitude N	Longitude W‹0
SA2	9/20	65°46.55'	-168°36.17'
SA3	9/21	66°17.68'	-168°58.73'
D	9/22	69° 0.74'	-168°29.36'
E	9/22	69° 1.02'	-166°57.52'
C	9/27	70°39.67'	-167° 1.64'
R	NOT RECOVERED (See Narrative for 9/2 and 10/4)		

Table 3.—Current Meter Moorings Deployed.

Name	Date 1992	Latitude N	Longitude W‹0	Equipment
A1-92	9/21	65°54.62'	-169° 26.08'	NOAA/PMEL
A2-92	9/21	65°46.51'	-168° 36.14'	NOAA/PMEL
A3-92	9/22	68° 9.97'	-168° 58.48'	NOAA/PMEL
B92	9/24	71° 1.82'	-159° 34.02'	UAF
JAMSTEC	9/24	71° 1.33'	-159° 34.03'	JAMSTEC

NOAA/PMELMoorings consistent of 1 Seabird temperature/conductivity recorder, 1 Aanderaa RCM4 current meter, and 1 Seabird pressure gauge, and 1 Applied Physics Lab-Upward Looking Sonar (APL-ULS).

UAF mooring consists of 3 Aanderaa RCM4 current meters, 2 Seabird temperature/salinity recorders and 1 APL-ULS.

JAMSTEC mooring consists of 1 600 kHz DRI ADCP w/ice-tracker.

Table 4.—Sea-ice stations and activities.

Date 1992	Latitude N	Longitude W	Activity
9/25	71° 4.73'	158° 43.33'	Wind-stress, albedo measurements,
9/27-28	71° 27.10'	167° 33.60'	ice sampling, sub-ice current measurements
9/29	71° 22.0'	174° 32.8'	Albedo measurements

Finally, the recent international concern pertaining to radioactive contamination of the Arctic Ocean waters, due to both American and Russian sources, prompted a request from the US Dept. of Energy to collect a small set of seawater samples for analysis of radioactive wastes. This request was made while the vessel was already at sea. Because these samples were not planned for only a few sample bottles were on board the ship, hence only a few samples could be obtained. Prior to collecting any samples in the Russian EEZ, the Chief Scientist obtained permission to do so from Sergei Barshanov. The sites of these samples are shown in Table 5.

Table 5.—Stations sampled for radioactivity.

CS#	Name	Date 1992	Time (GMT)	Latitude N	Longitude W<0	Sample Depths m
30	PF 11	09-25	02:00	71.01	-158.88	2
42	FW 10	09-27	05:58	70.84	-164.86	10
49	FW 15	09-29	01:24	70.43	-169.24	4
73	MS 3	10-01	21:03	68.94	-177.07	18, 43
74	MS 2	10-01	22:13	68.78	-177.21	22, 47
75	MS 1	10-01	23:30	68.62	-177.43	24, 33
89	B 9	10-03	07:50	68.32	-166.87	28, 8
90	B 8	10-03	08:48	68.19	-167.04	6
98	B 0	10-03	21:50	66.48	-170.17	10, 27

Schedule for submittance data to the Russian Foreign Ministry Office*

CTDF data (floppy disk)	included
Marine animal observation (report)	included
Sea-ice albedo measurements (report)	included
Dissolved nutrients, oxygen-isotope, dissolved oxygen, and dissolved barium	November 1994
Radioactivity samples	November 1994
ADCP data	November 1994

Underway measurements of meteorology, sea surface temperature and salinity | November 1994

*Separate copies of these data have been and will be sent to Drs. Pavlov and Kulakov of AARI. Both received disks containing all of the CTD data prior to leaving the ship.

Narrative (All times and dates are AST):

9/14 Dutch Harbor:

Unload from HX165 and load for HX166. Weingartner, Sasaki, Hatakeyama, H. Nakamura, Koyama, T. Nakamura arrive Dutch Harbor. Telex from Russia informs us that we must embark Sergei Barshanov at Provideniya. Mr. Barshanov represents the Chief of Naval Administration for Navigation and Oceanography. Telex indicates that failure to do so will prevent us from working in the Russian EEZ in spite of our clearance to do so. We are somewhat anxious about this information because our ship time is at a premium and we are hoping that Barshanov's arrival in Provideniya is not delayed.

9/15 Dutch Harbor:

George and Darnell arrive. All gear is secured and science Partv PrePares instrumentation.

9/16 - 9/19 Dutch Harbor - Provideniya:

Rough passage to Provideniya. Ship arrives Provideniya Roads at 1230 (AST) and stands by to receive pilot boat and the Russian party. Pilot boat arrives and we are informed that we must tie up at coal dock, clear customs, and be inspected. This requirement was contrary to our plans as we had anticipated embarking the Russian scientific party from the pilot boat. This procedure was to have been arranged by Dr. Pavlov of AARI. Similar arrangements had occurred in 1991 during the NOAA ship Surveyor's research cruise to the Chukchi Sea. No personnel disembarked during the several hours we were in Provideniya. Our departure from Provideniya was delayed upon discovering that cooling water was leaking into the crankcase of the main engine. Chief Engineer Menzel was able to make the necessary repairs. Payment to the various Russian agencies for pilotage, customs, and inspections amounted to $957.00 - an unexpected and unbudgeted expense. However, S. Barshanov, M. Kulakov, and V. Pavlov arrived as scheduled. We departed Provideniya about midnight of the 19th.

9/20 Bering Strait:

Recovered mooring SA2 at 1745. Weather conditions too rough to permit re-deployment. Commenced East-West CTD survey of Bering Strait (A-stations).

9/21 Bering Strait:

Completed CTD survey by 0530. Deployed A1-92 in western Bering Strait and A2-92 in eastern Bering Strait. Sailed north to SA3 and recovered. Attempted recovery of the AARI (R-mooring) at about 1700. The mooring apparently did not release after transmission of the release signal. Attempted several times. However, the listed position of the R-mooring (based upon TRANSIT satellite) did not agree w/ radar range and bearing information. Both of these were provided by Dr. Pavlov. We therefore decided to try several sites from which to send the release signal. Negative results. On the chance that the mooring was released but not observed we established a parallel visual search pattern in the area. Negative results but we felt that the mooring never released. Search suspended at 2130 due to failing light. We decided that we would attempt a search and dragging operation of the area later in the cruise before returning to Provideniya. Moreover, we might have a better chance of finding the mooring after 9/26 because, according to Drs. Pavlov and Kulakov, pingers associated with this mooring are scheduled to be self-actuated by this date. Steamed toward deployment position of A3-02. JAMSTEC personnel taking XBTs every 20 miles.

9/22-9/23 Lisburne Peninsula:

Deployed A3-92 at 0900. Steamed toward D mooring offshore of Cape Lisburne. XBT survey continues at 20 mile intervals. Recovered moorings D and E. Commenced CTD survey along C-Line. Suspended CTD operations at 0142 and made way for Pt. Hope. Arrived Pt. Hope at 0800 and debarked Steve Hartz and Clark Darnell. Set sail for Pt. Franklin vicinity and deployment of the JAMSTEC and B92 moorings.

9/24 NW of Pt. Franklin:

Ran bathymetric survey in deployment area. Deployed B92 and JAMSTEC moorings. Approximately 50% ice coverage w/in 2 mile radius of ship. Ice conditions range from rotting first year floes to frazil, grease, and small pancake ice. Very complex ice distribution, however, ice free conditions observed between mooring sites and the coast - w/in the Alaska Coastal Current. Conducted CTD survey (PF line) between ice edge and coast. Stations at 1 mile intervals - reveals structure of the ACC in this vicinity. Hove to in ice throughout the night so that JAMSTEC personnel could begin ice studies in the morning.

9/25 71°4'N 158°43.33'W:

Coolant leak occurs again in different cylinder & Chief Menzel repairs. JAMSTEC personnel deploy on ice and make wind, radiation, current and sea-ice property measurements. Begin steaming westward in evening taking CTD stations every 10 miles (the FW for Franklin-Wrangel Line). We attempted to run this line straight west along the southern limit of the ice-edge but were forced to detour as much as 8 miles south to avoid protruding tongues of ice.

9/26 71°11.6'N 163°44.8'W:

CTDs until daylight. Ship enters ice to find suitable conditions for JAMSTEC ice studies. Ice studies conducted from 1030 to 1800. Commenced CTD surveys along FW line - station spacing increased to 20 miles. XBTs at 10 miles. Angled line southward to 70° 40' N so as to intercept position of C mooring at daybreak.

9/27:

Recovered C-mooring at daylight and turned northward towards ice to continue ice studies. Ice studies from 1445 to 1015 the following morning.

9/28-29:

Continued CTDs along FW line. Slanting southwest to parallel ice pack. Entered Herald Sea Valley (Canyon) about noon. Deployed solar radiation measurement on sea-ice at 1500. Curious polar bear necessitated evacuating ice.

9/30:

Tried solar radiation measurements again at other ice floes but thwarted by large numbers of polar bears. Craig George observed 10 different bears this day. Eventually radiation measurements were successful. Left ice and headed southward doing CTDs at 5 mile intervals until intersecting FW line. Turned westward and continued CTDs.

10/1:

Halted FW line due to impenetrable sea-ice. Due to a lack of time we decided to abandon the Long Strait CTD survey and instead headed south toward Mys Smidta (MS-line). Station separation was meant to be 10 -20 miles but a tired chief scientist gave wrong position to bridge which resulted in a less than straight transect. Completed MS line by mid-afternoon and turned southeast to rendezvous w/ beginning of C line. Craig George observed large numbers of bowhead whales within 20 miles of the coast (~ 70 between 1430 and 2100).

10/2:

CTDs along C-line as far as C-10. Occupied PH 1 - 3 en route to station B9 (south of Pt. Hope).

10/3-4:

CTDs along B-line. Began search for AARI ("R" mooring) at 1650 under clear, sunny skies and calm conditions. We tried listening for the AARI 20 kHz pingers w/ UAF acoustic release deck gear. Smithhisler could not hear anything but both Drs. Kulakov and Pavlov were certain they heard the pingers. Moreover, they felt the signal strength was greatest at the Range and Bearing position than at their TRANSIT satellite position. I also learned from Dr. Pavlov that strong northeast winds were blowing during the deployment of this mooring in fall 1991. SATNAV position was obtained after the first anchor hit bottom but Pavlov felt that the wind dragged the ship 2 miles to the southwest before the second anchor was lowered. By this time insufficient satellites were available for adequately resolving the position and the mooring was deployed after obtain a range and bearing from Cape Uiqven. Release commands were sent repeatedly to this mooring but nothing was observed. Therefore a dragging operation was begun under the direction of John Smithhisler. Dragging efforts were centered on the position where Drs. Kulakov and Pavlov felt the pinger signal was strongest. Dr. Pavlov suspended the dragging operation at 0230 on 10/4 after concluding that he had insufficient positioning information to succeed at dragging.

After securing the deck, the A-line was re-occupied for CTDs. At the conclusion of this CTD line the ship science activities ended and the ship set course for Provideniya.

10/5:

Severe gale 55 kts (gusting to 70) from south prevented us from attaining Provideniya on this date as originally planned. We were forced to seek shelter in a small bay NW of Anadyr Strait until the winds abated.

10/6:

Entered Provideniya at about 1400 and transferred Barshanov, Pavlov and Kulakov to the pilot boat. Set course for Dutch Harbor and arrived there on 10/9.

SHIP PROBLEMS ENCOUNTERED

Overall, the problems encountered with ship's equipment were not serious enough to impact the scientific mission. However, there are several problems that need to be addressed.

1.) The electronics lab occasionally experiences a sooty odor and soot due to problems with the ship's boiler. Not only is the smell unpleasant but the soot poses problems to the computers. I recommend that the boiler be repaired ASAP and also that a filter be installed in the vent in the electronics lab.

2.) The Bernoulli drive in the Gateway 2000 486 analysis computer seems to have failed. At least it appears to have ruined 2 of my Bernoulli disks.

3.) It is absolutely essential that the SEASURF and MET package data logging system(s) be resolved. Not only is this corner of the lab a mass of cables which constantly require Steve Hartz's attention to insure that data recording continues but running the system is not easy for the uninitiated. Moreover, ship users are not obtaining the full benefit of these systems.

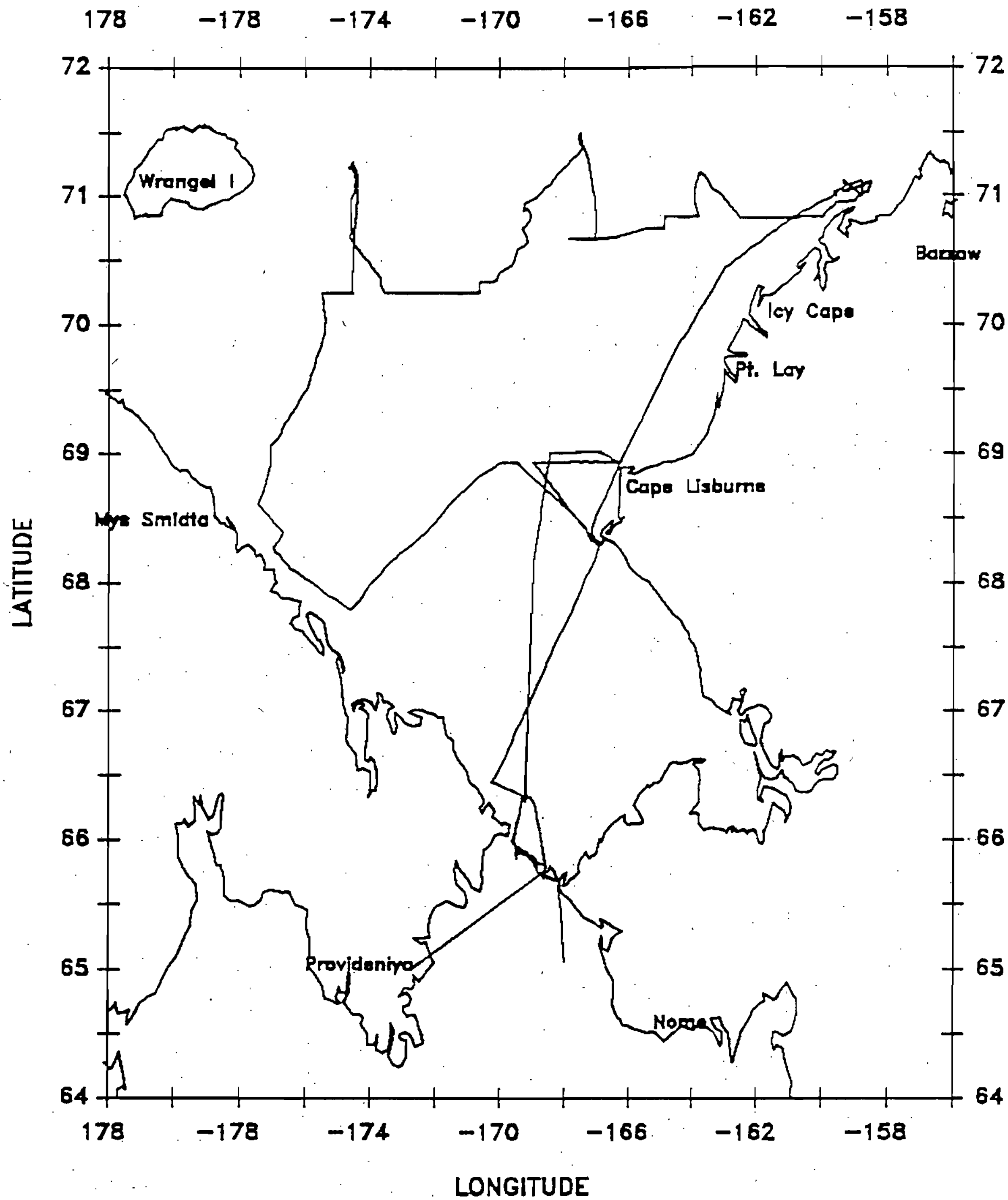
NON-SHIP PROBLEMS ENCOUNTERED

Better coordination/communication with port authorities in Provideniya is required. This seems to have been worked out by sending FAXes from the ship to Seward to Bering Air (in Nome) and onto Provideniya. However, better clarification is required from the State Department and from Russia regarding our operating requirements in Russian waters. For example the various inspections and delays in Provideniya were not expected nor was the need to embark S. Barshanov. These requirements are reasonable but, it is essential for planning purposes, that we understand them prior to the cruise. The port authorities of Provideniya were extremely courteous and helpful during our brief visit and we should obtain the necessary funds to make a formal port call in the future.

ACKNOWLEDGEMENTS

The bridge and deck crews performed superbly. Thanks to their efforts all operations were performed efficiently, safely, and enthusiastically. John Smithhisler assisted in all the mooring recovery and deployment operations and directed the search and dragging operation for the R mooring. These activities were often conducted under cold and wet conditions and, on occasion, with very little sleep. Thanks again to Clark Darnell, John Smithhisler and Kiyoshi Hatakeyama for being so well-organized during current meter operations. John "Craig" George's experience with sea-ice and polar bears proved valuable to the success of the ice sampling Program.

Chief Engineer Clifford Menzil's skill, diligence, and perseverance was crucial for repairing the main engine and thereby guaranteeing the continuation and success of the cruise.



Japanese/Russian/American 1992 Chukchi Sea Cruise; *Alpha Hellx* #166 HX166 9/20-10/4, 1992.

APPENDIX II

NORTH SLOPE BOROUGH

Department of Wildlife Management

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Benjamin P. Nageak, Director

MEMORANDUM

TO: Benjamin Nageak
THROUGH: Thomas Albert, Sr.
FROM: J.C. George, Wildlife Biologist JCG
DATE: 15 October, 1992
SUBJ.: TRIP REPORT: CRUISE OF THE R/V ALPHA HELIX (#HX-166) IN CHUKCHI SEA

(Note: Because this memo reports on sighting data, I found it more appropriate to write in standard scientific format.)

Introduction

Between 16 September and 9 October, I participated as a marine mammal observer aboard the 133 ft, 522 ton research vessel *Alpha Helix*. The cruise was a "multi-national" research effort referred to as the "*Japanese/ Russian/ American Chukchi Sea Circulation Study*". The *Alpha Helix* is owned by the National Science Foundation (NSF) but operated by the University of Alaska.

Dr. Weingartner and his associates planned the cruise such that they would transect the major oceanographic features of the Chukchi Sea--including those in Soviet waters. My function was to document primarily marine mammal distribution on an opportunistic basic as I had no control over the cruise track. The tracks, however, did cross many areas to logically expect to see bowhead whales which was one of the main objectives (Figure 1a). The major objectives of the cruise were:

1) To better document the major ocean and ice circulation properties of the Chukchi Sea (through measurements of temperature, salinity, chlorophyll, dissolved oxygen)
2) To conduct detailed sea ice experiments,
3) To opportunistically document marine mammals occurrence and distribution, and,
4) To collect water samples for assessment of radioactive waste.

These researchers' scientific interest in the Chukchi Sea is based on evidence that suggests that the northward Pacific water flow through the Bering Strait exerts a "profound influence on the regional oceanography of the Arctic Ocean" in Dr. Weingartner's words, which has "broad effects on global climate." Bering Sea currents also carry nutrients north, and this through-flow in part contributes to the comparatively higher productivity of the Chukchi Sea relative to the Beaufort Sea.

Methods

I made observations from the bridge during daylight hours and recorded the species, time, GPS location, watch effort and visibility for each sighting. Observations were made from the ship's bridge which is about 7 m above sea level. Only whales that were seen at close range (<2 km) were identified; none were identified by "blow type". Locations reflect the ships location at the time of sighting. Only whale and polar bear sightings were recorded in every case. Not all seals and walrus were counted or recorded (whales were given priority). I was the primary observer but the ship's crew were keen observers and made many of the initial sightings.

Results and Discussion

From 16 September to 9 October, we conducted a total of 166.2 hrs of watch from the ship's bridge. Essentially all the observational effort was with two or more observers. Visibility varied but was generally adequate in the waters north of the Bering Strait. Table 1 lists the (estimated) numbers of marine mammals seen:

Table 1.—Total numbers of marine mammals recorded during cruise HX-166.

Species	Bowhead whale	Gray whale	Walrus	Bearded seal	Ringed seal	Polar bear	Fin whale**	Spotted seal	Minke whale**
Totals	82 *	125	173	34	95	14	3	2+ ?	1

*= includes 6 questionable sightings
**= seen in the Bering Sea
?= unsure of identification

Whale Sightings

Gray whales. Gray whales were most common cetaceans seen. They were most abundant in the Bering Strait region and the Eastern Chukchi Sea coast north to Point Franklin. We may have seen a few distant bowheads in the Straits but only the blow was seen and we therefore could not confirm the species. From Pt. Franklin we headed west along the ice front to Herald Island and did not see any additional gray whales until we returned to the Bering Strait area.

Bowhead whales. From Herald Island, we turned south to the Chukotka Peninsula (Eastern Siberia) making landfall near Cape Vankarem. Once along the Siberian coast, bowheads were frequent beginning at the 55 m isobath about 20 nm offshore and all the way in to the coast (Fig. 1b). We traversed about 60 nm of coast spotting about 84 bowheads in the process. All appeared to be feeding as their swim direction was random. I would guess that at least several hundred whales were within the 60 nm strip of coast we surveyed from 177° 18'W to 176° 19'W. Unfortunately, our transect line then led east, away from shore, and did not see any more bowheads. Based on these findings and what I've gleaned from the scientific literature, I have the following observations and thoughts:

1) Bowhead whales were present, probably in considerable numbers, along the Siberian coast by at least 1 October--a time when many are still passing Barter Island. Thus, bowheads were distributed across a major portion of the Beaufort and Chukchi Seas by this date. This wide distribution lends some independent confirmation to the current population estimate (7,500 whales) considering the tremendous area they are spread over.

2) Because the Chukchi Sea is considerably more productive than the Beaufort Sea, it may be that the north shore of the Chukotka Peninsula is a major feeding area. Miller et al. (1986) reported seeing over 200 bowheads in this area during 1979 and 1980 cruises. It may be that bowhead whales are picking up the "Bering Sea signal" in their baleen, as described by Dr. Schell, in this region. Furthermore, such extensive feeding may explain the disagreement between Lloyd Lowry and Don Schell over the importance of winter Bering Sea feeding for this stock.

3) I expected to see bowheads between Pt. Franklin and the Siberian coast, but we saw none. Although little is known about this leg of their migratory route, Moore and Clarke (1992) suggest that most bowheads swim SW from Pt. Barrow and therefore our transect line should have crossed their path. Moore and Clarke (1992) also have data to suggest that bowheads travel due west from Pt. Barrow north of the 71st parallel. These authors report only a few sightings in the northerly transects but feel that may be due to poor visibility caused by sea ice and high sea states. Of course, bowheads may have traveled SW from Pt. Barrow but we simply did not see them--although this seems unlikely because of the relatively large survey effort in those waters. I also expected (but didn't) see bowheads near Herald Island where they were reported in October 1979 by Miller *et al.*(1986) and were historically hunted by Yankee whalers during October (1800's).

4) Should censusing bowhead whales during the fall migration ever become a research consideration, Cape Dezhneva, Siberia, with its high coastal bluffs (ca 2,500 ft), appeared to be a good location.

Other Marine Mammal and Bird Sightings

Although documenting whale distribution took priority, I attempted to document the distribution of other marine mammal and birds. A brief summary follows:

- Seals were common along most of the transect with higher concentrations near the sea ice.

- Walrus were associated with the ice front but a few were seen in open water. Most appeared to be females and many had calves--particularly in the region 71° N 163° W.

- Polar bears were also associated with the ice front but were most numerous near Herald Island where nearly every large floe had bears on it. In one instance, we spotted a large polar bear that had killed a walrus calf at 70°28' N, 169° 39' W.

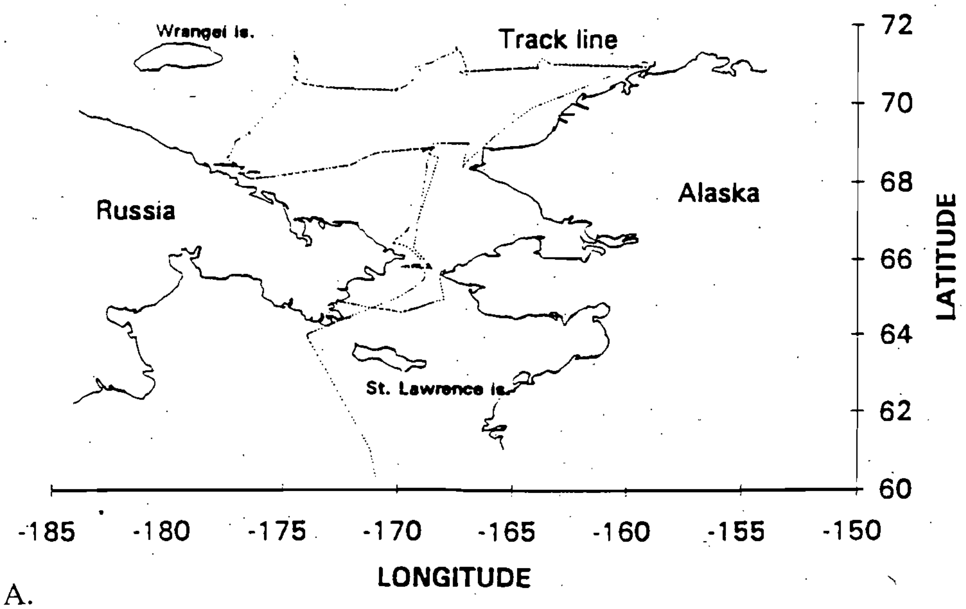
- We noted huge concentrations of Shearwaters (probably > 10,000) in the Bering Strait area. Ross' and Ivory gulls, Black-footed Kittiwakes and Crested auklets were associated with the ice front. Black guillemots were fairly numerous near Herald Island. Two Snowy owls were seen perch on ice floes along the ice front (at 70° 55' N, 164° 54' W and 71° 13' N, 174° 37' W), which is a considerable distance from shore. We found a dead Yellow-crowned sparrow aboard the ship near Herald Island.

Additional Comments:

Aside from documenting the wildlife, I learned a great deal about the operations aboard a major research vessel. I found the interaction with the Japanese and Russian scientists to be quite interesting. The Russian scientists the most familiar with the Western Chukchi Sea having conducted research there for over 20 years. The Japanese scientists seem to be quite committed to conducting Arctic research and are currently interested in modeling sea ice movements, remote sensing of sea ice and monitoring the effects of the Arctic Ocean on global climate change. The Japanese scientists were associated with the Japanese Marine Science and Technology Center (JAMSTEC), which is a highly sophisticated oceanographic institute which conducts research around the world.

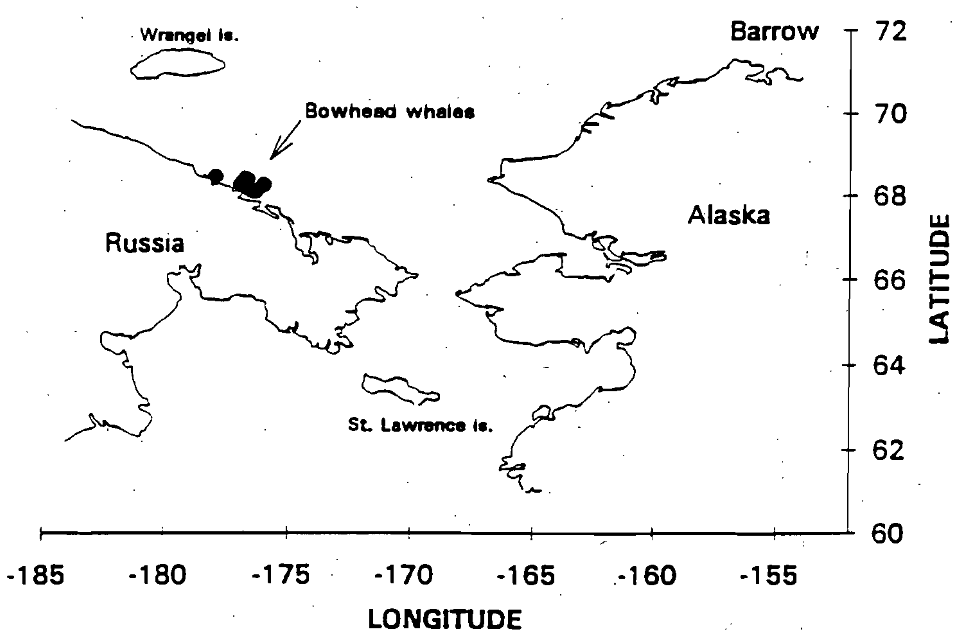
Another cruise is planned for Fall 1993 and there may again be a slot available for a biologist. We may want to request a place for a Department observer on next year's cruise depending on our research priorities.

cc: Mike Philo
Robert Suydam
Tom Weingartner



Wrangel Is.
Track line
Russia
Alaska
St. Lawrence Is.
72
70
68
66
64
62
60
LATITUDE
-185
-180
-175
-170
-165
-160
-155
-150
LONGITUDE

1A.



Wrangel Is.
Barrow
Bowhead whales
Russia
Alaska
St. Lawrence Is.
72
70
68
66
64
62
60
LATITUDE
-185
-180
-175
-170
-165
-160
-155
LONGITUDE

1B.

HX-166 CRUISE DATA
FILE: JCGSITE.XLS SUMMARY TOTALS

BM 82	PH 95	OR 173
ER 125	UM14	MINK 1
EB 34	FIN 3	

Sighting Codes:
OR = walrus; ER = gray whale; BM = bowhead whale; PH = ring seal; EB = bearded seal; UM = polar bear.
Note: bird codes are labeled in comments.

	Date	SF	VIS	HR	SEC	LAT	MN	LONG	MN	#	SPC	COMMENTS
1	16-Sep-92	S	F	9	57	54	27.80	166	39.80	6	DOPO	DALLS PORPOISES
2	16-Sep-92		F	10	13	54	27.40	166	41.70	3	DOPO	DALLS PORPOISES
3	16-Sep-92		G	10	28	54	29.50	166	43.10	12	DOPO	DALLS PORPOISES
4	16-Sep-92		G	10	52	54	33.50	166	44.90	12	DOPO	DALLS PORPOISES
5	16-Sep-92		G	14	50	54	8.00	167	10.00	2	FUSE	FUR SEAL
6	16-Sep-92		G	16	43	54	27.70	167	23.10	1	FUSE	FUR SEAL
7	16-Sep-92		G	16	50	54	29.50	167	24.00	1	FUSE	FUR SEAL
8	16-Sep-92	F	G	17	30							
9	16-Sep-92	S	G	18	0							
10	16-Sep-92		G	18	13	55	43.30	167	32.10	1	FUSE	FUR SEAL
11	16-Sep-92		G	19	35	55	57.30	167	36.70	1	FUSE	FUR SEAL
12	16-Sep-92	F	G	20	30							
13	17-Sep-92	S	P	9	0							
14	17-Sep-92	F	P	9	30	54	14.70	169	2.20	1	POJA	POMERINE JAEGER
15	18-Sep-92	S	P	12	0							
16	18-Sep-92		P	13	30	60	58.70	171	8.00	100	SHER	SHEARWATER
17	18-Sep-92	F	P	14	0							
18	18-Sep-92	S	P	19	0							
19	18-Sep-92	F	P	21	30							
20	19-Sep-92	S	F	9	0	63	48.30	173	48.50	3	WHAL	UNSURE
21	19-Sep-92		G	9	30	63	53.60	173	53.50	2	ER	GRAY WHALE?
22	19-Sep-92		G	10	0	63	55.40	173	55.30	1	ER	
23	19-Sep-92		G	10	5	63	56.00	173	55.00	2	ER	
24	19-Sep-92		G	10	15	63	58.10	173	57.30	3	ER	
25	19-Sep-92		VG	10	30	64	1.00	173	57.00	1	FIN	FIN WHALE
26	19-Sep-92		VG	10	30	64	2.00	173	57.00	2	FIN	
27	19-Sep-92		VG	10	50	64	2.90	173	52.30	2	ER	
28	19-Sep-92		VG	11	0	64	5.00	173	46.90	1	MINKE	MINKE WHALE
29	19-Sep-92	F	VG	11	30							
30	19-Sep-92	S	VG	12	0							
31	19-Sep-92		VG	12	23	64	16.50	173	29.20	3	ER	GRAY WHALE
32	19-Sep-92		VG	12	55	64	19.90	173	25.20	2	ER	

HX-166 Cruise Data continued

	Date	SF	VIS	HR	SEC	LAT	MN	LONG	MN	#	SPC	COMMENTS
33	19-Sep-92	F	VG	13	0							PROVIDENIYA
34	20-Sep-92	S	F	8	30							
35	20-Sep-92		F	11	30	65	1.03	169	57.90	1	ER	UNCERTAIN
36	20-Sep-92		F	11	30	65	1.03	169	57.90	500	SHER	
37	20-Sep-92		F	12	30							
38	20-Sep-92		F	13	0							
39	20-Sep-92		F	13	15	65	12.50	169	29.30	1	ER	
40	20-Sep-92		F	13	35	65	14.70	169	23.50	1	ER	
41	20-Sep-92		P	13	35	65	14.70	169	23.50	1	BM	BOWHEAD; UNSURE; DISTANT SIGHTING
42	20-Sep-92		P	14	0	65	17.90	169	15.20	2	WHAL	SPECIES?
43	20-Sep-92		F	14	7	65	18.50	169	15.00	3	BM	??;UNCERTAIN
44	20-Sep-92		G	14	59	65	25.60	168	59.30	1	ER	UNCERTAIN
45	20-Sep-92		P	15	3	65	26.10	168	58.30	1	ER	
46	20-Sep-92		P	15	21	65	28.80	168	53.90	1	WHAL	SPECIES?
47	20-Sep-92		P	15	30	65	30.10	168	52.20	6	ER	
48	20-Sep-92		P	15	47	65	32.90	168	50.70	1	ER	
49	20-Sep-92		P	20	30	65	44.00	168	50.00	999	SHER	
50	20-Sep-92	F	P	21	0							
51	21-Sep-92	S	P	8	30							
52	21-Sep-92		F	9	45	65	53.50	169	19.00	999	SHER	
53	21-Sep-92		F	11	5	65	52.40	169	2.70	3	ER	
54	21-Sep-92		F	11	32	65	50.00	169	52.30	1	ER	
55	21-Sep-92	F	F	11	40							
56	21-Sep-92	S	F	13	30	65	48.00	168	36.00			TRACK LINE
57	21-Sep-92		F	14	0	65	53.30	168	38.80	2	ER	WHALES BREACHED
58	21-Sep-92	F	F	17	0							
59	21-Sep-92	S	F	18	0	66	19.00	169	20.00	2	BM	UNSURE; DISTANT
60	21-Sep-92	F	F	22	0							
61	22-Sep-92	S	F	10	0							
62	22-Sep-92		G	10	45	68	25.10	168	46.50	1	ER	
63	22-Sep-92		G	11	5	68	28.70	168	46.90	4	ARLO	ARCTIC LOON?; PACIFIC??
64	22-Sep-92	F	G	11	30							
65	22-Sep-92	S	VG	12	30							
66	22-Sep-92		E	14	12	69	0.70	168	29.10	1	EB	BEARDED SEAL
67	22-Sep-92	F	E	14	30							
68	22-Sep-92	S	E	15	35							
69	22-Sep-92	F	VG	18	0	69	1.08	166	57.50			TRACK LINE?
70	22-Sep-92	S	G	18	30							
71	22-Sep-92	F	G	21	0							

HX-166 Cruise Data continued

	Date	SF	VIS	HR	SEC	LAT	MN	LONG	MN	#	SPC	COMMENTS
72	23-Sep-92	S	G	9	0	68	24.30	167	11.50			START TRACK
73	23-Sep-92		G	10	45	68	35.40	166	55.90	2	ARLO	
74	23-Sep-92	F	G	11	45							
75	23-Sep-92	S	VG	12	30							
76	23-Sep-92		VG	13	15	68	56.40	166	17.10	1	PH	RING SEAL
77	23-Sep-92		VG	14	20	69	6.20	165	58.30			
78	23-Sep-92		VG	14	30	69	7.70	165	55.30	1	ARLO	
												MANY LOONS, MURRES, KITTIWAKES
79	23-Sep-92		VG	14	37	69	8.70	165	53.30	2	PH	
80	23-Sep-92		VG	14	40	69	9.00	165	53.00	1	EB	
81	23-Sep-92		G	14	45	69	9.70	165	51.30	3	PH	
82	23-Sep-92		G	15	0	69	11.70	165	47.20	1	PV	SPOTTED SEAL?
83	23-Sep-92		G	15	22	69	15.40	165	39.30	1	WWSC	WHITE-WINGED SCOTER
84	23-Sep-92		G	15	29	69	16.30	165	37.50	1	PH	
85	23-Sep-92	F		15	30							
86	23-Sep-92	S	F	16	0							
87	23-Sep-92		P	16	12	69	22.90	165	24.50	1	PV	SPOTTED SEAL?
88	23-Sep-92	F	P	17	0							
89	23-Sep-92	S	F	18	15							
90	23-Sep-92		P	19	51	69	55.00	164	13.20	2	OR	OR=WALRUS
91	23-Sep-92	F	P	20	0							
92	24-Sep-92	S	F	8	30	71	0.90	159	32.60	1	PH	ICE EDGE
93	24-Sep-92		F	9	0	71	2.00	159	34.20	1	UM	UM=POLAR BEAR
94	24-Sep-92		F	9	0	71	2.00	159	34.20	3	PH	
95	24-Sep-92		G	10	33	71	0.20	159	36.08	14	OR	
96	24-Sep-92		G	10	40	70	59.90	159	36.70	4	OR	
97	24-Sep-92		G	10	50	70	59.50	159	36.70	1	EB	
98	24-Sep-92		VG	10	58	71	0.70	159	33.90	3	ROGU	ROSS GULL
99	24-Sep-92		VG	11	3	71	0.70	159	33.90	1	BLKI	BLACK-LEGGED KITTIWAKE
100	24-Sep-92		VG	11	3	71	0.70	159	33.90			
101	24-Sep-92		VG	11	45	71	2.50	159	25.50	2	OR	
102	24-Sep-92	F	VG	11	46							
103	24-Sep-92	S	VG	12	15	71	4.50	159	14.50			NEW ICE 10 CM
104	24-Sep-92		VG	12	30	71	4.50	159	14.50	1	PH	
105	24-Sep-92		VG	12	57	71	5.60	159	18.80	1	EB	
106	24-Sep-92		VG	13	8	71	6.60	159	21.50	3	EB	HAULED OUT ON ICE
107	24-Sep-92	F	VG	13	15							
108	24-Sep-92	S	E	14	45							
109	24-Sep-92		E	16	0	71	3.90	159	6.80	1	OR	
110	24-Sep-92		E	16	18	71	0.00	159	0.00	1	ER	DISTANT

HX-166 Cruise Data continued

	Date	SF	VIS	HR	SEC	LAT	MN	LONG	MN	#	SPC	COMMENTS
111	24-Sep-92	F		16	30							
112	24-Sep-92	S	F	18	0							
113	24-Sep-92	F	P	18	30							
114	24-Sep-92	S	G	19	2	71	0.24	158	47.10	4	ER	
115	24-Sep-92		VG	19	34	71	6.40	158	47.10	12	OR	
												FEM. W/ YOUNG; ONE WOULDN'T FL
116	24-Sep-92		G	19	35	71	6.00	158	47.00	12	PH	MANY
117	24-Sep-92		G	19	35	71	6.00	158	47.00	6	EB	MANY
118	24-Sep-92	F	P	21	8							
119	25-Sep-92	S	G	8	30	71	4.10	158	47.20	1	UM	
120	25-Sep-92		G	10	0	71	4.10	158	47.20		GLGU	MANY GLAUCOUS GULLS, ROSS'
121	25-Sep-92	F	G	10	0	71	4.10	158	47.20		ROGU	MANY; @ ICE STATION
122	25-Sep-92	S	G	19	1	71	0.68	158	47.79	3	ER	
123	25-Sep-92		G	19	1	71	0.68	158	47.79	1	OR	PRESENT
124	25-Sep-92		G	19	1	71	0.68	158	47.79	1	PH	PRESENT
125	25-Sep-92		G	19	31	70	57.90	158	59.00	20	PH	
126	25-Sep-92		G	19	31	70	57.90	158	59.00	300	CRAU	CRESTED AUKLETS
127	25-Sep-92		G	19	31	70	57.90	158	59.00	3	ER	
128	25-Sep-92	F	P	21	0							
129	26-Sep-92	S	P	8	30	71	1.50	163	11.10			POOR VISIBILITY
130	26-Sep-92		P	9	0	71	2.90	163	24.00			ICE EDGE
131	26-Sep-92		F	9	12	71	4.30	163	26.80	6	OR	W/ YOUNG
132	26-Sep-92		F	9	15	71	5.00	163	28.30	5	OR	
133	26-Sep-92		F	9	15	71	5.00	163	28.30		ROGU	ROSS' GULLS
134	26-Sep-92	F	F	10	32	71	10.50	163	44.70			ICE RESEARCH; END TRANSECT
135	26-Sep-92	S		18	0	71	3.00	163	55.80	20	PH	
136	26-Sep-92			18	50	70	59.40	163	58.60	3	OR	
137	26-Sep-92		G	19	10	70	56.40	163	56.30	3	OR	
138	26-Sep-92		VG	19	27	70	55.70	164	54.20	1	SNOW	SNOW OWL; ICE EDGE
139	26-Sep-92	F	P	21	0	70	49.80	167	21.00	50	CRAU	CRESTED AUKLETS
140	27-Sep-92	S	F	9	0	70	44.20	167	1.00	50	BLKI	
141	27-Sep-92		G	10	59	70	57.00	167	2.10	50	ROGU	
142	27-Sep-92		G	11	0	70	57.10	167	2.10	3	OR	IN OPEN WATER
143	27-Sep-92		G	11	15	70	59.90	167	3.50	4	OR	
144	27-Sep-92	F	G	11	45	71	5.00	167	7.50			
145	27-Sep-92	S	VG	12	15	71	11.30	167	11.10	12	EI	EIDER
146	27-Sep-92		VG	12	45	71	16.30	167	14.70	2	EB	
147	27-Sep-92		VG	13	0	71	17.00	167	15.00	20	BLGU	

HX-166 Cruise Data continued

	Date	SF	VIS	HR	SEC	LAT	MN	LONG	MN	#	SPC	COMMENTS
148	27-Sep-92		VG	13	4	71	19.50	167	16.70	20	OR	
149	27-Sep-92		VG	13	4	71	19.50	167	16.70	100	BLGU	BLACK GUILLEMOT
150	27-Sep-92		VG	13	36	71	23.00	167	24.00	3	OR	
151	27-Sep-92		VG	13	36	71	23.00	167	24.00	1	EB	
152	27-Sep-92	F	VG	13	54	71	24.40	167	28.00			ICE STATION
153	27-Sep-92	S	VG	16	30	71	24.70	167	30.70	6	IVGU	IVORY GULLS; SOME ROSS' ALSO
154	27-Sep-92	F	F	17	45							
155	27-Sep-92	S	F	19	0							
156	27-Sep-92	F	P	20	0							
157	28-Sep-92	S	F	10	0	71	29.00	167	27.00	1	PH	UNDERWAY AGAIN
158	28-Sep-92		F	10	0	71	29.00	167	27.00	1	ROGU	
159	28-Sep-92		F	10	50	71	26.40	167	28.60	2	OR	
160	28-Sep-92		F	11	5	71	24.50	167	25.20	3	EB	
161	28-Sep-92		F	11	10	71	23.90	167	25.10	12	OR	HAULED OUT
162	28-Sep-92		F	11	13	71	22.80	167	25.70	5	OR	COW/CALF;SEA ICE EDGE
163	28-Sep-92		F	11	35	71	20.20	167	34.90	4	OR	OPEN WATER
164	28-Sep-92	F	F	11	45	71	19.00	167	38.40			OPEN WATER
165	28-Sep-92	S	F	12	30	71	13.70	167	59.80	12	BLKI	"MANY"
166	28-Sep-92		F	12	45	71	8.50	168	18.80	6	EI	WESTBOUND EIDERS
167	28-Sep-92		G	13	45	71	4.80	168	28.20			FEW BIRDS; SOUTH EDGE OF ICE
168	28-Sep-92		G	14	20	71	1.90	168	45.40	2	PH	CRESTED AUKLETS
169	28-Sep-92		G	14	20	71	1.90	168	45.40	1	CRAU	PRESENT
170	28-Sep-92		G	14	30	71	1.00	168	47.70	12	ROGU	
171	28-Sep-92		G	15	45	70	56.50	169	16.30	100	CRAU	
172	28-Sep-92		G			70	53.90	169	10.00	20	ROGU	TURNED 180
173	28-Sep-92		G	16	35	70	52.60	169	3.80	2	OR	COWS/CALFS
174	28-Sep-92		F	16	45	70	50.90	169	2.90	3	OR	
175	28-Sep-92		F	16	45	70	50.90	169	2.90	3	ROGU	
176	28-Sep-92		F	16	45	70	50.90	169	2.90	1	PH	
177	28-Sep-92	F	F	17	0							
178	28-Sep-92	S	F	18	45	70	36.30	169	22.00	3	OR	COW-CALF; ROSS' GULLS PRESENT
179	28-Sep-92		G	19	2	70	35.80	169	27.20	12	BLGU	
180	28-Sep-92		G	19	2	70	35.80	169	27.20	6	IVGU	
181	28-Sep-92		G	19	2	70	35.80	169	27.20	6	OR	
182	28-Sep-92		G	19	30	70	29.40	169	36.50	12	OR	SOME HAULED OUT
183	28-Sep-92		G	19	45	70	28.60	169	39.60	1	UM	"HOT SPOT" LOTS OF WILDLIFE
184	28-Sep-92		G	20	36	70	25.90	169	51.40	5	OR	
185	28-Sep-92		P	21	3	70	24.10	170	3.20	10	OR	
186	28-Sep-92	F	P	21	18	70	21.40	170	5.80			
187	29-Sep-92	S	P	9	0	70	25.50	173	5.30	1	BLGU	

	Date	SF	VIS	HR	SEC	LAT	MN	LONG	MN	#	SPC	COMMENTS
188	29-Sep-92		P	9	0	70	25.50	173	5.30	1	CRAU	
189	29-Sep-92		P	9	0	70	25.50	173	5.30	1	BLKI	
190	29-Sep-92		G	9	45	70	30.10	174	5.40	1	OR	
191	29-Sep-92		G	10	7	70	32.68	174	14.11	1	PH	OCEAN FRONT-WATER CHANGE
192	29-Sep-92		VG	11	3	70	40.60	174	36.60	1	YCSP	
												YELLOW-CROWNED SPARROW (DEAD ON SHIP)
193	29-Sep-92	F	VG	11	45	70	48.30	174	36.20			OPEN WATER
194	29-Sep-92	S	VG	13	20	71	5.40	174	24.60	1	BLKI	FEW MAMMALS
195	29-Sep-92		VG	14	4	71	12.40	174	26.20	1	EB	
196	29-Sep-92		VG	14	4	71	12.40	174	26.20	1	GLGU	
197	29-Sep-92		VG	14	20	71	14.70	174	30.90	5	PH	
198	29-Sep-92		VG	15	0	71	21.90	174	32.80	1	UM	@ ICE STATION
199	29-Sep-92	F	VG	15	30	71	21.90	174	32.80	1	ROGU	
200	29-Sep-92	S	G	17	0	71	21.90	174	32.80	1	IVGU	
201	29-Sep-92	F	G	20	0	71	21.90	174	32.80	1	BLKI	
202	30-Sep-92	S	F	9	0	71	13.20	174	36.80	2	UM	
203	30-Sep-92		F	9	0	71	13.20	174	36.80	1	ARLO	
204	30-Sep-92		F	9	0	71	13.20	174	36.80	1	SNOW	
205	30-Sep-92		F	9	0	71	13.20	174	36.80	1	OR	
206	30-Sep-92		G	12	0	71	12.60	174	29.00	1	UM	
207	30-Sep-92		G	12	20	71	10.70	174	28.80	1	UM	
208	30-Sep-92		G	12	30	71	10.10	174	30.70	1	UM	
209	30-Sep-92		G	12	50	71	8.30	174	25.00	3	UM	SOW W/ 2 CUBS
210	30-Sep-92		G	13	0	71	7.20	174	26.00	1	UM	
211	30-Sep-92		G	13	7	71	6.10	174	26.00	50	ROGU	
212	30-Sep-92		G	13	9	71	5.10	174	26.00	1	UM	
213	30-Sep-92		G	13	10	71	5.10	174	26.00	1	SNBU	
214	30-Sep-92		G	13	50	71	2.80	174	23.50	1	EI	
215	30-Sep-92	F	G	18	0	70	49.60	174	26.70			OPEN WATER
216	30-Sep-92	S	F	20	30	70	34.60	174	31.10	1	PH	NW-SE CONVERGE. LINE
217	30-Sep-92		F	20	30	70	34.60	174	31.10	12	BLKI	BLACK-LEGGED KITTIWAKE
218	30-Sep-92	F	F	21	0	70	34.60	174	31.10	12	ROGU	
219	01-Oct-92	S	P	9	30	69	19.00	176	25.70	3	EB	
220	01-Oct-92		F	10	0	69	17.00	176	27.00	1	PH	
221	01-Oct-92		G	10	22	69	16.60	176	31.40	2	PH	
222	01-Oct-92		G	10	22	69	16.60	176	31.40	12	BLKI	IMMATURES
223	01-Oct-92		G	10	22	69	16.60	176	31.40	12	ROGU	
224	01-Oct-92		G	10	22	69	16.60	176	31.40	1	EB	
225	01-Oct-92		G	10	22	69	15.00	176	25.00	1	EB	
226	01-Oct-92		G	10	55	69	12.50	176	42.80	1	EB	

HX-166 Cruise Data continued

	Date	SF	VIS	HR	SEC	LAT	MN	LONG	MN	#	SPC	COMMENTS
227	01-Oct-92		VG	11	25	69	7.90	176	51.00	2	PH	
228	01-Oct-92	F	VG	11	35	69	6.60	176	54.10	1	EB	
229	01-Oct-92	S	VG	12	0	69	5.30	176	59.60	1	PH	
230	01-Oct-92		E	12	15	69	3.40	177	3.90	2	EB	
231	01-Oct-92		E	12	30	69	0.50	177	4.10	2	PH	
232	01-Oct-92		E	12	55	68	56.90	177	3.70	2	PH	
233	01-Oct-92		E	12	55	68	56.90	177	3.70	1	STSH	SHORT-TAILED SHEARWATER
234	01-Oct-92		E	12	55	68	56.90	177	3.70	1	CRAU	PRESENT
235	01-Oct-92		E	13	30	68	53.10	177	7.60	3	PH	
236	01-Oct-92		E	14	5	68	48.00	177	12.30	2	PH	
237	01-Oct-92		E	14	47	68	40.00	177	18.50	5	BM	BM = BOWHEAD WHALE
238	01-Oct-92		E	15	5	68	40.50	177	22.00	10	BM	
239	01-Oct-92		E	15	6	68	40.50	177	22.00	4	OR	
240	01-Oct-92		E	15	10	68	39.60	177	23.40	2	BM	
241	01-Oct-92		E	15	40	68	39.60	177	23.40	20	EI	
242	01-Oct-92		E	16	30	68	34.10	177	18.30	3	OR	
243	01-Oct-92		E	16	30	68	34.10	177	18.30	4	BM	CONFIRMED CLOSE BOWHEADS
244	01-Oct-92		E	16	50	68	32.20	177	10.80	10	ROGU	
245	01-Oct-92		VG	17	0	68	31.20	177	7.50	1	BM	
246	01-Oct-92		VG	17	15	68	29.50	177	3.50	3	BM	
247	01-Oct-92		VG	17	15	68	29.50	177	3.50	3	OR	
248	01-Oct-92		VG	17	15	68	29.50	177	3.50	2	PH	
249	01-Oct-92		VG	17	30	68	28.00	177	0.60	3	OR	20 FATHOMS
250	01-Oct-92		VG	17	39	68	27.50	177	55.50	4	BM	1 COW/CALF PAIR
251	01-Oct-92		VG	18	10	68	23.90	176	43.70	5	BM	
252	01-Oct-92		VG	18	20	68	23.20	176	40.30	10	BM	
253	01-Oct-92		VG	18	35	68	22.10	176	43.50	2	BM	
254	01-Oct-92		VG	18	40	68	21.20	176	45.80	1	BM	CARGO SHIP PASSES
255	01-Oct-92		VG	18	40	68	21.20	176	45.80	2	OR	
256	01-Oct-92		F	18	52	68	19.70	176	50.30	1	BM	
257	01-Oct-92		F	19	20	68	15.80	176	1.30	3	BM	POSSIBLY GRAY WHALES?
258	01-Oct-92		F	19	40	68	14.70	176	54.60	2	BM	
259	01-Oct-92		F	19	50	68	14.10	176	51.40	2	BM	
260	01-Oct-92		F	20	0	68	12.90	176	47.60	1	BM	
261	01-Oct-92		F	20	4	68	12.30	176	45.60	4	BM	
262	01-Oct-92		F	20	11	68	11.60	176	43.20	2	OR	
263	01-Oct-92		F	20	16	68	11.20	176	41.50	1	BM	LARGE WHALE
264	01-Oct-92		F	20	27	68	9.70	176	37.40	1	BM	
265	01-Oct-92		F	20	36	68	8.70	176	34.10	5	BM	
266	01-Oct-92		G	20	47	68	7.50	176	30.30	5	BM	

HX-166 Cruise Data continued

	Date	SF	VIS	HR	SEC	LAT	MN	LONG	MN	#	SPC	COMMENTS
267	01-Oct-92		G	20	57	68	6.30	176	26.50	1	BM	
268	01-Oct-92		P	21	4	68	5.60	176	23.60	1	BM	
269	01-Oct-92		P	21	13	68	5.30	176	19.20	2	BM	
270	01-Oct-92	F	P	21	20							
271	02-Oct-92	S	P	9	0	68	27.20	172	6.10	2	OR	COW/CALF
272	02-Oct-92		P	9	25	68	28.60	172	0.70	2	OR	COW/CALF
273	02-Oct-92		P	9	30	68	28.60	172	0.00	1	OR	DEAD FLOATING: SMALL TUSKS
274	02-Oct-92		F	9	58	68	31.90	171	49.62			
275	02-Oct-92		F	10	50	68	36.50	171	35.70	20	ROGU	
276	02-Oct-92		F	10	50	68	36.50	171	35.70	1	MURRE	
277	02-Oct-92		F	10	50	68	36.50	171	35.70	5	BLKI	
278	02-Oct-92		F	10	50	68	36.50	171	35.70	1	NOFU	NORTHERN FULMAR
279	02-Oct-92		F	11	21	68	39.50	171	23.60	2	OR	MURRE
280	02-Oct-92	F	F	11	30							
281	02-Oct-92	S	F	12	0							
282	02-Oct-92		G	12	35	68	46.70	170	52.20	6	OLDS	OLDSQUAW
283	02-Oct-92		G	16	45	68	55.10	168	24.60			
284	02-Oct-92	F	F	17	45	68	48.50	168	57.80	2	EB	
285	02-Oct-92	S	F	18	45	68	44.30	168	39.40	2	PH	
286	02-Oct-92		F	18	50	68	43.70	168	36.70	1	SEAL?	
287	02-Oct-92		F	19	45	68	38.80	168	14.30	50	EI	
288	02-Oct-92	F	F	20	0							
289	03-Oct-92	S	P	9	30	67	2.90	169	8.00	2	ARLO	
290	03-Oct-92		P	10	0	66	59.70	169	14.20	50	COMU	COMMON MURRE: UBQ.
291	03-Oct-92		P	10	0	66	59.70	169	14.20	50	CRAU	UBIQUITOUS
292	03-Oct-92		P	10	0	66	59.70	169	14.20	50	LEAU	LEAST AUKLET: UBQ.
293	03-Oct-92		P	10	0	66	59.70	169	14.20	50	BLKI	UBIQUITOUS; ADULTS
294	03-Oct-92		P	10	20	66	55.80	169	21.30	3	ER	
295	03-Oct-92		F	10	58	66	51.90	169	29.20	4	ER	
296	03-Oct-92		F	11	19	66	49.80	169	32.90	6	ER	
297	03-Oct-92		F	11	32	66	47.60	169	35.90	999	STSH	
298	03-Oct-92		F	11	36	66	46.00	169	35.00	3	EB	
299	03-Oct-92		VG	11	40	66	46.00	169	38.30	1	ER	
300	03-Oct-92		VG	11	51	66	44.60	169	41.20	3	ER	
301	03-Oct-92	F	VG	11	56	66	43.90	169	42.40	4	ER	
302	03-Oct-92	S	G	12	25	66	39.00	169	50.00	5	ER	
303	03-Oct-92		G	12	46	66	37.90	169	51.80	1	ER	
304	03-Oct-92		F	13	30	66	34.10	170	4.80	1	OR	
305	03-Oct-92		VG	14	10	66	28.10	170	11.80	1	ER	
306	03-Oct-92		VG	14	32	66	26.90	170	14.10	20	NOPH	N. PHALAROPE, UNSURE; PASSED CARGO SHIP

HX-166 Cruise Data continued

	Date	SF	VIS	HR	SEC	LAT	MN	LONG	MN	#	SPC	COMMENTS
307	03-Oct-92		VG	14	32	66	26.90	170	14.10	1	ER	
308	03-Oct-92		VG	14	50	66	26.20	170	8.00	5	ER	UNSURE IDENT.: BOWHEADS?
309	03-Oct-92		VG	14	59	66	25.30	169	59.00	2	ER	UNSURE IDENT.: BOWHEADS?
310	03-Oct-92		VG	15	7	66	24.80	169	58.40	500	SHER	PASSED ICEBREAKER "KIEV"
311	03-Oct-92		VG	15	30	66	23.50	169	46.40	2	ER	
312	03-Oct-92	F	VG	17	30							
313	03-Oct-92	S	E	18	0							LOOKING FOR SOVIET MOORING
314	03-Oct-92		E	18	15	66	18.50	169	30.20	3	ER	
315	03-Oct-92	F	E	19	30							
316	04-Oct-92	S	P	9	30	65	42.70	168	27.40			START WATCH: BERING ST.
317	04-Oct-92		F	10	40	65	37.90	168	11.40	50	COMU	UBIQUITOUS
318	04-Oct-92		F	10	40	65	37.90	168	11.40	50	ARLO	UBIQUITOUS
319	04-Oct-92		F	10	40	65	37.90	168	11.40	50	BLKI	UBIQUITOUS
320	04-Oct-92		F	10	59	65	30.29	168	10.23			
												FRONT: WATER CHANGE GREEN TO BROWN
321	04-Oct-92	F	F	11	30							
322	04-Oct-92	S	F	13	30							
323	04-Oct-92		F	14	50	64	57.20	167	59.70	50	COR	CORMORANT: KING ISLAND
324	04-Oct-92		F	15	30	64	55.40	168	16.50	2	ER	
325	04-Oct-92		F	16	15	64	54.20	168	27.30	2	ER	
326	04-Oct-92		F	16	15	64	53.60	168	26.80	1	WHAL	
												BELUGA?: LOTS OF WHITE BELOW SURFACE
327	04-Oct-92		F	16	15	64	53.20	168	29.40	1	ER	
328	04-Oct-92		F	16	36	64	52.00	168	36.00	4	ER	
329	04-Oct-92		F	16	45	64	51.40	168	39.30	2	ER	
330	04-Oct-92		F	16	57	64	50.60	168	43.30	1	ER	
331	04-Oct-92		F	17	15	64	49.88	168	47.30	2	ER	
332	04-Oct-92		F	17	25	64	48.90	168	51.90	5	ER	
333	04-Oct-92		F	17	40	64	47.70	168	57.90	1	ER	
334	04-Oct-92		F	18	13	64	45.80	169	7.30	5	ER	
335	04-Oct-92		F	18	48	64	43.70	169	18.00	2	ER	
336	04-Oct-92		F	18	52	64	43.40	169	19.30	2	ER	
337	04-Oct-92		P	19	7	64	42.40	169	24.30	3	ER	
338	04-Oct-92		P	19	19	64	41.60	169	28.90	2	ER	
339	04-Oct-92		P	19	48	64	39.70	169	38.80	3	ER	
340	04-Oct-92		P	20	28	64	37.20	169	52.20			END WATCH
341	05-Oct-92		F	13	0	64	53.00	172	30.00	1	SHER	NO WATCH
342	05-Oct-92		F	13	0	64	53.00	172	30.00	1	NOFU	
												SHEARWATERS, FULMARS, KITTIWAKES
343	05-Oct-92		F	13	0	64	53.00	172	30.00	1	BLKI	
344	05-Oct-92		F	15	9	64	18.00	173	27.00	2	ER	

Appendix 6

FISHERIES OCEANOGRAPHY OF THE NORTHEASTERN CHUKCHI SEA

RESPONDER BARGE REPORT

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INTRODUCTION

An opportunity was available to sample in the vicinity of a drill ship in the northeast Chukchi Sea to examine the spatial and temporal distribution of fish. The purpose of this pilot program was to look for effects of the drill ship on fish distribution. The effectiveness of sampling from a small skiff with gear was also examined.

METHODS AND MATERIALS

Four stations were established 3.2 km off each side of the drill ship. Sampling took place 24 - 27 July 1991, 13 - 18 August 1991, and 28 September 1991 during daylight hours (07:00 - 17:00). A 122 m oil spill response barge, the *Responder*, was used as a base. The *Responder* barge was located at 71° 20.0' N and 165° 25.8'W during the first two sampling periods. For the third visit, the *Responder* moved to 71° 18.54' N and 161° 51.65' W. A complete sampling regime was not done in August or September due to sea ice moving into the area (the sampling area was not accessible). During the second sampling period two additional stations were sampled (total of 6 stations), still in the vicinity of the drill ship. Sampling was conducted from a 10.9 m boat launched from the *Responder* barge. The boat was equipped with a detachable A-frame and diesel powered winch system to deploy and retrieve sampling equipment. At each station, an attempt was made to sample twice with each gear type.

Bottom fish were sampled with a 4.9 m wide otter trawl with 5 mm mesh. Fish were frozen and returned to the laboratory. Young-of-the-year fishes were sampled with an Isaacs-Kidd midwater trawl (IKMT) net having a 1.8 m head bar (sampling a 2.65 m^2 area), 5 mm meshed net, and a collecting bucket with a 1 mm mesh screen. A flow meter was hung in the net's mouth to determine water volume sampled. A double oblique tow was made by letting the wire out until it was estimated to be several meters above the bottom.

Ichthyoplankton were sampled with a Bongo net having 60 cm diameter openings (110 cm^2 area) and 1 mm mesh netting. A flow meter was suspended in the mouth of each net. The bucket screens were of 0.5 mm mesh netting. IKMT and Bongo net samples were preserved in 5% formaldehyde solution, returned to the laboratory, where they were sorted, identifies and counted. Detailed data collection methods can be found in Chapter 4.

RESULTS AND DISCUSSION

Statistical results were not possible since the number of fish were too small, especially in otter trawl samples. In addition, exact station replication was not possible due to the inability to locate our position with a GPS, inclement weather, and sea ice movement. During the third sampling period weather prevented any sampling other then the deployment of the otter trawl on one day. No further sampling was possible for that period. The number of samples taken by each gear type are listed in Table 1.

Results pertaining to number of fish and species can be seen in Table 2 for bongo and Table 3 IKMT samples. The volume sampled by bongo net was calculated (Table 4). Further details can be found in Chapter 4. In general, more species were collected with the bongo net than the IKMT. For both of those nets, especially the bongo, Arctic cod was the dominant species encountered.

Otter trawl filed identification showed fish primarily consisted of *Boreogadus saida* (Arctic cod), Cottids (sculpins), *Eleginus gracilis* (saffron cod), and *Gymnocanthus* sp.

Unfortunately, additional workup of these samples was not possible as they were lost in transit.

Some problems were encountered in sampling off a small boat. Running water for washing samples off the sides of nets was unavailable; buckets were dipped over the side of the boat and that water used for washing. Sampling with the IKMT was difficult and clumsy. When the IKMT was deployed, it caught few or no fish.

Table 1. Number of samples taken by each gear type.

Station	Sample Period	Otter	IKMT	Bongo
1	1	2	3	1
1	2	2	0	0
2	1	2	0	3
2	2	2	0	2
3	1	2	0	2
3	2	2	0	0
4	1	2	0	2
4	2	2	0	2
5	2	2	1	2
6	2	1	1	0

Table 2.—Number of fish found in bongo net samples. Left indicates the left net, and right the right net. Sample period 1 was in July while 2 was in August.

Sample			Station 1		Station 2		Station 3		Station 4	
Period	Haul	Species	Left	Right	Left	Right	Left	Right	Left	Right
1	1	*Boreogadus saida*	43	0	30	43	14	20	4	4
1	2	*Boreogadus saida*			35	23	9	19	8	3
2	1	*Boreogadus saida*	3	2	2	2			0	6
2	2	*Boreogadus saida*	3	1	1	3			5	5
1	1	*Cottidae*	0	0	0	0	0	0	0	0
1	2	*Cottidae*			0	1	0	0	0	0
2	1	*Cottidae*	0	0	0	0			0	0
2	2	*Cottidae*	0	0	0	0			0	0
1	1	*Eleginus gracilis*	1	0	0	0	1	1	1	0
1	2	*Eleginus gracilis*			2	1	1	0	0	0
2	1	*Eleginus gracilis*	0	0	0	0			0	0
2	2	*Eleginus gracilis*	0	0	0	0			0	0
1	1	*Gymnocanthus* sp.	0	0	0	0	0	0	0	0
1	2	*Gymnocanthus* sp.			0	0	1	0	0	0
2	1	*Gymnocanthus* sp.	0	0	0	0			0	0
2	2	*Gymnocanthus* sp.	0	0	0	0			0	0
1	1	*Liparis* sp.	0	0	0	1	0	0	0	0

Table 2. continued

Sample Period	Haul	Species	Station 1 Left	Station 1 Right	Station 2 Left	Station 2 Right	Station 3 Left	Station 3 Right	Station 4 Left	Station 4 Right
1	2	*Liparis* sp.			0	0	0	0	0	0
2	1	*Liparis* sp.	0	0	0	0			0	0
2	2	*Liparis* sp.	0	0	0	0			0	0
1	1	*Lumpenus* sp.	5	0	2	1	9	11	3	1
1	2	*Lumpenus* sp.			3	3	4	5	2	0
2	1	*Lumpenus sp.*	0	0	0	0			0	0
2	2	*Lumpenus sp.*	2	0	0	0			0	0
1	1	*Myoxocephalus* sp.	0	0	0	0	0	0	2	0
1	2	*Myoxocephalus* sp.			0	0	0	0	1	1
2	1	*Myoxocephalus* sp.	0	0	0	0			0	0
2	2	*Myoxocephalus* sp.	0	0	0	0			0	0
1	1	*Pleuronectidae*	0	0	0	0	0	1	0	0
1	2	*Pleuronectidae*			0	0	0	1	0	0
2	1	*Pleuronectidae*	0	0	0	0			0	0
2	2	*Pleuronectidae*	0	0	0	0			0	0
1	1	*Pholidae*	0	0	0	0	0	0	0	0
1	2	*Pholidae*			0	0	0	0	0	0
2	1	*Pholidae*	0	0	0	2			0	0
2	2	*Pholidae*	0	0	0	0			0	0

Table 3.—Number of fish found in IKMT samples. Sample period 1 was in July while 2 was in August.

Sample Period	Haul	Species	Station 1	Station 5	Station 6
1	1	*Boreogadus saida*	2		
1	2	*Boreogadus saida*	2		
1	3	*Boreogadus saida*	4		
2	1	*Boreogadus saida*		2	4
2	2	*Boreogadus saida*			1
1	1	*Liparis* sp.	0		
1	2	*Liparis* sp.	0		
1	3	*Liparis* sp.	0		
2	1	*Liparis* sp.		1	0
2	2	*Liparis* sp.			0
1	1	*Myoxocephalus* sp.	0		
1	2	*Myoxocephalus* sp.	0		
1	3	*Myoxocephalus* sp.	0		
2	1	*Myoxocephalus* sp.		0	2
2	2	*Myoxocephalus* sp.			0

Table 4.—Volume of water (m^3) sampled by bongo net in the northeast Chukchi Sea.

Sample Period	Haul	Station 1	Station 2	Station 3	Station 4	Station 5
1	1	166	156	167	101	
1	2		169	167	87	
1	3		298			
2	1	122	103		96	111
2	2	101	104		93	131
2	3		12			

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.