Volume 2

Principal Investigators' Reports
July–September 1976

U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

VOLUME 1. Marine Mammals, Marine Birds

VOLUME 2. Fish, Plankton, Benthos, Littoral

VOLUME 3. Effects, Chemistry and Microbiology, Physical Oceanography

VOLUME 4. Geology, Ice, Data Management

Environmental Assessment of the Alaskan Continental Shelf

July - Sept 1976 quarterly reports from Principal Investigators participating in a multi-year program of environmental assessment related to petroleum development on the Alaskan Continental Shelf. The program is directed by the National Oceanic and Atmospheric Administration under the sponsorship of the Bureau of Land Management.

ENVIRONMENTAL RESEARCH LABORATORIES
Boulder, Colorado
November 1976

VOLUME 2

FISH, PLANKTON, BENTHOS, LITTORAL

FISH, PLANKTON, BENTHOS, LITTORAL

FISH, PLANKTON, BENTHOS, LITTORAL

FISH, PLANKTON, BENTHOS, LITTORAL

Quarterly Report

Contract #03-5-022-56
Research Unit #5/303
Reporting Period 7/1 - 9/30/76
Number of Pages 4

THE DISTRIBUTION, ABUNDANCE, DIVERSITY AND PRODUCTIVITY OF BENTHIC ORGANISMS IN THE BERING SEA

Dr. Howard M. Feder
Professor of Marine Science
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

October 1, 1976

QUARTERLY REPORT

I. Task Objectives

A. Qualitative and quantitative census of dominant species within oil lease sites.

B. Description of seasonal and spatial distribution patterns, with emphasis on assessing patchiness and correleation with microhabitat.

C. Comparison of species distribution with physical, chemical and geological factors.

D. Observations of biological interrelationships in benthic biota of the study area.

II. Field and Laboratory Activities

A. No cruise was scheduled during the last quarter.

B. A continuation of the analysis of grab and trawl samples taken in the past year is in progress at the Marine Sorting Center and the biological laboratory of the Institute of Marine Science. All data is being keypunched as it becomes available. Refinement of computer programs developed for the Gulf of Alaska studies is in progress. The methods used in Cluster Analysis are outlined in the Annual Report for the Gulf of Alaska (Feder, et al., 1976, *The Distribution, Abundance, Diversity and Productivity of Benthic Organisms in the Bering Sea*).

GRAB PROGRAM

III. Results

1. A selected set of stations from the cruise of the *R/V Discoverer* in 1975 have been processed by the Marine Sorting Center. This data has been keypunched, and analysis, inclusive of cluster analysis, will take place when 60 selected stations on the MB grid have been completely processed.

2. A series of stations have been given to the Marine Sorting Center for processing in the coming quarter:

MB Station	Number of replicates
1	5
2	3
3	5
4	3
6	5
8	5
10	5
11	5
12	5
19	5

20	5
23	5
24	5
25	2
27	5
28	5
35	5
38	5
39	5
43	5
42	5
59	4

3. Refinement of computer programs used in the Gulf of Alaska benthic investigation has progressed. One set of the Clustering Programs has been modified to accept the increased number of stations involved in the grid in the Bering Sea.

4. All grab programs have been modified to accept the 12-digit species code decided upon by the Marine Sorting Center and NOAA.

IV. Preliminary Interpretation of Results

No preliminary interpretations are currently available. It is anticipated that an additional 10 stations will be given to the Sorting Center for processing in the coming quarter. It is currently projected that numerical analysis will be initiated by December 1976.

Coordination between the Gulf of Alaska and the Bering Sea projects has been initiated to facilitate programming compatability.

V. Problems Encountered

The nature of the substrate in many of the stations sampled in the Bering Sea is such that considerable time is needed to process each replicate for each station. Thus, the cost per sample in the Bering Sea is considerably higher than originally anticipated. A careful selection of stations to be processed has been made, and these stations are double checked as they are completed to avoid processing of any extra samples. The end result of this unexpected problem is a much slower completion rate of samples in the Bering Sea as compared to the Gulf of Alaska. In addition, a reduced grid of stations will be processed as compared to the extensive coverage originally anticipated. It is anticipated that a continuing problem in the sorting of materials will ensue; thus, it is probable that a full second-year coverage will not be possible. Instead, only a very limited number of selected stations will be processed for comparison over a wide area on the Bering Sea grid.

TRAWL PROGRAM

III. Results

Benthic invertebrates obtained on Leg I 1976 have been processed. Verification of specimens from Legs II and III will follow.

IV. Preliminary Interpretation of Results

No new interpretations at present.

V. Problems Encountered

No problems.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: September 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 15 R.U. NUMBER: 5/303

PRINCIPAL INVESTIGATOR: Dr. H. M. Feder

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]			
	From	To	Batch 1	2		
Discoverer Leg I #808	5/15/75	5/30/75	*	None		
Discoverer Leg II #808	6/2/75	6/19/75	*	None		
Miller Freeman	8/16/75	10/20/75	*	10/30/76[b]		
Miller Freeman	3/76	6/76	(a)	(a)		

Note: [1] Data Management Plan and Data Format have been approved and are considered contractual.

(a) These materials will be archived. Selected samples will be processed in FY '77, providing project is funded.

* That portion of cruise 808 grabs sorted, approximately 1/2 of those taken will be submitted about July 30, 1976. The remainder will receive top priority in FY '77, providing project is funded.

(b) Data is ready to be keypunched in E.D.S. Format. Submission date is dependent on project continuation and funding in FY '77.

QUARTERLY REPORT

Contract No. 03-5-022-68, Task Order 5
Research Unit #6
Reporting Period: 1 July - 30 September 1976

The distribution, abundance, diversity and productivity of the western Beaufort Sea benthos.

Andrew G. Carey, Jr., Principal Investigator
School of Oceanography
Oregon State University
Corvallis, Oregon 97331

September 24, 1976

John J. Dickinson

I. Task Objectives

A. General nature and scope of the problem

The distribution, abundance and natural variability of benthic macrofauna will be described on the southwestern Beaufort Sea continental shelf. Patterns of faunal distributions will be described and characterized using suitable bio-indices and multivariate techniques. Seasonal changes in the structure of benthic populations will be studied by sampling four times within a single year.

B. Specific Objectives

We propose to describe the benthic infauna of the western Beaufort Sea continental shelf including studies of both geographic seasonal variability. Data are to be obtained on the faunal composition and abundance to form baselines to which potential future changes can be compared.

Specific objectives include the continuation of studies and analyses to:

1. Describe the distribution, species composition, numerical density, and biomass of the benthos in the area of interest.
2. Describe the spatial and seasonal variability of faunal distributions and abundances.
3. Describe the benthic communities present and delineate their geographical and environmental extent.
4. Describe the effect of seasons on population size and reproductivity activity of dominant species.
5. Determine the degree of correlation of species distributions and of various bio-indices with features of the benthic

environment and oceanography of the region.

II. Research Activities

A. Field Activities

Two separate cruises were completed during the summer of 1976 involving work off the USCGC Glacier (OCS-4) and the R/V Alumiak (OCS-5). The results of these cruises will be described in separate sections below.

1. OCS-4

a. Ship Schedule

During the period 6 August-3 September, the fourth seasonal Arctic field trip (OCS-4) was undertaken on the USCGC Glacier.

b. Scientific Party

Dr. Andrew G. Carey, Jr. Associate Professor	Oregon State University
Eugene Ruff Research Assistant	Oregon State University

c. Methods

Benthic sampling off the Glacier was to involve the use of several samplers including: the Smith-McIntyre Grab, the Hessler-Sandia Box Core, the otter trawl, the beam trawl, and the Benthos Edgerton Camera System. Heavy ice conditions prevented extensive trawling and box coring, but the grab and camera system were used effectively. Smith-McIntyre Grab samples were washed on board using the OSU Benthos cascading multiple sieve system. The biological samples were all preserved in buffered 10% formalin. Sediment samples were frozen for potential future analysis. The camera system was used to obtain stereo photographs of the larger benthic fauna from approximately two meters above the bottom. Each camera was loaded with 100 feet of film, and was capable of obtaining up to 750 exposures per station. Plus-X film was utilized in one camera, and Vericolor II, a color reversal film, was utilized in the second camera. A time lag of 3-12 seconds was used between exposures, depending on the ship's drift. Normally at least 60 feet of film was exposed during each camera run, ensuring that at least 100 frames would be of printable quality.

d. Sample Localities

Benthic sampling on the Glacier cruise included work in both the Chukchi and Beaufort Seas. There were 11 stations occupied in the Chukchi Sea and 16 stations in the Beaufort Sea (Figure 1).

e. Data Collected - Number and Type of Samples

In the Chukchi Sea, 51 biological samples and 10 sediment samples were collected with the Smith-McIntyre Grab at 10 stations. One box core and two bottom trawls were also obtained (Tables 1,3 and 4). Benthic sampling in the Beaufort Sea yielded 85 biological samples and 14 sediment samples collected with the Smith-McIntyre grab at 14 stations. Four bottom trawls, eight camera runs, and three box cores were also obtained (Tables 2,3, 4 and 5).

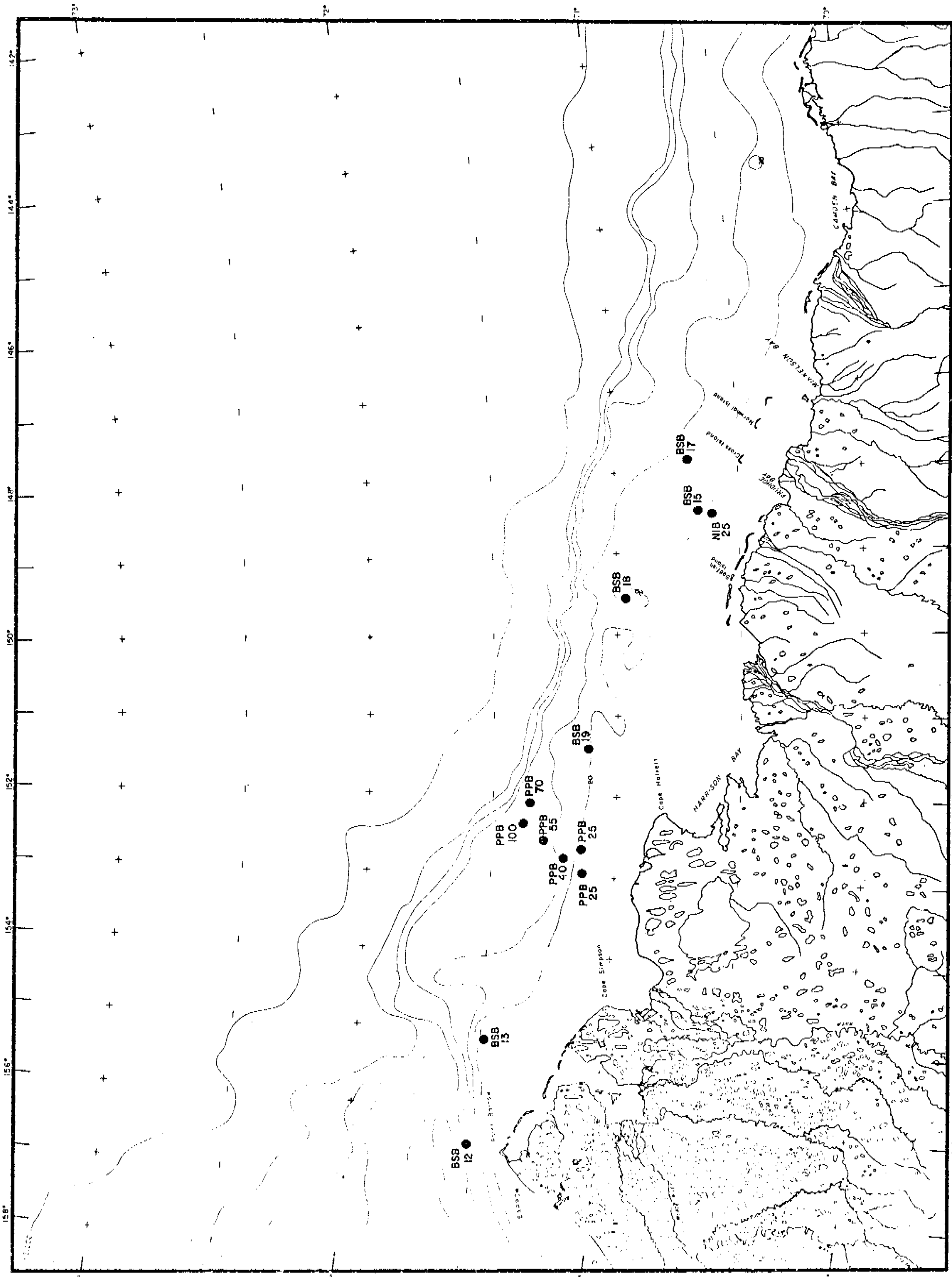

BSB 17
BSB 15
NIB 25
BSB 18
BSB 19
PPB 70
PPB 100
PPB 55
PPB 25
PPB 40
PPB 25
BSB 13
BSB 12
CAMDEN BAY
HARRISON BAY
Cape Halkett
Cape Simpson

Figure 1.

Table 1. OCS-4 Smith-McIntyre Grab Results

SMG #	Station	Date	Position		Depth	Type
1205	CSB-1	8 Aug.	70° 55'N	160° 13'W	57 m	non-quant
1206					55 m	non-quant
1207					55 m	non-quant
1208					55 m	non-quant
1209					64 m	non-quant plus sediment
1210	CSB-2	9 Aug.	70° 50'N	160° 30'W	51 m	non-quant
1211					51 m	quant
1212					51 m	sediment
1213					60 m	non-quant
1214					60 m	quant
1215					60 m	quant
1216					51 m	quant
1217	CSB-3	9 Aug.	70° 45'N	160°44.5'W	46 m	sediment
1218					46 m	discarded
1219					46 m	quant
1220					46 m	quant
1221					46 m	non-quant
1222					46 m	quant
1223					46 m	quant
1224					46 m	quant
1225	CSB-4	10 Aug.	70° 50'N	162° 09'W	40 m	sediment
1226					40 m	quant
1227					40 m	quant
1228					40 m	quant
1229					42 m	quant
1230					42 m	quant
1231	CSB-5	11 Aug.	70° 37'N	162°14.5'W	40 m	sediment
1232					40 m	quant
1233					40 m	quant
1234					40 m	quant
1235			70° 36'N	162° 11'W	40 m	quant
1236					40 m	quant
1237	CSB-6	11 Aug.	70° 39'N	162° 38'W	38 m	sediment
1238					38 m	quant
1239					38 m	quant
1240					38 m	quant
1241					38 m	quant
1242					38 m	quant
1243	CSB-7	12 Aug.	70° 28'N	163° 24'W	44 m	sediment
1244					44 m	quant
1245					44 m	quant
1246					44 m	quant
1247					44 m	quant
1248					44 m	quant
1249	CSB-9	14 Aug.	71° 02'N	159° 32'W	75 m	sediment
1250					75 m	quant
1251					75 m	quant
1252					75 m	quant
1253					75 m	quant
1254	CSB-10	15 Aug.	71° 16'N	157° 58'W	81 m	sediment
1255					81 m	quant
1256					81 m	quant
1257					81 m	quant
1258					81 m	quant
1259					81 m	quant
1260	CSB-11	15 Aug.	71° 23.7"N	156°58'W	101 m	sediment
1261					101 m	quant
1262					101 m	quant
1263					101 m	quant
1264					101 m	quant
1265					101 m	quant

Table 2. OCS-4 Smith-McIntyre Grab Results in the Beaufort Sea

SMG #	Station	Date	Position		Depth	Type
1266	BSB-12	17 Aug.	71° 31'N	156° 24'W	157 m	sediment
1267					157 m	quant
1268					157 m	quant
1269					157 m	quant
1270					157 m	quant
1271					154 m	quant
1272	BSB-12	17 Aug.	71° 31'N	156° 02'W	110 m	non-quant
1273	BSB-13	18 Aug.	71° 29'N	155° 06'W	35 m	sediment
1274					35 m	quant
1275					35 m	quant
1276					35 m	quant
1277					35 m	quant
1278					35 m	quant
1279					35 m	quant
1280	PPB-25	20 Aug.	71° 09'N	152° 38'W	26 m	sediment
1281					25 m	quant
1282					27 m	quant
1283					26 m	quant
1284					27 m	quant
1285					27 m	quant
1286	BSB-15	22 Aug.	70° 40.1'N	148° 28.6'W	25 m	quant
1287					25 m	quant
1288					25 m	sediment
1289					25 m	quant
1290					25 m	quant
1291					25 m	quant
1292					25 m	quant
1293	NIB-25	25 Aug.	70° 37.5'N	148° 31.5'W	29 m	sediment
1294			70° 37.6'N	148° 31.7'W	29 m	quant
1295			70° 37.6'N	148° 32.0'W	29 m	quant
1296			70° 37.6'N	148° 32.1'W	29 m	quant
1297			70° 37.6'N	148° 32.2'W	29 m	quant
1298			70° 37.6'N	148° 32.4'W	29 m	quant
1299	BSB-17	26 Aug.	70° 41.8'N	147° 51.2'W	38 m	quant
1300			70° 41.8'N	147° 51.3'W	37 m	quant
1301			70° 41.8'N	147° 51.4'W	36 m	quant
1302			70° 41.9'N	147° 51.5'W	36 m	quant
1303			70° 41.9'N	147° 51.6'W	37 m	quant
1304			70° 41.9'N	147° 51.7'W	37 m	sediment
1305	BSB-18	27 Aug.	70° 57.5'N	149° 31.9'W	32 m	quant
1306			70° 57.5'N	149° 32.1'W	32 m	quant
1307			70° 57.5'N	149° 32.2'W	32 m	quant
1308			70° 57.5'N	149° 32.2'W	32 m	quant
1309			70° 57.5'N	149° 32.3'W	32 m	quant
1310			70° 57.5'N	149° 32.3'W	32 m	sediment
1311	BSB-19	28 Aug.			23 m	quant
1312					24 m	quant
1313					25 m	quant
1314			71° 07.9'N	151° 22.1'W	23 m	quant
1315					25 m	quant
1316					24 m	sediment
1317	PPB-100	30 Aug.	71° 22.6'N	152° 23.5'W	93 m	sediment
1318			71° 22.6'N	152° 23.1'W	92 m	quant
1319			71° 22.5'N	152° 22.9'W	90 m	quant
1320			71° 22.5'N	152° 22.6'W	88 m	quant
1321			71° 22.5'N	152° 22.3'W	86 m	non-quant
1322			71° 22.4'N	152° 21.9'W	84 m	quant
1323			71° 22.4'N	152° 21.5'W	83 m	quant

Table 2 (cont.)

SMG #	Station	Date	Position	Depth	Type
1324	PPB-70	31 Aug.		70 m	sediment
1325				73 m	non-quant
1326				73 m	quant
1327				73 m	quant
1328			71° 22.4'N 152° 06.1'W	71 m	quant
1329				69 m	quant
1330	PPB-55	31 Aug.		55 m	quant
1331			71° 18.1'N 152° 32.2'W	55 m	quant
1332				55 m	sediment
1333				55 m	quant
1334				55 m	quant
1335				55 m	quant
1336				55 m	quant
1337				55 m	quant
1338				55 m	quant
1339				55 m	quant
1340				55 m	quant
1341				55 m	quant
1342				55 m	quant
1343	PPB-55	31 Aug.		53 m	quant
1344				53 m	sediment
1345			71° 17.9'N 152° 33.5'W	53 m	quant
1346				53 m	non-quant
1347				53 m	quant
1348				53 m	quant
1349				53 m	quant
1350				53 m	quant
1351				53 m	quant
1352	PPB-40	31 Aug.	71° 13'N 152° 46'W	40 m	sediment
1353				40 m	quant
1354				40 m	quant
1355				40 m	quant
1356				40 m	quant
1357				40 m	quant
1358	PPB-25	1 Sept.		26 m	sediment
1359				26 m	quant
1360				26 m	quant
1361				27 m	non-quant
1362				26 m	quant
1363			71° 08.2'N 152° 57.5'W	27 m	quant
1364				26 m	quant

Table 3. OCS-4 Box Corer Results

BxC #	Station	Date	Position		Depth
047	CSB-7	12 Aug.	70° 28'N	163° 24'W	49 m
048	BSB-7	29 Aug.	71° 44'N	151° 45'W	1738 m
049	BSB-7	29 Aug.	70° 43.6'N	151° 46.5'W	1643 m
050	BSB-7	29 Aug.	71° 43.6'N	151° 46.5'W	1659 m

Table 4. OCS-4 Trawling Results

Trawl #	Station	Date	Position	Depth
1	CSB-7	12 Aug.	70° 28'N 163° 24'W	49 m
2	CSB-8	14 Aug.	71° 05.5'N 159° 06'W	70 m
3	PPB-25	20 Aug.	71° 08.8'N 152° 40.1'W	28 m
4	PPB-100	30 Aug. - trawl torn by large rocks	71° 23.1'N 152° 24.7'W	120 m
5	PPB-100	30 Aug.		127 m
6	PPB-40	31 Aug. - trawl lost during tow	71° 14.4'N 152° 42.9'W	42 m

Table 5. OCS-4 Deep-Sea Camera Results

DSC #	Station	Date	Position		Depth	Footage	
05	BSB-16	24 Aug.	70° 36'N	148° 11'W	24 m	65'	Plus-X
						65'	Vericolor II
06	BSB-17	26 Aug.	70° 40.5'N	147° 46.9'W	35 m	60'	Plus-X
						60'	Vericolor II
07						40'	Plus-X
						40'	Vericolor II
08	BSB-7	30 Aug.	71° 44'N	151° 45'W	1695 m	85'	Plus-X
						100'	Vericolor II
09	PPB-70	30 Aug.	71° 20.6'	152° 12'W	70 m	50'	Plus-X
						10'	Vericolor II
10	PPB-70	30 Aug.			65 m	50'	Plus-X
11	PPB-55	31 Aug.	71° 18.3'N	152° 34.1'W	53 m	75'	Vericolor II
12	PPB-40	31 Aug.	71° 14.4'N	152° 43'W	40 m	100'	Vericolor II
13	PPB-25	1 Sept.	71° 08.2'N	152° 57.9'W	26 m	95'	Vericolor II

2. OCS-5

a. Ship Schedule

During the period 19 August through 7 September 1976, the fifth seasonal Arctic field trip (OCS-5) was undertaken. The cruise was aboard the R/V Alumiak, operated by the Naval Arctic Research Laboratory, Barrow, Alaska.

b. Scientific Party

Paul A. Montagna	Oregon State Univ.	Party Chief
Paul H. Scott	Oregon State Univ.	Res. Asst.
Jeff Cordell	West. Wash. State College	Res. Asst.
Mark Canfield	West. Wash. State College	Res. Asst.
Doug Forcell	Alaska Fish & Game	Sea Bird Biol.
Ed Good	Alaska Fish & Game	Sea Bird Biol.

c. Methods

Bottom samples were taken by lowering a 0.1 m^2 Smith-McIntyre grab. Five samples were taken at each station for the analysis of the benthic community. These samples were washed on board in the OSU Benthos cascading multiple sieve system. Each sample was preserved in 10% formalin in sea water, and buffered with 8 oz. of Borax per gallon of sample. A sixth cast was also made at each station for sediment analysis, and this sample was preserved by freezing. Conductivity, salinity, and temperature of the bottom water at each station was also measured by lowering a probe connected to a KAHLSICO *in situ* salinometer.

d. Sample Localities

Benthic stations were located along five transect lines between Point Barrow and Barter Island (Figure 2). An effort was made to sample five depths along each transect between 5 m and 25 m. Ice conditions prevented the sampling of the deeper stations on the Pitt Point, Pingok Island, and Narwhal Island transect lines.

e. Data Collected - Numbers and Types of Samples

Twenty stations were occupied, and five biological and one sediment sample were collected at each station (Table 6). Temperature and salinity data were taken whenever possible.

B. Laboratory Activities

1. Personnel

a.	Andrew G. Carey, Jr.	Oregon State University School of Oceanography, Associate Professor Principal Investigator
	Responsibilities:	Coordination, evaluation, analysis, reporting, and holothurian systematics
b.	John J. Dickinson	Oregon State University School of Oceanography, Research Assistant
	Responsibilities to date:	Gammarid amphipod systematics
c.	James B. Gish	Oregon State University School of Oceanography, Research Assistant
	Responsibilities to date:	Data management, statistical analysis, and field collection
d.	R. Eugene Ruff	Oregon State University School of Oceanography, Research Assistant Unclassified

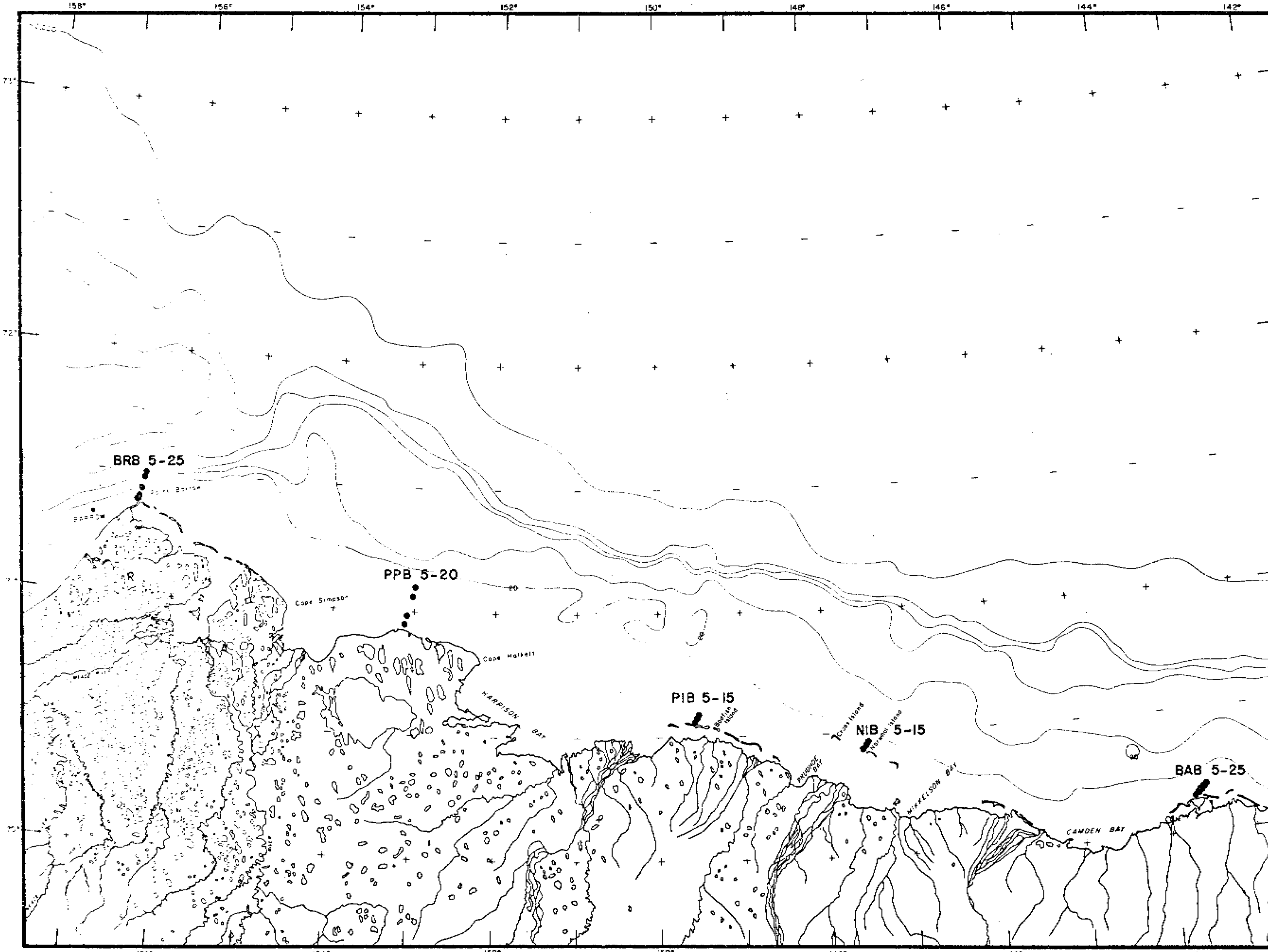

158°
156°
154°
152°
150°
148°
146°
144°
142°
73°
72°
71°
70°
BRB 5-25
Point Barrow
Barrow
PPB 5-20
Cape Simpson
Cape Halkett
Harrison Bay
PIB 5-15
NIB 5-15
Cross Island
Narwhal Island
Prudhoe Bay
Mikkelson Bay
Camden Bay
BAB 5-25

Figure 2.

Table 6. OCS-5 Smith-McIntyre Grab Results.

Transect	Date (1976)	Station	Position	Depth (m)	Cond.	Salinity (‰)	Temperature (°C)	No. Biol. Samples	No. Sed. Samples
Point Barrow	19 Aug.	BRB-25	71°27.3'N 156°22.3'W	25.9				5	1
		BRB-20	71°28.0'N 156°18.6'W	19.5				5	1
		BRB-15	71°28.2'N 156°13.1'W	15.5				5	1
		BRB-10	71°24.9'N 156°23.8'W	9.8				5	1
		BRB-5	71°23.4'N 156°27.1'W	5.2	25.00	27.00	3.50	5	1
Pitt Point	20 Aug.	PPB-20	71°05.2'N 152°58.7'W	19.2	11.10	12.70	-1.60	5	1
		PPB-15	71°04.4'N 153°01.5'W	14.9	25.50	31.20	-1.30	5	1
		PPB-10	70°59.1'N 153°08.8'W	9.9	25.10	27.77	-0.80	5	1
		PPB-5	70°56.4'N 153°12.9'W	5.5	23.20	25.10	-1.90	5	1
Pingok Island	22 Aug.	PIB-15	70°33.2'N 149°34.6'W	14.9	24.87	31.45	1.88	5	1
		PIB-10	70°34.8'N 149°32.3'W	10.2	23.00	22.32	2.15	5	1
		PIB-5	70°34.9'N 149°32.0'W	4.5	20.65	22.08	2.08	5	1
Narwhal Island	28 Aug.	NIB-15	70°26.0'N 147°26.2'W	16.2	24.93	31.76	-1.98	5	1
			70°24.3'N 147°29.2'W	9.8	24.50	31.02	-1.96	5	1
	27 Aug.	NIB-5	70°24.9'N 147°30.5'W	5.0	24.09	30.10	-0.88	5	1
Barter Island	31 Aug.	BAB-25	70°11.3'N 143°31.5'W	24.6	24.82	31.88	-2.00	5	1
		BAB-20	70°10.8'N 143°33.7'W	20.3	24.46	31.33	-2.00	5	1
	3 Sept.	BAB-15	70°09.5'N 143°36.2'W	15.1	24.24	30.78	-1.98	5	1
		BAB-10	70°09.0'N 143°32.2'W	10.1	24.28	30.75	-1.86	5	1
		BAB-5	70°08.4'N 143°37.7'W	5.0	23.47	28.40	-0.98	5	1
TOTALS									
5 Transects		20 stations						100 Biol. samples	20 Sed. samples

Responsibilities to date:	Invertebrate reference museum, species list, laboaratory personnel, bottom photography and photo analysis, and echinoderm and anthozoan systematics
e. Paul H. Scott	Oregon State University School of Oceanography, Research Assistant Unclassified
Responsibilities to date:	Field equipment, wet weights, sample picking and sorting, molluscan systematics, and field collection

f. Part-Time Workers:
Kamran Malik
Patricia Tester
Don Ward

Responsibilities:	Assist with key punching, sample processing, equipment maintenance, photographic processing, sediment analysis, wet weight measurement

2. Methods

Laboratory techniques for sample washing, sorting and weighing have been consistant for the past six months. New methodology developed and reported last spring was used throughout this quarter. The sample washing procedure involves a simple sprinkler system placed over a series of three sieves (aperatures of 9.5 mm, 1.00 mm and 0.42 mm). Water is sprinkled over the entire surface gently washing the sample with a minimum of effort and attention from laboratory personnel. Sample processing by this method has proved to be very effective with negligible damage to the animals.

Biomass-wet weight determinations have also followed methodology developed last quarter. The technique involves: 1) washing animals into a Millipore filtering apparatus, 2) slowly applying a vacuum to the filtering apparatus in order to remove excess liquid, 3) removing the tared filter paper and animals from the holder, 4) weighing the animals and filter paper to the nearest 0.01 gram and 5) replacing animals into the sample container. This method has proved to be very consistant with a precision near ± 0.01 gram.

3. Data Analyzed

One hundred and sixty-eight Smith-McIntyre grab samples from five seasonal Arctic field trips (OCS-1-5) are being processed at the Oregon State University benthic laboratory. Analysis of these samples follows a five step procedure: 1) laboratory washing and sorting of samples into macrofauna (1.0 mm and larger) and larger meiofauna (0.42 mm to 1.0 mm), 2) initial picking and sorting of animals into major phyla, 3) determination of wet weights for estimation of biomass, 4) counting and resorting of samples into finer taxonomic groups and 5) final taxonomic identification. Fifty-eight samples from OCS-1 and OCS-2 have been washed, initially sorted, weighed, counted and resorted into finer taxonmic groups (steps 1-4). Final systematic study of molluscs, polychaetes and amphipods has begun on the October 1975 (OCS-1) and March 1976 (OCS-2) samples. All 64 samples from OCS-3 have been washed and sorted into size fractions and are now being sorted into major phyla. Samples from OCS-4 and OCS-5 which were collected in August and early September of this year are now being washed and sorted into size fractions.

One of the main goals at the OSU benthic laboratory has been final species identification. Progress has remained steady in this area of final analysis. Systematic study of polychaetes, molluscs, amphipods and bottom copepods has continued throughout the quarter.

III. Results

A. Field Activities

The benthic sampling conducted during OCS-4 and OCS-5 greatly broadened the geographic coverage within the Beaufort Sea (Figures 1 and 2), and continued the seasonal sampling of the Pitt Point Transect (Table 7).

B. Laboratory Results

1. Biomass

Wet weights (as outlined in Methods Sections) for all OCS-2 samples have been determined this quarter. Animals of six major phyla and one group of miscellaneous phyla have been weighed for each sample (Table 8). Major phyla include the annelids, molluscs, arthropods, echinoderms, sipunculids and anthozoans. The miscellaneous group is comprised of Porifera, Rhynchecoela, Brachiopoda, Nematoda, Echiura, Phoronida, Cordata and Hemicordata.

2. Gammarid Amphipods

All the gammarid amphipod crustaceans have been sorted to family from cruises OCS-1 and OCS-2. This material included 55 Smith-McIntyre grab samples from 8 stations between 25 and 100 meters. Representatives of fifteen gammarid families were found. The results including counts for each family for each grab are listed in Tables 9 and 10.

Table 7. Summary of Seasonal Sampling on the Pitt Point Transect.

Cruise	Dates	Number of Stations	Number of Samples
OCS-1	7 Oct. - 30 Oct.	3	16
OCS-2	1 Mar. - 21 Mar.	5	42
OCS-3	14 May - 3 Jun.	5	50
OCS-4	6 Aug. - 3 Sept.	5	25
OCS-5	19 Aug. - 7 Sept.	4	20

Table 8. OCS-2 Wet Weight in Grams. Pitt Point Transect

Station and SMG #	Annelida	Arthropoda	Mollusca	Miscellaneous	Echinodermata	Sipuncula	Anthozoa
	Animal Group						
PPB-25							
1098	0.94	0.22	4.30	+	0.11	-	-
1099	2.71	0.05	0.77	-	-	-	-
1100	0.29	0.04	0.12	+	-	-	-
1101	0.78	+	0.40	-	-	-	-
1102	0.58	0.20	2.57	+	-	-	-
1103	0.28	+	0.07	-	-	-	-
1104	1.36	+	0.96	+	-	-	-
1105	0.90	0.07	1.63	+	-	-	-
1106	0.56	0.12	0.04	+	-	-	-
1107	3.02	0.04	0.34	+	-	-	-
PPB-40							
1115	0.33	0.24	3.25	0.09	0.33	-	-
1116	0.08	0.07	0.22	0.05	-	-	-
1117	0.12	0.08	+	+	0.15	+	-
1118	0.41	0.22	+	+	-	-	-
1119	0.20	0.65	-	+	-	-	-
1120	0.08	0.11	0.20	0.13	-	0.04	-
PPB-55							
1121	1.08	1.07	1.88	0.04	3.29	0.03	-
1122	0.75	0.84	5.18	+	1.29	+	-
1123	0.92	1.33	5.13	0.19	-	0.05	0.15
1124	0.13	0.13	-	+	-	+	-
1125	0.21	0.10	0.21	+	-	+	0.05
1126	1.71	0.68	1.64	+	-	+	0.19
1127	0.35	0.16	3.19	0.03	0.21	+	+
1128	1.10	0.20	+	+	-	0.06	-
1129	0.48	0.34	1.42	+	-	+	+
1130	0.39	0.69	0.52	0.04	-	+	0.04
PPB-70							
1108	1.03	1.73	2.62	0.09	0.22	0.62	-
1109	0.67	1.54	1.50	0.03	3.05	0.55	-
1110	0.45	1.25	2.67	0.19	1.96	1.09	-
1111	1.577	1.99	2.26	0.29	0.98	0.33	-
1114	1.14	1.57	0.32	0.03	0.41	0.05	-
PPB-100							
1131	4.08	0.91	0.98	0.06	3.31	0.05	0.03
1132	1.41	0.98	0.48	0.20	0.11	+	0.23
1133	1.35	0.89	1.06	+	2.54	0.04	1.34
1134	2.59	0.10	0.19	0.06	0.18	-	0.07
1135	2.11	0.18	0.22	0.10	+	0.03	-
1136	0.87	0.46	0.38	0.03	0.11	+	0.04
1137	1.51	1.08	3.63	0.12	0.03	0.04	0.30
1138	0.93	0.74	1.06	0.03	0.06	-	0.04
1139	1.32	1.56	0.98	0.07	0.03	0.24	0.36
1140	1.34	0.72	0.71	0.09	0.08	-	0.19

Table 9. Counts of specimens in each family of gammarid amphipods from OCS-1.

STATION: PPB-25

SMG	Family	Count
1082	Ampeliscidae	4
	Corophidae	1
	Gammaridae	1
	Lysianasidae	1
	Oedicerotidae	3
	Pleustidae	1
		10
1083	Ampeliscidae	3
	Gammaridae	3
	Oedicerotidae	4
	Stenothidae	1
		11
1084	Ampeliscidae	4
	Oedicerotidae	1
		5
1085	Stenothidae	1
1087	Ampeliscidae	1
	Oedicerotidae	2
	Pleustidae	5
	Stenothidae	5
		13

STATION: PPB-55

SMG	Family	Count
1088	Ampeliscidae	11
	Corophidae	40
	Dexaminidae	7
	Lysianasidae	2
	Pardaliscidae	2
	Phoxocephalidae	15
	Podoceridae	2
	Pleustidae	1
	Oedicerotidae	6
	Stenothidae	8
	Synopidae	15
		109
1089	Ampeliscidae	5
	Corophidae	12
	Dexaminidae	2
	Gammaridae	1
	Oedicerotidae	1
	Phoxocephalidae	3
	Pleustidae	1
	Synopidae	2
		27

STATION: PPB-55 (cont.)

SMG	Family	Count
1090	Ampeliscidae	9
	Corophidae	26
	Dexaminidae	3
	Oedicerotidae	1
	Phoxocephalidae	11
	Stenothidae	1
	Synopidae	3
		54
1091	Ampeliscidae	27
	Corophidae	31
	Dexaminidae	3
	Eusiridae	1
	Lysianasidae	1
	Oedicerotidae	5
	Phoxocephalidae	4
	Synopidae	6
		78
1092	Ampeliscidae	5
	Corophidae	42
	Dexaminidae	2
	Eusiridae	1
	Oedicerotidae	1
	Phoxocephalidae	8
	Stenothidae	1
		60

STATION: PPB-100

SMG	Family	Count
1093	Ampeliscidae	1
	Corophidae	7
	Dexaminidae	12
	Eusiridae	4
	Lysianasidae	10
	Oedicerotidae	20
	Pardaliscidae	2
	Phoxocephalidae	1
	Pleustidae	8
	Stenothidae	2
	Synopidae	1
		68
1094	Corophidae	1
	Lysianasidae	2
	Stenothidae	2
		5

STATION: PPB-100 (cont.)

SMG	Family	Count
SMG	Ampeliscidae	17
	Corophidae	8
	Gammaridae	1
	Lysianasidae	7
	Oedicerotidae	2
	Phoxocephalidae	7
	Pleustidae	2
	Stenothidae	1
		45
1096	Ampeliscidae	6
	Corophidae	6
	Dexaminidae	2
	Lysianasidae	9
	Oedicerotidae	2
	Pardaliscidae	1
	Phoxocephalidae	6
		32
1097	Lysianasidae	14

Table 10. Counts of specimens in each family of gammarid amphipods from OCS-2.

STATION: PPB-25

SMG	Family	Count
1098	Ampeliscidae	1
	Calliopidae	4
	Lysianasidae	1
	Oedicerotidae	6
		12
1099	Oedicerotidae	3
1100	Calliopidae	1
	Oedicerotidae	3
		4
1102	Lysianasidae	2
	Oedicerotidae	4
		6
1104	Oedicerotidae	2
1105	Oedicerotidae	2
	Lysianasidae	1
		3
1106	Gammaridae	1
	Oedicerotidae	1
	Stenothidae	1
		3
1107	Calliopidae	1
	Stenothidae	1
		2

STATION: PPB-40

SMG	Family	Count
1115	Ampeliscidae	10
	Gammaridae	1
	Oedicerotidae	6
	Phoxocephalidae	3
		20
1116	Ampeliscidae	6
	Eusiridae	1
	Isaeidae	1
	Phoxocephalidae	4
		12
1117	Oedicerotidae	2
	Phoxocephalidae	1
		3

STATION: PPB-40 (cont.)

SMG	Family	Count
1118	Ampeliscidae	1
	Gammaridae	1
	Oedicerotidae	1
		3
1119	Ampeliscidae	4
	Gammaridae	2
	Oedicerotidae	1
	Phoxocephalidae	2
		9
1120	Ampeliscidae	8
	Isaeidae	1
	Oedicerotidae	2
		11

STATION: PPB-55

SMG	Family	Count
1121	Ampeliscidae	6
	Corophidae	15
	Dexaminidae	1
	Isaeidae	20
	Lysianasidae	3
	Oedicerotidae	6
	Phoxocephalidae	6
	Synopidae	8
		65
1122	Ampeliscidae	4
	Corophidae	15
	Dexaminidae	1
	Isaeidae	20
	Oedicerotidae	4
	Phoxocephalidae	11
	Syopidae	3
		58
1123	Ampeliscidae	10
	Corophidae	23
	Isaeidae	35
	Oedicerotidae	1
	Phoxocephalidae	6
	Stenothidae	1
	Synopidae	3
	Dexaminidae	2
		81
1124	Ampeliscidae	1
	Corophidae	4
	Isaeidae	1
		6

STATION PPB-55 (cont.)

SMG	Family	Count
1125	Ampeliscidae	1
	Corophidae	2
		3
1126	Ampeliscidae	4
	Corophidae	15
	Gammaridae	1
	Isaeidae	12
	Lysianasidae	1
	Phoxocephalidae	5
	Synopidae	1
		39
1127	Ampeliscidae	2
	Corophidae	4
	Isaeidae	1
	Phoxocephalidae	2
		9
1128	Calliopidae	1
	Corophidae	9
	Pleustidae	1
		11
1129	Ampeliscidae	2
	Corophidae	3
	Lysianasidae	2
		7
1130	Ampeliscidae	13
	Corophidae	18
	Dexaminidae	2
	Gammaridae	2
	Isaeidae	8
	Oedicerotidae	2
	Phoxocephalidae	8
		53
1108	Ampeliscidae	2
	Calliopidae	2
	Corophidae	40
	Dexaminidae	1
	Eusiridae	1
	Isaeidae	20
	Lysianasidae	2
	Oedicerotidae	3
	Pleustidae	2
	Phoxocephalidae	5
	Stenothidae	1
	Synopidae	1
		80

STATION PPB-70

SMG	Family	Count
1108	Ampeliscidae	2
	Calliopidae	2
	Corophidae	40
	Dexaminidae	1
	Eusiridae	1
	Isaeidae	20
	Lysianasidae	2
	Oedicerotidae	3
	Pleustidae	2
	Phoxocephalidae	5
	Stenothidae	1
	Synopidae	1
		80
1109	Ampeliscidae	8
	Calliopidae	1
	Corophidae	35
	Gammaridae	1
	Dexaminidae	10
	Isaeidae	40
	Lysianasidae	3
	Oedicerotidae	9
	Phoxocephalidae	11
	Stenothidae	6
	Synopidae	14
		138
1110	Ampeliscidae	8
	Corophidae	25
	Dexaminidae	3
	Eusiridae	1
	Isaeidae	20
	Lysianasidae	3
	Oedicerotidae	2
	Phoxocephalidae	5
	Synopidae	6
		73
1111	Ampeliscidae	6
	Atylidae	1
	Calliopidae	1
	Corophidae	89
	Dexaminidae	2
	Isaeidae	27
	Lysianasidae	3
	Oedicerotidae	3
	Phoxocephalidae	8
	Lysianasidae	3
		143

STATION: PPB-70 (cont.)

SMG	Family	Count
1114	Ampeliscidae	14
	Corophidae	74
	Dexaminidae	3
	Eusiridae	3
	Gammaridae	2
	Isaeidae	27
	Lysianasidae	1
	Pardaliscidae	1
	Phoxocephalidae	8
	Oedicerotidae	5
	Stenothidae	1
	Synopidae	12
		151

STATION: PPB-100

SMG	Family	Count
1131	Ampeliscidae	1
	Calliopidae	1
	Corophidae	17
	Dexaminidae	4
	Haustoridae	1
	Isaeidae	13
	Lysianasidae	8
	Oedicerotidae	8
	Phoxocephalidae	15
	Stenothidae	4
		72
1132	Ampeliscidae	1
	Corophidae	25
	Dexaminidae	4
	Isaeidae	8
	Lysainasidae	8
	Phoxocephalidae	8
		54
1133	Ampeliscidae	1
	Corophidae	25
	Dexaminidae	9
	Lysianasidae	9
	Oedicerotidae	6
	Phoxocephalidae	12
	Synopidae	1
		63
1134	Calliopidae	1
	Corophidae	2
	Isaeidae	2
	Lysianasidae	1
	Oedicerotidae	4
	Phoxocephalidae	7
		17

STATION: PPB- 100(cont.)

SMG	Family	Count
1135	Calliopidae	2
	Corophidae	5
	Dexaminidae	1
	Isaeidae	5
	Lysianasidae	6
	Oedicerotidae	2
	Phoxocephalidae	4
	Pleustidae	1
		26
1136	Ampeliscidae	1
	Corophidae	12
	Dexaminidae	1
	Isaeidae	6
	Lysianasidae	6
	Phoxocephalidae	8
	Pleustidae	1
		35
1137	Corophidae	17
	Dexaminidae	12
	Lysianasidae	10
	Oedicerotidae	10
	Pardaliscidae	1
	Phoxocephalidae	21
	Stenothidae	2
		95
1138	Dexaminidae	2
	Isaeidae	12
	Lysianasidae	20
	Oedicerotidae	5
	Phoxocephalidae	8
		47
1139	Ampeliscidae	3
	Corophidae	30
	Dexaminidae	5
	Isaeidae	30
	Lysianasidae	15
	Oedicerotidae	5
	Phoxocephalidae	20
	Stenothidae	9
		117

STATION: PPB- 100(cont.)

SMG	Family	Count
1140	Corphidae	12
	Lysianasidae	8
	Oedicerotidae	1
	Phoxocephalidae	8
		29

3. Data Management

In order to fascilitate the transfer of data to NOAA/BLM, several new techniques of data management have been developed by the OSU Benthos Group. Biological data are now recorded directly on specially designed forms from which computer cards can be punched directly. This procedure will eliminate a transcription step involving the transfer of data from notebooks to standard keypunch forms, thus both eliminating one possible source of error and speeding up data processing. Also, a new system of computer programs has been developed and implemented to maintain and manipulate the data bases at OSU being acquired by the benthic portion of the NOAA/BLM study. These programs will greatly expedite the preparation of final information products for this study in digitized form.

IV. Preliminary Interpretation of Results

It would be premature to discuss interpretations of the results available at present. Sufficient amounts of data have not been processed to allow any statistical conclusions to be drawn.

V. Problems Encountered

A major difficulty encountered during field operations this quarter was the persistence of sea ice in the Beaufort Sea throughout the summer season. The heavy ice conditions greatly limited the possible geographic coverage. During the first portion of the OCS-4 cruise much sampling time was spent in the Chukchi Sea because the ice breaker Glacier was unable to steam through the Beaufort Sea ice pack. The warping tug Alumiak also encountered difficulty, and several stations on the OCS-5 cruise plan could not be reached.

The sampling strategy at each station was also greatly affected. The trawling scheduled aboard the Glacier was severely hampered by lack of sufficient open water, and box coring could be done only with great difficulty. The Smith-McIntyre Grab could be used effectively between ice floes, but any operation with either it or with the camera system required a careful watch to make sure that the ice was not moving relative to the ship. The vessel was required to drift with the ice pack, and precise station locations could not be maintained.

Special navigation problems were encountered throughout the OCS-4 cruise on the Glacier. During the early portion of the cruise in the Chukchi Sea both the Loran and the satellite navigation systems were inoperative, and the resultant station location information was correspondingly vague. The satellite navigator was repaired in the Beaufort Sea, but a lack of satellites in appropriate polar orbit resulted in few accurate positions. Despite these difficulties, the summer sampling was accomplished rather successfully.

VI. Estimates of funds expended - Task Order 5

	NOAA Carey 976 Productivity			9/30/76
	Budget	Spent	Outstanding	Spent This Quarter
Salaries & Wages	42,710	42,232	478	8,317
Materials & Services	14,990	17,769	<2,779>	168
Travel	6,500	5,010	1,490	<57>
Equipment	47,617	47,154	463	1,000
Overhead	19,310	19,097	213	6,091
Payroll Assessment	6,410	6,263	147	2,025
TOTAL	137,537	137,525	12	22,697

RU# 7

NO REPORT AVAILABLE AT THIS TIME

Quarterly Report

R.U. 19/19E
July-September 30

SPAWNING HERRING SURVEYS IN THE BERING SEA AND FINFISH RESOURCE SURVEYS IN NORTON SOUND AND KOTZEBUE SOUND

Principal Investigator

LOUIS H. BARTON
Alaska Department of Fish and Game
Commercial Fisheries Division
333 Raspberry Rd.
Anchorage

September 30, 1976

INTRODUCTION

This paper is a progress report of activities extending through September 30, 1976, for two OCS Research Units (RU 19/19E) contracted to the Alaska Department of Fish and Game, Commercial Fisheries Division. The primary study area for R.U. 19, SPAWNING HERRING SURVEYS IN THE BERING SEA, includes all coastal waters from Unimak Pass, north, to the Yukon River Delta including Nunivak Island. The study area for R.U. 19E FINFISH RESOURCE SURVEYS IN NORTON SOUND AND KOTZEBUE SOUND, includes all coastal waters of the western coast of Alaska extending north from the Yukon River Delta to Point Hope, Alaska. Thus, the entire study area encompasses more than 3,700 statute miles (5,955 km) of coastline (Figure 1).

Investigations on spawning herring populations and other foraging finfish from Unimak Pass to the Ugashik River Mouth (part of R.U. 19) were conducted under the supervision of Mr. Irving M. Warner, Assistant to the Principal Investigator, from the State OCS office in Kodiak. A progress report of activities for that area are presented separately in Appendix I. The remainder of this paper deals with all activities occurring from the Ugashik River Mouth to Point Hope, as conducted under both RU 19 and RU 19E.

It should be noted that all figures and findings presented in this paper are preliminary and subject to change pending completion of final analysis. A project completion report for R.U. 19 will be prepared by January 1, 1977, while the final completion report for RU 19E is tentatively scheduled for September 30, 1977.

I. Task Objectives

The objectives of these research units are to:

1) Determine the spatial and temporal distribution, species composition and relative abundance of finfishes in the coastal waters of Norton Sound and Kotzebue Sound east of 166 Degrees West Longitude.

2) Determine the timing and routes of juvenile salmon migrations as well as examine age and growth, relative maturity and food habits of important species in Norton Sound and Kotzebue Sound east of 166 Degrees West Longitude.

3) Determine the spatial and temporal distribution and relative abundance of spawning populations of herring and capelin from Unimak Pass to Point Hope.

4) Monitor egg density, distribution and development and document types of spawning substrates of herring and capelin.

5) Monitor the subsistence utilization of fishery resources by local residents.

II. Field and Laboratory Activities

Subsistence Surveys

Radio and typed news releases were made in selected communities throughout the study area in late May and early June to explain the scope and purpose of the OCS program and to solicit local cooperation in the subsistence utilization studies. These releases were followed by meetings in selected villages in June to disseminate subsistence catch calendar forms.

Thirteen villages south of the Yukon River Delta were included in the subsistence survey (RU 19). Periodic interviews and collection of subsistence calendar forms were conducted by a two-man herring ground crew during herring spawning activities. Upon termination of the herring ground surveys Fisheries Technicians frequented all 13 villages to collect remaining subsistence forms and interview as many local residents as possible. Both commercial and bush plane services were utilized for this part of the subsistence survey study.

Twelve coastal villages were included in the subsistence survey north of the Yukon River Delta to Point Hope (RU 19E). A temporary Fishery Technician frequented villages about every two weeks from July through mid September to interview local residents and document subsistence catches by species.

Following is a list of information that was monitored in all 26 villages:

1. Fishery resources by species utilized by village.

2. Amount (when possible) of key species utilized in weight or actual numbers. Such species include herring and salmon. Other fishery resources utilized by villagers were noted.

3. How various resources are utilized by village (human vs non-human consumption).

4. Spatial and temporal distribution and spawning information by various resources as possible.

5. In some cases, species varification of aerial herring survey observations.

Herring Surveys

The entire coastline of Western Alaska was divided into census areas delineated by prominent geographical features prior to field investigations. This was to facilitate transcribing aerial survey data onto Data Management forms to be later submitted to NODC for archiving. Twenty-nine aerial surveys (about 80 hours of airtime) have been flown throughout the study area, extending from the Ugashik River to Shishmaref, from May 20 through July 25, 1976. The purpose of the surveys were to monitor the location, time and relative abundance of spawning herring populations and other foraging finfish. All surveys were flown on an opportunistic basis.

It was realized in the course of field investigations that aerial surveys for herring populations in the Kotzebue Sound area be aborted. This was a result of the extremely large study area included in the two Research Units and limited personnel available to conduct aerial surveys. To circumvent the loss of all 1976 herring information in Kotzebue Sound more emphasis was shifted to the subsistence surveys than was originally planned. It was hoped that information could be obtained on when and where herring occur as well as their spawning areas. Obviously, local interviews cannot take the place of aerial surveys, but at least some information will be available for future planning in the event surveys are continued.

Excellent assistance was obtained from permanent Commercial Fisheries staff Biologists of the Alaska Department of Fish and Game in flying aerial surveys. It should be realized that many of these personnel assisted during the peak of salmon field season activities and their assistance to the Principal Investigator helped contribute to more than 650 schools of fish and herring spawn being sighted. Following is a list of ADF&G permanent staff Biologists and the area of their assistance.

Michael Nelson, Bristol Bay Area Biologist - Dillingham to Cape Newenham.

Richard Randall, Bristol Bay Assistant Area Biologist - Ugashik River to Dillingham.

Don Bill, Bristol Bay Assistant Area Biologist - Ugashik River to Dillingham.

Fritz Kuhlmann, Former Kuskokwim Area Biologist - Western Coast of Alaska north of Cape Newenham.

Mike Geiger, Yukon Area Biologist - Kuskokwim River to Yukon River.

Ronald Regnart, Regional Supervisor, Region III - Western coast of Alaska.

Paul Cunningham, Former Arctic Area Biologist - Norton Sound.

Louis Barton, Principal Investigator - Dillingham to Shishmaref.

The following information was recorded during each aerial survey and immediately transcribed onto appropriate data management forms for later archiving:

a. Observer, type aircraft, speed, altitude, time.

b. Weather, sea conditions, stage of tide.

c. Species and location of fish schools.

d. Number and surface area estimates of fish schools

Attempts were made to photograph as many schools of sighted fish and spawn as possible with a hand-held 35 mm camera utilizing color slide film. All pictures were developed and the surface area of each sighted school and spawn activity calculated. Calculations were obtained by placing a calibrated grid over projected slides. Grid calibration was obtained by knowing the camera focal length and altitude at which a particular photograph was taken.

To augment aerial surveys, two-man mobile crews were deployed to primary spawning areas as determined from aerial surveys. Each crew was equipped with inflatable boats, portable camps and various types of sampling gear.

The main objective of mobile crew sampling was to define and characterize primary spawning habitats. Field sampling consisted of monitoring dates and exact location of spawning activities, species composition, extent of spawn and spawning substrates. Further, objectives were to collect a limited number of herring samples for age, length, fecundity and gut analysis. Other observations included monitoring air and water tempera-tures, weather conditions, escarpment type, beach type (intertidal and subtidal) and the presence or absence of kelp beds, *Fucus* and *Zostera* (eelgrass).

Location of herring ground crews along the coastal waters varied throughout the season as herring populations began to spawn. One crew was transported to Metervik Bay in the Togiak area of Bristol Bay on May 27. This area was one of two which supported a commercial herring operation in 1976. The crew sampled along the coast from Metervik Bay to the village of Togiak through June 12.

A second crew sampled Goodnews Bay from June 9 through June 15 and was then relocated to Cape Vancouver on June 16. Cape Vancouver was sampled from June 16 through June 25 and the crew was relocated to Cape Romanzof where they sampled from June 26 to July 7. A second short survey of Cape Vancouver was made by the crew from July 12 through July 14 to try and varify the species composition of sighted fish schools.

The second commercial herring operation along the western coast of Alaska was located at the village of St. Michael. A herring crew was transported to this area on June 16 where they remained sampling until the end of August. Their sampling area extended from St. Michael to Tolstoi Point. Two other field crews sampled herring in Norton Sound; a crew based out of Unalakleet from June 22 through Sept 10 and a crew in Golovin Bay sampling from July 7 through Sept 15. No herring samples were collected north of Golovin Bay due to limited personnel.

Pelagic Fish Sampling

Pelagic finfish surveys were included under R.U. 19E and in 1976 all onshore sampling was restricted to Norton Sound due to project funding levels. These investigations in Norton Sound were limited to onshore waters (0-3 fathoms) and based from four field camps: Unalakleet, Golovin Bay, St. Michael and Flat Island (South Mouth of Yukon River).

Unalakleet:

A two-man crew set up a base camp in Unalakleet on June 17 from which to operate. Their study area included about 60 miles of coastline extending from Tolstoi Point to Cape Denbigh. The crew operat-ed from a 22 foot open skiff and were equipped with a mobile camp and various types of fishing gear which consisted of variable mesh gillnets, beach seines, dip nets and cast nets.

About 14 permanent sampling sites were established for sampling with gillnets and beach seines and sampling commensed on June 22, 1976. All sites were sampled on a periodic basis throughout the summer with the last sample being taken on September 10. A total of 192 sets (all gear types) was made during this period. One beach seine haul and two gillnet sets were made at each station. An inshore set was made with a floating gillnet and an offshore set was made when possible with a sinking gillnet. All gillnets were of variable mesh sizes ranging from about 13 mm to 62 mm stretch mesh measure. Two 61 meter beach seines of 3.2 mm and 6.4 mm mesh size were fished.

Sampling with dip nets and cast nets was conducted randomly between established sample sites. These fishing gear were utilized primarily for species composition on schools of fish observed in areas apart from established sample stations.

The time all fishing gear were disployed and retrieved was monitored as well as depth of sample site, distance from shore, weather conditions, water temperatures, tidal stage, beach and biota type and the presence of marine mammals or birds.

Golovin Bay

A two-mah crew set up a base camp in Golovin on July 3 from which to conduct sampling operations. Sampling was conducted from a 17 foot Boston Whaler and included coastal waters extending from Rocky Point to Cape Darby. About ten permanent sampling sites were established and 207 sets (all gear types) were made from July 7 through September 15 on a periodic basis. The crew was equipped with a mobile camp and various fishing gear and observations made at each station held consistent with those made by the Unalakleet crew.

St. Michael

The two-man herring crew which had been sampling for herring from a 15 foot inflatable boat since June 16 was equipped with two large variable mesh gillnets (one sinking and one floating) on July 15. This crew established several permanent sample sites from St. Michael to Tolstoi Point and sampled on a periodic basis with the larger variable mesh gillnets for all pelagic finfish until August 17. A total of 100 gillnet sets were made. Characteristics of the beaches in this study area precluded the use of beach seines. As catches began to decline in mid August this camp was closed down on the 23rd. A special thanks is due Guy and Tina Morris for their hospitality in providing the crew with housing in St. Michael.

Flat Island

A two-man OCS crew was deployed at Flat Island (South Mouth of Yukon River) on June 9. The crew shared facilities with an ADF&G management crew who was conducting adult salmon studies. The OCS crew was equipped with variable mesh gillnets with the same specification as the Unalakleet, Golovin Bay and St. Michael nets. Hand purse seines 30.5 meters long by 3.0 meters deep and 6.4 mm mesh size were utilized as opposed to beach seines. This was due to the characteristics of the Yukon River estuary in which the crew was sampling. The primary study area included approximately 250 square miles of the Yukon River Delta including Kwikluak Pass, Kwemuluk Pass, Alakanuk Pass and Kwiguk Pass.

Since little was known of pelagic finfish occurring in the study area, sampling by the Flat Island crew consisted of a reconnaissance type survey. Few permanent sampling sites were located due to the extremely large area to be covered and unlikely chance that replicate sets could be made. Sampling began on June 16. The first area covered was in the immediate vacinity of Flat Island and the Kwikluak Pass. The OCS camp was relocated to the village of Emmonak on July 17 where sampling Alakanuk Pass and Kwiguk Pass could be more readily accomplished. These areas were sampled from July 20 through August 5.

Biological sampling by all four pelagic fish crews was held consistent and included the following being monitored:

a. The total catch of all finfish by species and gear type was recorded for each set.

b. Incidental catches of shellfish, molluses, etc., was also recorded.

c. Lengths were taken on not more than 25 fish of each species captured and the type of length measurement recorded.

d. No length measurements were taken on adult salmon, molluses or shellfish.

e. No more than eight juvenile salmon of each species captured by seine nor more than four per pannel size in gillnets were preserved for age and foregut analysis.

f. Fifty to sixty herring were preserved for later length, age, fecundity and foregut analysis in the case of large catches.

It was realized in the course of field investigations that the NOAA ship, Miller Freeman would be conducting demersal and pelagic fish trawl studies in the Northern Bering Sea and Chukchi Sea during September and October. Arrangements were made for Alaska Department of Fish and Game personnel involved with R.U. 19E investigations to conduct gillnetting studies on board the vessel. Seven, 50 by 3 fathom shackles connected together to form 350 fathoms of long net were fished in hours of darkness for approximately eight to ten hours each night. A radio buoy, marker and floats were attached to the end of the net for ease in recovery. The seven shackles varied in size as follows 0.83" (21mm), 1.83" (35mm), 1.65" (42mm), 2.50", 3.25", 4.50" and 5.25". Upon retrieval of the gillnets, the catches were removed from each shackle and placed into separate baskets in order that catch records could be obtained by mesh size.

A series of replicate gillnet stations were reoccupied to determine temporal changes in species composition and density. Duration between initial and replicate sets varied from a few days to two weeks. Approximately 24 hours were spent at each replicate site. Four gillnet sets were preformed including an 8-10 hour set identical to the earlier evening set, and three daytime sets of eight, four and two hours duration. Location of replicate sets varied. Sampling procedures for the replicate and variabletime gillnet sets was held consistent with those methods used for the standard evening sets. Figure 2 shows all sampling stations for Legs I & II of the Miller Freeman cruise.

Thanks is in order for Fishery Biologist, Rae Baxter of the Alaska Department of Fish and Game for his assistance in monitoring the gillnet program for the second half of Leg I.

Following is a list of personnel and their respective duties during the 1976 field season for studies conducted from the Ugashik River, north, to Point Hope:

Dan Schneiderhan, Fishery Biologist (A.P.I.) - field supervision of pelagic fish crews in Norton Sound.

Pete Mikolaitis, Fishery Biologist - Crew leader, Golovin Bay pelagic fish crew.

Lawrence Field, Fisheries Technician - Golovin Bay pelagic fish crew.

John Edmundson, Fishery Biologist - Crew leader, Unalakleet pelagic fish crew.

Donna Manders, Fisheries Technician - Unalakleet pelagic fish crew and Togiak herring crew.

Lee NeMark, Institute Marine Service, University of Alaska - Unalakleet pelagic fish crew.

Jerry Ruehle, Fisheries Technician - Crew leader, St. Michael pelagic fish crew.

Tom LeMon, Fisheries Technician - St. Michael pelagic fish crew and Togiak herring crew.

Don Acker, Fishery Technician - Crew leader Flat Island pelagic fish crew.

Patrick Reinhard, Fisheries Technician - Flat Island pelagic fish crew.

Michael Jonrowe, Fishery Technician - Crew leader, West Coast herring crew.

Eugene Joseph, Fishery Technician - West coast herring crew and subsistence surveys south of Yukon River Delta.

Catherine Tate, Fishery Technician - Subsistence surveys north of Yukon River Delta.

Don Seagren, Fishery Biologist - Party chief on Leg II of R/V Miller Freeman cruise.

III. Results and Preliminary Interpretation

Data compilation and analysis at present is still being conducted due to the large amount collected. Most of the field projects were not terminated until late August and mid September. Leg II of the R/V Miller Freeman cruise is not to be completed prior to mid October. The number of individual projects and field crews collecting data over more than 3,500 miles of coastline together with only recent shut-down of operations for most of them has precluded having all data summarized prior to this report. At the present time data is still being transcribed onto data management forms. Herring scales have yet all been read, fecundity samples analyzed, catch per unit effort (CPUE) indices calculated by gear type, and analysis of herring aerial photographs for relative abundance made. Therefore, only few results and limited interpretation of the same are presented in this paper.

Subsistence Surveys

Subsistence fishing by coastal villages south of the Yukon River Delta is one of the most important factors for means of survival by local residents. Most subsistence catches consist of herring, chum salmon, king salmon, sockeye salmon and pink salmon. Other species of fish are captured but not to the degree of those listed above. Such species include sole, Irish Lord, whitefish and Northern pike.

Herring are the first species to appear after ice breakup and runs are relatively short. As a consequence, local residents catch as many as they can and preserve them for the winter season. Whole herring as well as herring roe is usually preserved by drying. Roe on kelp is also harvested by some villagers and serve as side orders for the dinner table.

Herring runs are followed by adult salmon runs which may vary from one to two months depending upon run strength. All five species of Pacific salmon are harvested to some degree, dried and preserved for the winter. Other fish that are harvested for subsistence purposes during the summer season are sole and Irish Lords. Northern pike and whitefish are taken year-round and winter months they are captured with gillnets under the ice.

Villages that were surveyed south of the Yukon River Delta in 1976 were Goodnews Bay, Quinhagak, Chefornak, Kongiganak, Kwigillingok, Kignuk, Mekoryuk, Toksook, Umkumiut, Tanunak, Hooper Bay, Scammon Bay, Newtok and Chevak. Results from the survey are presented in Table 1. Pacific herring was taken by 12 of the 14 villages surveyed (including Goodnews Bay which showed poor response) for subsistence purposes. An estimate of over 181,000 pounds of herring were taken throughout the sampling period. The largest catches of herring were made by the Nelson Island villages: Toksook, Umkumiut and Tanunak. Nelson Island aerial surveys revealed this area to be one of primary spawning for herring.

The survey revealed that nearly 39,000 adult chum salmon were harvested by nine of the villages for subsistence purposed. Hooper Bay took nearly 65% of this figure alone. In all probability these chums were destined for the Yukon River.

The location of villages seems to play an important role in the amount and type of fish species taken. Coastal villages tend to take more herring and salmon as opposed to the inland villages which rely more on pike, blackfish and whitefish. Villages located near primary spawning areas for herring usually harvest more of that species such as at Nelson Island.

Results from the subsistence surveys conducted north of the Yukon River Delta are presented in Table 2. Catch figures are presented from 12 villages for the five species of Pacific salmon and Pacific herring. Other fishery resources utilized by village are listed and the resource given as the common name known to villagers. In most cases the actual species could not be varified because none were available at the time of the survey. The OCS survey revealed that villages in Kotzebue Sound are involved in subsistence fishing to a much greater extent than Norton Sound villages, even though this is not clearly seen from Table 2.

A total of three subsistence survey rounds were made in Norton Sound with two rounds being completed in Kotzebue Sound. It was felt that subsistence fishing in Norton Sound may have been greater in 1976 than previous years due to the weak salmon runs in that area and resulting commercial fishing closures.

Preliminary findings suggest that fishery resources north of the Yukon River Delta are not utilized by local residents for subsistence purposes as extensively as those villagers living below the Yukon River. Reason for this may be due in part to more involvement of Norton Sound/Kotzebue Sound villagers in commercial fishing as opposed to area south of the Yukon River. Also, local residents north of the Yukon River supplement much of their subsistence needs with big game animals. This important resource is not present along the western Alaska coast from the Yukon River Delta to Cape Newenham. It should be pointed out however, that a commercial herring roe extraction operation occured at St. Michael this season and over 17,000 pounds of herring were processed. After extracting the roe, fish were given to the villagers, thereby reducing the need for subsistence efforts in that area.

Herring Surveys

Inclimate weather and size of the study area were determining factors on the number of surveys conducted in 1976 and as already indicated all surveys were flown on an opportunistic basis. Consequently, time of spawning activity and identity of primary spawning habitats could not be determined for certain locals throughout the study area. This is particularly true of areas on the Seward Peninsula. However, data collected should provide information on the spatial and temporal distribution of fish schools.

One of the problem areas associated with aerial surveys this past season has been with species identity. This is particularly true in the area of Pt. Clarence to Shishmaref. No float or amphibious plane service is available north of the Yukon River mouth and consequently lack of this service precluded landing,to varify species composition when in doubt. Exact identity of many fish schools sighted along the coastline from the village of Togiak to Cape Newenham could not be made also.

Figure 3. reveals where fish school sightings were made as well as preliminary indications of primary herring spawning habitats. Most of the primary spawning areas for herring as observed from aerial surveys revealed them to be areas where little or no beaches existed. Such areas usually consisted of large rocks or cliffs and where beaches occurred, the substrate was generally comprised of large rocks covered with fucus. Schools of capelin were usually observed off fine sand to small clean gravel beaches. A preliminary review of data collected by herring ground crews support this observation.

Generally speaking, herring populations appear on their respective spawning grounds along the western coast of Alaska at different times in the spring and summer months. Peak of spawning activity along the northern coast of Bristol Bay (Togiak Fishing District) generally occurs in late May or not later than the first week in June. Spawning populations along the western Alaska coastline appear about mid June to early July, while populations in Norton Sound were observed spawning in early to mid July. Although no spawning activity was observed, many schools of fish believed to be herring were noted on July 21 in Pt. Clarence and Grantley Harbor. No schools were observed in this area four days later but large concentrations were observed along the coastline extending from Cape Prince of Wales to the village of Shishmaref. Some spawning activity was observed at Shishmaref on that same survey.

Analysis of biological samples collected by the herring ground crews is not entirely completed and thus, no information in reference to age, length and fecundity on herring populations is available at this time.

Pelagic Fish Surveys

A total of 37 species of finfish were captured and identified by the four pelagic finfish crews sampling Norton Sound from Flat Island to Golovin Bay (Table 3). Twenty-nine species were captured by the Unalakleet crew, 25 species at Golovin Bay, 18 species by the St. Michael's crew and 19 species were identified at the south mouth of the Yukon River. Ten species were captured by all four crews:

Pink Salmon

Chum Salmon

Coho Salmon

Arctic Char

Humpback Whitefish

Broad Whitefish

Bering Cisco

Least Cisco

Yellow Fin Sole

Rainbow Smelt

The most abundant fish captured by the St. Michael crew was Pacific herring. The three most frequently captured species were least cisco, Pacific herring and saffron cod, respectively. The St. Michael crew capture relatively few species of fish as well as low numbers of fish when compared to Unalakleet and Golovin Bay results. Preliminary indications are that this may be due to the St. Michael crew not being able to fish with small mesh beach seines. Both the Unaklakleet and Golovin Bay crews found the beach seines to be the most effective gear fished. Both crews indicated that beach seines captured the largest variety of species as well as a greater number of fish of each species than the variable mesh gillnets. Twenty-eight percent of the sets by the St. Michael crew revealed no catch. No juvenile salmonids were captured with the gillnets in this area and catches of most all other species began to decline by August.

Both the Unalakleet and Golovin Bay crews fished beach seines as well as gillnets and the former proved vital for capturing juvenile salmonids. Juvenile salmon (primarily pink followed in order by chum and king) were captured in the course of the season but not in large numbers. The Golovin Bay crew began sampling operations on July 7 and Unalakleet the last of June. Ice breakup in Norton Sound was later than usual occurring about June 10-20. Therefore, the Golovin Bay crew got in the water about 3 weeks late due to late arrival of equipment and Unalakleet began about 1-2 weeks late.

The Unalakleet crew saw a peak in juvenile salmon catches about the first week in July and the Golovin Bay crew caught small numbers of juvenile salmon from July 7 through about July 19 at which time a decrease occurred. These findings are based on a very cursory review of EDS forms which are still in the process of being completed.

The most abundant and frequently captured species by the Unalakleet crew was rainbow smelt. This species was captured in 43% of the sets of all gear types and numbered more than 4,000 for the season. The second and third most frequently captured species were saffron cod and Bering cisco, respectively. Only about 6% of all gear sets revealed negative catches.

Although the Golovin Bay crew captured more than 17,000 sand lance in the course of the season, they were not among the three most frequently capture species. The most frequently captured was saffron cod followed in order by stary flounder and Bering cisco. Negative catches resulted in approximately 23% of all sets made in Golovin Bay.

On May 31 ice was still in the Yukon River and did not move out until June 1. At that time Sheldon Point was iced-in but sampling could have began on that date. The Flat Island OCS crew made their first set for pelagic fish on June 16 and consequently more than two weeks of sampling was lost due to a late start from arrival of sampling equipment. All catch data is still being summarized at this time. However, preliminary figures indicate that species belonging to the family Coregonidae were the most abundant and frequently captured. It can be stated also that hand purse seines were the only gear that captured juvenile fishes.

A total of 63 purse seine sets and 91 gillnet sets were made throughout the course of the season. Gillnet sets involved both beach and drift sets and varied in duration from 2-26 hours with a mean of about 11.5 hours per set. Preliminary figures show approximately 875 total fish captured for the season for all gear types.

Catch per unit effort indices by gear type and location are still being calculated for all of the pelagic fish data collected under RU 19E. This task must be completed before any inferences or conclusions can be made about the spatial and temporal distribution or relative abundance of fish species.

The first leg of the Miller Freeman cruise (76B) was completed on September 24. A total of 22 gillnet sets were made and represented 202 hours of fishing time. Following is a list of species capture and the total catch of each:

King Salmon	4 (juveniles)
Pink Salmon	5 (juveniles)
Chum Salmon	4 (1 juvenile)
Bering Cisco	3
Arctic Char	8
Pacific Herring	132
Rainbow Smelt	47

Pond Smelt	4
Saffron Cod	5
Myoxocephalus joak	7
Gmnocanthus sp.	1
Stary Flounder	2
Total fish	222

Approximately 23% of the gillnet sets produced negative catches. The most frequently captured species was Pacific herring which were taken in 55% of the sets. Rainbow smelt occurred 41% of the time.

The gillnetting studies as conducted on board the Miller Freeman were not as successful as initially hoped. Only one set of backup gillnets were available for use. About half way through the first leg both the initial and backup nets consisting of the smaller mesh sizes (21mm, 35mm and 42mm) were destroyed. This left only the larger mesh pannels (5-1/4 inch, 4-1/2 inch, 3-1/2 inch and 2-1/4 inch) available for use during the remaining part of Leg I and all of Leg II. Preliminary findings reveal the three smaller pannels were the most effective in capturing most species apart from adult salmon, thus, it is felt much "would be" valuable data cannot be collected for the remainder of the cruise.

IV Problems/Changes

The largest single problem associated with all studies as conducted under RU 19/19E was the extremely large size of the study area (3,784 miles of coastline from Unimak Pass to Point Hope). This factor together with inclimate weather conditions would have resulted in minimal aerial herring surveys if it had not been for the much appreciated assistance of permanent Alaska Department of Fish and Game Biologists. All surveys had to be flown on an opportunistic basis and thus the Principal Investigator could not have flown all aerial surveys. On occasions optimum survey conditions would exist in one area that may be several hundred miles from the surveyors location, but due to inclimate weather conditions at his location, assistance from ADF&G representatives had to be obtained. This problem could have been much greater in magnitude had herring populations arrived at all coastal spawning sites at the same time.

A second factor which hindered aerial surveys conducted under RU 19E resulted from no float or amphibious plane service being available north of the Yukon River Delta. As a consequence, time of spawning activity and identity of primary spawning habitats could not be determined for certain locals throughout the study area. This is particularly true of areas on the Seward Peninsula. Numerous schools of fish were observed in the Port Clarence/Grantley Harbor area and along the coast from Cape Prince of Wales to the village of Shishmaref but no spawning activity was observed. Return flights later showed fish had left the areas but no documentation of spawning grounds could be obtained. 1977 aerial surveys should be conducted to augment the 76 surveys in order to try and define some of the spawning habitats and locals as well as spawning dates in these areas.

One problem associated with herring ground sampling resulted from different populations of spawning fish arriving on their respective spawning grounds at or near the same time, thus, most spawning populations were not biologically sampled. Although this was anticipated initial plans included having the aerial surveyor land, varify species and collect a limited sample. Inclimate weather was the deciding factor in not permitting this to be done. This technique of sampling generally posed a very hazardous situation for the surveyor and was not relied upon. No herring samples were collected north of Golovin Bay due to limited personnel.

Major problems associated with pelagic fish sampling have been with start-up difficulties. Most of these problems stemmed from late funding of R.U. 19E. State of Alaska standard operational procedures in reference to receiving and spending Federal funds, purchase calendar dates and contract award vendors had to be adhered to. This in turn resulted in late arrival of boats and large quantities of sampling equipment and supplies. Boats had to be fabricated and all equipment purchased, assembled and shipped to remote locations.

Late start-up by the pelagic crews resulted in about two weeks of no sampling effort during, perhaps the most critical time of the year. The first two weeks of open water after spring breakup in Norton Sound and the Yukon River mouth were not sampled. It is felt that valuable information in reference to juvenile salmon species was not obtained. This problem should be alleviated in 1977 since most of the sampling supplies and equipment is already on site.

Difficulties encountered with gillnetting activities on board the Miller Freeman resulted from weakly constructed gillnets for such activities. The float lines stretched under extreme tension when retrieving the gillnets causing the webbing to pop, especially on the smaller mesh shackles. A more stiff webbing in all shackles together with different floats and a heavier float line may have helped reduce the gillnets from bunching together during long soaks.

Purchase of dissecting microscopes for field use in identifying species would greatly benefit the entire OCS program. At present only the laboratory is equipped with one.

IV. Estimate of Funds Expended

Spawning Herring Surveys-Ugashik River to Yukon River Delta (R.E 19)

A.	Salaries 1/	19.7 K
B.	Travel & Subsistence	2.2 K
C.	Contractual Services	11.9 K
D.	Commodities	8.4 K
E.	Equipment	9.7 K
	10% Overhead	4.2 K
	Total Est.	56.1 K

Research Unit 19E

A.	Salaries 1/	41.7 K
B.	Travel & Subsistence	6.2 K
C.	Contractual Services	19.7 K
D.	Commodities	16.2 K
E.	Equipment	14.6 K
	10% Overhead	8.4 K
	Total Est.	98.4 K

1/ These figures do not include expenditures for the month of September.

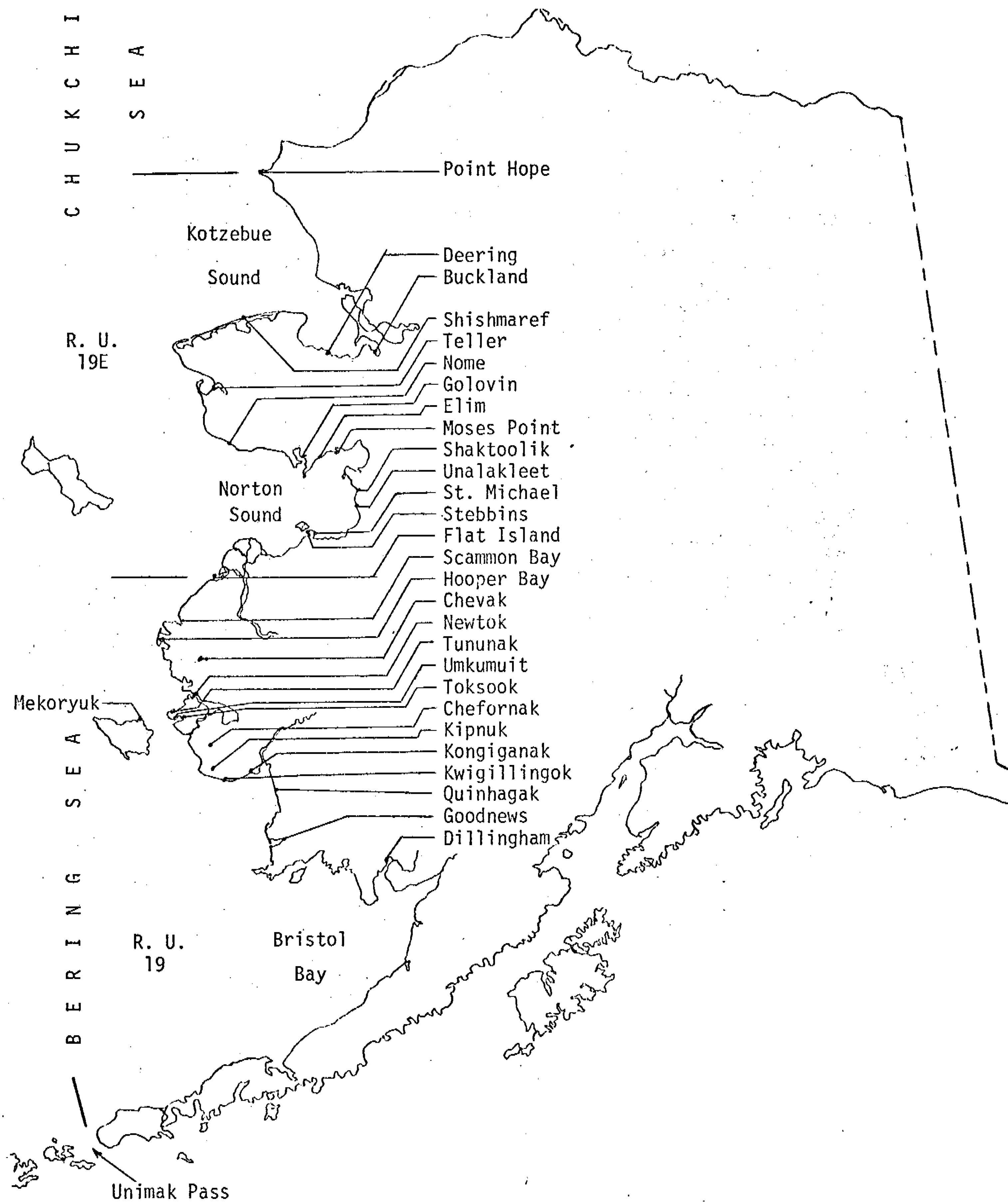


Figure 1. Study area of OCS research activities as conducted under R.U. 19 and R.U. 19E (Approximately 3,750 miles of coastline), 1976.

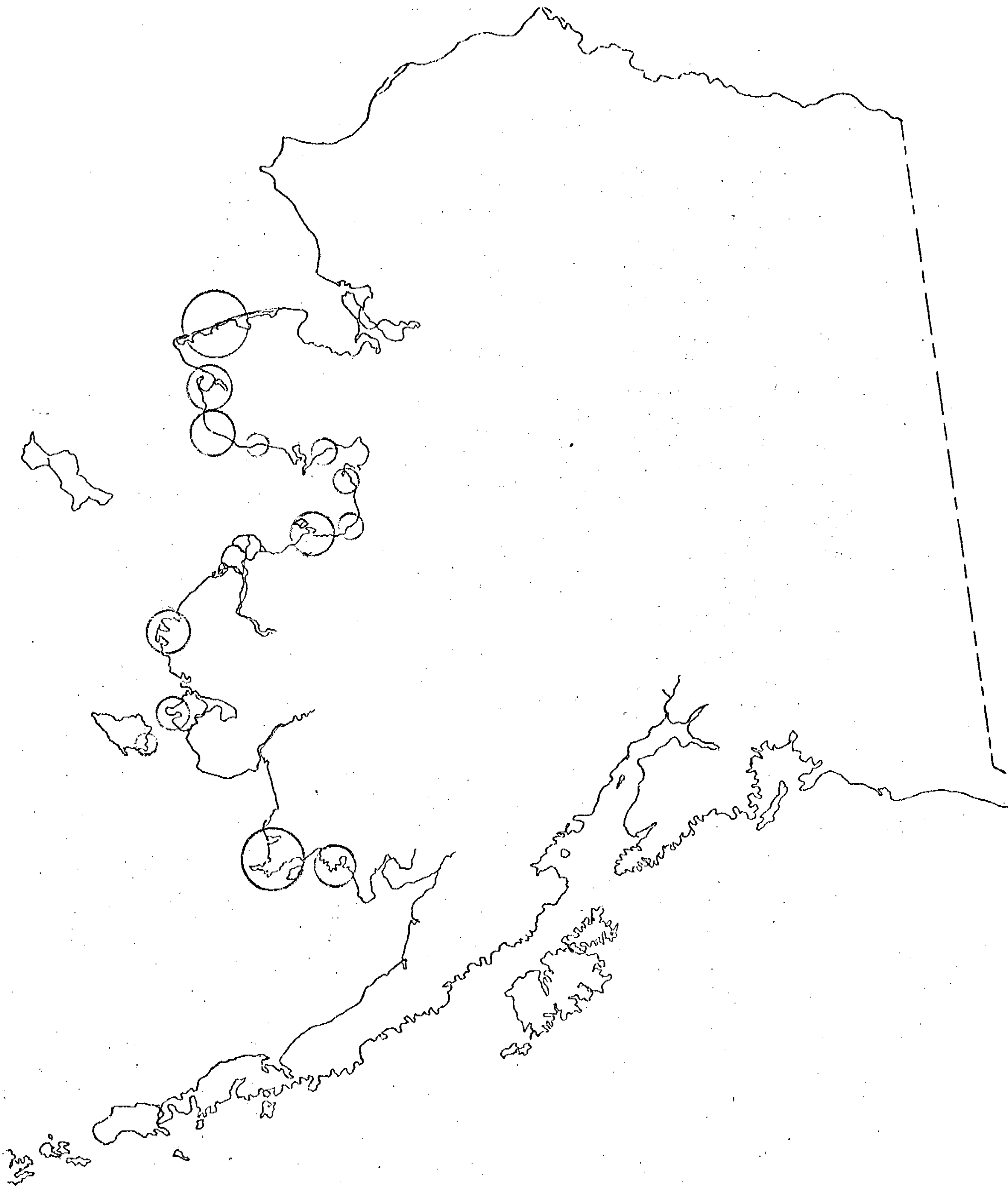


Figure 2. Locations of sighted fish schools and/or spawn as observed from aerial surveys, 1976.

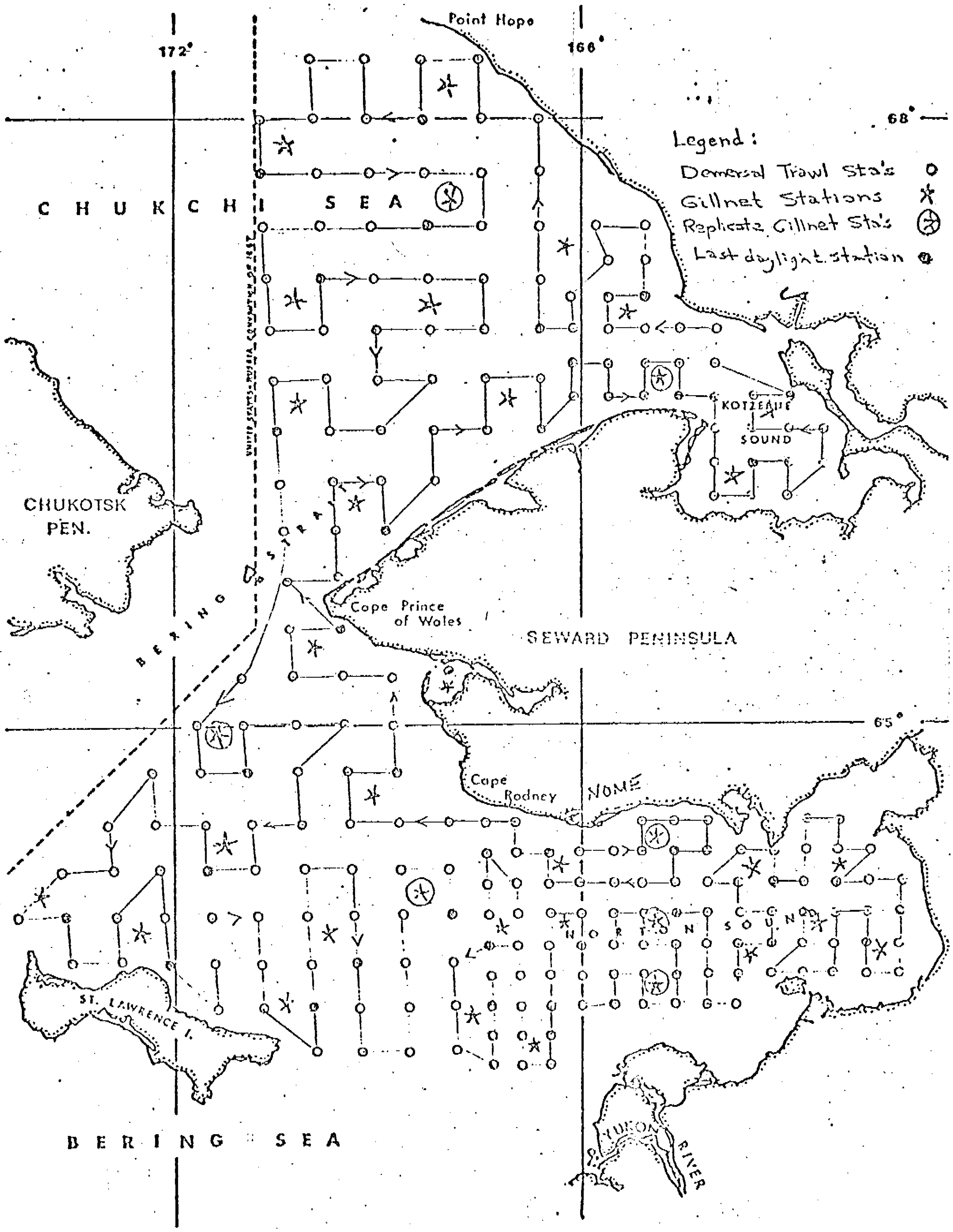


Figure 3. Station Locations, Legs I & II

Table 1. Results of subsistence surveys as conducted under R.U. 19 for 14 villages south of the Yukon River Delta, 1976.

Village	Salmon King	Salmon Chum	Salmon Sockeye	Salmon Pink	Herring	Smelt	Capelin	Tomcod	Whitefish	Irish Lord	Sole	Trout	Blackfish	Pike
Scammon Bay	184 1/	2,173			1,390# 2/			79	235	4	16			
Hooper Bay	750	25,016		113	6,007#			215	780	2	19			
Tanunak	102	100	881		30,593#			20						
Umkumiut	57	50	872		18,660#		1,140#	30						
Toksook Bay	435	933	1,930	545	85,675#	125#	600#		150		40#			
Mekoryuk		2,364		290	2,360#					3		5		
Newtok	2		384	5	300				174				10#	1,484
*Chevak	83	7,925			1,400#			730	215	200	8			
*Kipnuk					1,500#				100#					
Kwigillingok	60	224			21,350#				300					
Kongiganak		146												
*Chefornak			15		12,050#									
Quinhagak						6,450								
Goodnews Bay	POOR RESPONSE													
Estimated Totals	1,673	38,931	4,082	953	181,000#	6,500	1,740#	1,074	2,000	209	75	5	10#	1,484

1/ Represents numbers of fish.

2/ # represents pounds of fish.

* Non-coastal villages.

Table 2. Results of subsistence surveys as conducted under R.U. 19E for 12 villages north of the Yukon River Delta, 1976.

Village	Salmon					Herring	Smelt	Whitefish	Tomcod	Flounder	Arctic Grayling	Trout	Bullheads	Lingcod	Skipjacks	Northern Pike	Cigarfish	Mud Sucker	Blue Cod	Pollock	Halibut	Blackfish	Needlefish	Rockfish	Sheefish	Clam (Blue)	Mussels	Crab (King)
	Pink	Chum	King	Silver	Sockeye																							
Stebbins	564	4,285	471	1,071		2,463	X	X	X	X		X									X	X	X		X	X	X	
St. Michael	39	2,385	89	50	2	2,734	X	X	X	X																		
Unalakleet/Shaktoolik	1,076	920	26	234		300	X	X	X	X	X	X												X				
Moses Pt./Elim	5,016	1,548	22	X		150	X	X	X	X	X	X	X	X	X													X
Golovin	1,995	1,128	0	11		0	X	X	X		X	X																
Teller	200	5,800	4	X	200	X	X	X	X	X		X	X	X	X	X												
Shishmaref	410	300	5	5	50	X	X	X	X	X	X	X	X	X					X									
Deering	21	731	0	88		X	X	X	X	X	X	X	X				X											
Buckland	23	600	3	10		X	X	X	X	X	X	X	X					X		X								
Pt. Hope	X	X			X		X	X	X		X																	
Total	9,344	17,697	620	1,469	252	5,647																						

Table 3. A list of fish species identified in Norton Sound by sampling crews, 1976.

Species	Field Camps[1/]			
	Unk	Gol	St. M	F. I
Oncorhynchus gorbuscha (pink salmon)	X	X	X	X
Oncorhynchus keta (chum salmon)	X	X	X	X
Oncorhynchus tshawytscha (king salmon)	X	X		X
Oncorhynchus kisutch (coho salmon)	X	X	X	X
Salvelinus alpinus (arctic char)	X	X	X	X
Coregonus pidschian (humpback whitefish)	X	X	X	X
Coregonus nasus (broad whitefish)	X	X	X	X
Coregonus cylindraceus (round whitefish)	X			
Coregonus laurettae (Bering cisco)	X	X	X	X
Coregonus sardinella (least cisco)	X	X	X	X
Eleginus gracilis (saffron cod)	X	X	X	
Platichthys stellatus (starry flounder)	X	X	X	
Liopsetta glacialis (Arctic flounder)	X	X		
Pleuronectes quadrituberculatus (Alaska plaice)	X	X		
Limanda proboscidea (longhead dab)	X			
Limanda aspera (yellow fin sole)	X	X	X	X
Agonus acipenserinus (sturgeon poacher)		X	X	
Pallasina barbata aix (Tubenose Poacher)	X	X		
Ocella dodecaedria (Bering poacher)	X	X		
Clupea harengus pallasi (Pacific herring)	X	X	X	
Mallotus villosus (capelin)	X			X
Osmerus dentex (rainbow smelt)	X	X	X	X
Hypomesus olidus (pond smelt)	X			
Pungitius pungitius (ninespine stickleback)	X	X		X
Gasterosteus aculeatus (threespine stickleback)		X		
Hexagrammus stelleri (whitespotted greenling)	X	X	X	
Hexagrammus lagocephalus (terpug)	X	X	X	
Stenodus leucichthys (Sheefish)				X
Esox lucius (Northern pike)				X
Lota lota leptura (burbot)				X
Catostomus catostomus (Northern sucker)				X
Entosphenus tridentatus (Pacific lamprey)				X
Entosphenus lamottei japonicus (Arctic lamprey)	X			X
Liparis rutteri (ringtail snailfish)	X			
Cottidae sp. (sculpins)	X	X	X	
Stichaeidae sp. (prickleback species)	X		X	
Ammodytes hexapterus (sandlance)		X		
Total	29	25	18	19

1/ Unk - Unalakleet
Gol - Golovin
St. M - St. Michael
F. I - Flat Island

APPENDIX I

FORAGE FISH SPAWNING SURVEYS, UNIMAK PASS TO UGASHIK RIVER

(PART OF R.U.19)

Quarterly Report

Irving M. Warner
Pamela M. Shafford
Alaska Department of Fish and Game
P.O. Box 686
Kodiak, Alaska 99615

Prepared for:

National Oceanic and Atmospheric Administration
Environmental Research Laboratories
Boulder, Colorado

RU #19
Census Areas 1-5

QUARTERLY REPORT

I TASK OBJECTIVES

The primary objectives of the herring-forage fish assessment were as follows: 1) to determine seasonal occurance, 2) to determine the distribution and relative abundance of herring-forage fish resources in the contract area, and 3) to determine utilization of the resource by coastal residents. Secondary objectives of this study included studies of the life history of the various forage fish in the study area, and to determine substrate utilization in regards to spawning requirements of the fish.

II FIELD ACTIVITIES AND LABORATORY ACTIVITIES

The study area was on the north coast of the Alaska Peninsula between Cape Sarichef and Ugashik Bay. A field camp was established in the study area on 5/13/76, and test fishing was begun at that time. A mobile camp was moved into the area on 6/3/76, and maintained until 7/4/76. Aircraft surveys were initiated on 4/6/76 and ended on 7/12/76. Chartering was done exclusively with Peninsula Airways Inc., based in King Salmon, Alaska. Early flights were completed in twin engine Grumman "Widgeons", and later surveys were done in a single engine Cessna 206. Laboratory operations began on a part time basis on 5/25/76, and continued until full time laboratory activities began on 7/15/76. The laboratory is located in Kodiak, Alaska, and is operated by the ADF&G, OCSEAP. A herring-forage fish literature search was carried on at the University of Washington fisheries library between 9/6/76 and 9/13/76. Fecundity samples were taken in field and in the laboratory. Samples were taken by a NMFS charter boat, the M/V PAT SAN MARIE in the Bering Sea-Bristol Bay area; these samples were taken between 5/17 and 5/21. Field samples were taken between 5/20/76 and 6/17/76 on the Bering Sea side of the Alaska Peninsula from Ugashik Bay to Cape Sarichef at various onshore sites.

Members of the scientific team which comprised this section of RU 19 were supervised by Mr. Irving M. Warner (Assistant to the Principal Investigator, henceforth termed A.P.I.). Members are as follow: 1) Mrs. Pamela Shafford, Fisheries Biologist, ADF&G, 2) Mr. John Marholic, Fisheries Technician III, ADF&G, 3) Mr. Henry Morgan, Fisheries Technician III, ADF&G, and 4) Mr. Mike Whelan, Fisheries Technician II, ADF&G, Kodiak. Mr. Warner carried on his activities under the immediate supervision of Mr. Peter B. Jackson, OCS Coordinator, ADF&G, Kodiak, and under the overall project coordination and supervision of Mr. Lou Barton, Principal Investigator, ADF&G, Anchorage. Technical advice and services were generously given by Mr. Tom Copeland, ADF&G, Ketchikan, Mr. James Blackburn, ADF&G, Kodiak, and Dorothy Lunsford, Librarian ADF&G, Juneau. Offshore specimens were collected by Mr. Larry Bartlett, NMFS, Kodiak

III METHODS

Aerial surveys were conducted at an altitude of 300 meters and at a speed of 115 knots. Surveys were always begun during favorable weather, i.e. the ceiling had to be at least 300 meters, with a forward visibility of four kilometers; winds had to be less than 15 knots for a successful survey. No precipitation was preferable, although on two occasions surveys were begun with very light rainfall in progress. All physical, biological and aerodynamic parameters were noted on standard aerial survey forms (Figure 1) which will be submitted for keypunching and eventual transfer to diskettes. Information was dictated into a casette-type tape recorder in the air, and transcribed onto forms at the Port Heiden field base. Polaroid sun glasses were worn to reduce glare and enhance water-depth visibility. If inclement weather was encountered, the survey was terminated in that census area. To facilitate geographical location of sighted fish schools, the study area was divided into alpha-numerically designated plots termed "CENSUS AREAS" (Figure 2).

Field methods employed to catch specimens were of two types: 1) variable mesh gillnets, ranging from 14 mm to 40 mm (unstretched mesh measurement), that were from 17 meters to 23 meters in length by 1.75 meters in depth. Gillnets were set "dry" at low tide, allowed to be inundated by the incoming tide, allowed to fish for the entire tide cycle, then picked prior to the net going dry because of heavy bird predation. A New England fish trawl was operated off the boat M/V PAT SAN MARIE, under charter to the National Marine Fisheries Service; forage fish specimens were taken ancillary to demersal fish and shellfish operations on an interagency request from the A.P.I. All specimens were measured in millimeters, and weights taken to the nearest gram; measurements were taken on a standard fish measuring board and weights with a standard triple beam balance. Herring were measured in standard length (Eddy, 1969) and all other specimens measured in fork lengths (Carlander, 1969). All scales and/or otoliths were put in small 3"x 5" field envelopes, where the data was recorded for each specimen. Any gonads taken were fixed in either 50% isoprophyl alcohol, 50% methyl alcohol or standard Gilson's solution. Whole specimens, when taken at onshore sites, were fixed in 50% methyl alcohol ("Ban Ice"). Specimens were processed directly at the field sites; shipboard samples were frozen whole, transported to the Kodiak facility, and all sampling was completed there in a manner identical to those methods employed in the field.

Ageing of herring is being accomplished by microscopic examination of otoliths and scales. The otoliths will be read on a black plastic otolith card after being placed in Xylene. Laboratory techniques used to mount herring scales were acquired during a three day scale workshop held at the Kodiak laboratory on August 4 and 5, 1976. Mr. Tom Copeland (ADF&G, Kodiak) directed the workshop, which was attended by the Principal Investigator, his assistant, and other ADF&G personnel involved in forage fish/finfish research. Scales were mounted directly onto glass slides by the use of a 10% mucilage glue solution. After the scale was cleaned and dryed, it was dipped in the glue solution, then mounted on the slide immediately. The slide was then blotted thoroughly; when 15 of the scales were mounted on the slide, they were then ready for immediate "reading". Consecutive numbering and dating was used to coordinate the data sheets with the slides. Reading of the scales is being conducted presently through a standard dissection microscope by counting all the annuli including the outside edge of the scale as being an annulus (Blackenbeckler, personal communication, 1976). Ageing of Osmerids is being done by a similar use of scales and otoliths when possible. Otolith weight frequencies, obtained by use of an analytical balance, are being employed for ageing (Ricker, 1971).

The Gonad index (Table III) described by Moberly (1971) for use on herring, was used on all specimens of forage fish. Field samples of herring ovaries were taken from fresh fish, preserved in 50% methyl alcohol or Gilson's fluid, stored in "Whirl-Pak" bags and kept at ambient temperature until the field crew returned to Kodiak in July.

Lab samples of ovaries were taken from thawed fish, stored in 50% methyl alcohol solution, kept in "Whirl-Pak" bags and stored in a refrigerator for later analysis. Fecundity was estimated by both volumetric displacement and weight methods. The weight method proved to be far more expedient and accurate with the means available, however, the volumetric displacement data will be used and reported in separate tabl with the preliminary assumption that the weight data is the more reliable.

The displacement method entailed displacing one cc of water with eggs for three replicates from each female, similarly finding the displacement of the remaining eggs, counting the number of eggs in each replicate and calculating total estimated egg count. Fecundity of eleven individuals was done by this method at which time it was felt that the weighing of eggs would be more reliable, therefore we proceeded with dry weight measurements.

For dry weight analysis the ovaries were broken up manually and as much of the membrane was removed as possible by repeated washings through a sieve. The eggs were then laid on filter paper and allowed to air dry for five to sev days at room temperatures of between 80°-90° F. No weights were taken on any eggs that were not completely dry, that is, in a dry, pebble-like condition. At this time each sample was carefully placed in envelopes, and sealed until analysis could begin. Three subsamples of 250 eggs were weighed per individual as outlined by Nagasaki (1958). A Mettler analytical balance was used for this study courtesy of the NMFS Food Laboratory, Kodiak. Then the complete sample was weighed and fecundity was estimated from the mean weight of the three subsamples. Ten subsamples of one individual yielded a standard deviation of ±0.000467 gram/250 eggs. Since the weight of the 250 eggs ranged from .041 - .045 grams it was felt that this method of estimating the total number of eggs from the mean weight of three 250-egg samples was reliable.

The herring-forage fish literature search was carried on by Mrs. Dorothy Lunsford (ADF&G staff librarian) at the University of Washington. The search was only very recently completed, and the 15-17 kilograms of offprints and copies obtained to serve as a literature base for this study have yet to be surveyed and catalogued. Literature gathered shall be included in the bibliography to be included with the annual report.

IV SAMPLE LOCATIONS

The sample locations are as follow: 1) Meshik/Port Heiden: this is located on the north coast of the Alaska Peninsula, about midway between Pilot Point and Port Moller Actual sample site was located ½ mile from Meshik, an Aleut village about 5½ miles from Port Heiden (a former WW II PB-Y station). Presently it serves as the air terminal for the entire area, and during the summer it received daily passenger and freight service from Anchorage. A single phone is also located at the Port Heiden air terminal, and for this reason Port Heiden was chosen by the A.P.I. to be the logistic base for aerial census flights. Coordination with Kodiak was carried on from here, and a fishing station was fished regularly at Meshik Beach by the A.P.I. who resided in rented facilities in the village. Biological sampling was done in this facility, and a three-wheeled ATV was used as transportation between the village, fishing site, and air terminal. Most aerial surveys originated from Port Heide although several began from King Salmon. 2) Herendeen Bay: the mobile field camp was located in this area between 6/8/76 and 6/23/76. Herendeen Bay is located about ten kilometers from Port Moller on the north coast of the Alaska Peninsula. Ongoing oil activity in this area has resulted in the construction of a large airfield on this bay, and the mobile field camp was located at this location, then later moved further into the bay near the abandoned cannery at Gravel Point. 3) Seal Islands: this area is located approximately 50 kilometers from Port Heiden on the north coast of the Alaska Peninsula. The field crew was moved here on June 24, and was located here for a period of three days. 4) King Salmon Creek: forage fish were captured in this area by Mr. Lou Gwartney of the ADF&G, King Salmon. King Salmon Creek is a tributary of the Naknek River, and is located several miles out of King Salmon, Alaska.

Offshore sampling was done at various stations, most of them immediately adjacent to the study area. Stations fished by the PAT SAN MARIE may be seen in Figure 2. All aerial censuses were taken between Cape Sarichef, on the southwest end of Unimak Island, north to Smoky Point, at Ugashik Bay (Figure 2). This area encompassed the study area which was the direct responsibility of the ADF&G research team working out of Kodiak, Alaska. This area is about 530 nautical miles in straight line length, and 1360 kilometers in actual length.

DATA COLLECTED AND ANALYZED

A total of 3,905 specimens were collected between 5/12/76 and //5/76. For preliminary species breakdown by area refer to Table 1. A total of 623 schools of forage fish were sighted between 5/8/76 and 7/12/76. Approximately 1,200 scale samples were mounted on glass slides, and 1,022 were read and catalogued. A total of 76 otoliths were weighed on a Mettler analytical balance, and the results then plotted for age purposes. The lengths and weights from all forage fish specimens were plotted for age determination and to determine possible sexual dimorphism. Methodology to determine age on collected osmerids was extensively examined, with some literature examined for these purposes.

RESULTS

Pacific Herring (*Clupeas pallasi*)

This species of forage fish was the most numerous captured. The largest specimen caught was 282 mm and the smallest was 116 mm. A total of 1,648 herring were caught overall, 458 from onshore stations and 1,190 in offshore areas. For preliminary length and weight distributions refer to Figures 5, 21, and 22. When separating the length distribution into onshore and offshore groups, it can be seen that the offshore group falls into a bimodal category, while the onshore fish, which were actively spawning, fall into a single mode. This is a typical pattern between breeding and non-breeding forage fish. Actual ageing was accomplished on 1,022 specimens, and the results of this can be seen in Figures 6 and 7. Again, a single age group predominates onshore specimens, yet offshore populations tend to be less predominated by a single year class.

Breeding populations of Pacific herring were found in three areas: 1) Herendeen Bay, 2) Port Moller Bay and 3) Port Heiden. Herring were seen in these areas from survey aircraft, and were caught by groundcrews in Port Heiden and Herendeen Bay. Breeding activity of herring was determined from a visual examination of the gonad and/or actual direct observation of spawning activity (e.g. herring spawning on the test nets, and masses of Larids feeding on roe at low tide). Offshore gonad indexes were lower, indicating that herring captured in the offshore areas were not in spawning condition. Still, anecdotal evidence was gathered by the A.P.I. that indicates spawning activities occur in offshore areas in deep water, much in the manner of Atlantic herring (*Clupea harengus*).

Fecundity Analysis

Fecundity analysis was done on 56 herring. One out of every ten females captured was sampled for fecundity analysis. Eighteen of the ovary pairs were taken from Batches #1 and #2 of the M/V PAT SAN MARIE (Table II) offshore herring samples. Both volumetric displacement and dry weights were used. However, after several samples of both types were completed we discarded volumetric displacement in favor of dry weights for greater expediency and accuracy.

Fecundity was extrapolated for 56 female herring of age classes IV-VI, standard lengths of 192-276 mm and whole fish weights of 80-312 gr. The estimated number of eggs per female ranged from 12,687 to 84,875. The overall mean fecundity for all herring sampled was 26,473 with an overall mean weight of 142 gr. The gonad maturity index (Moberly, 1971) ranged from III-VI. A linear relationship between body length and fecundity is portrayed in Figures 15 (offshore herring) and 16 (onshore herring). The volumetric displacement results are shown on a separate graph (Figure 17) with only the means shown because of the small number of points available for plotting. For offshore herring the intercept is -59.039 with a slope of 0.40157 and a correlation coefficient of 0.9087. For onshore herring the intercept is -103.8042 with a slope of 0.5854 and a correlation coefficient of 0.8204.

To date no results have been tabulated showing the relationship between weights of eggs and maturity of females (Nagasaki, 1958), as the necessary computations are not yet complete.

We grouped all the onshore data together and assumed it to be from a breeding population; all offshore samples were assumed to be nonbreeding. On Table II under column "Area Code" the onshore samples will be referred to as #1 and the offshore samples as #2. It can be observed that all of the samples taken from Herendeen Bay have "no scales" under the age column. This is due to the fact that the field technicians placed the scale envelope in the same "Whirl-Pak" with the gonads, hence "preserving" the scales in Gilson's fluid. It was later discovered that Gilson's fluid very effectively dissolves herring scales. Thus we have no ages to coincide with any fecundity from Herendeen Bay.

Capelin (*Mallotus villosus*)

This was the third most numerous species of forage fish taken; a total of 643 capelin were collected between 5/12/76 and 7/5/76, the largest being 196 mm in standard length, and the smallest 109 mm in fork length. Capelin were captured at Port Heiden, and to a lesser extent, Herendeen Bay. Large populations of breeding capelin were observed frequently between Smoky Point and Cape Krenitzin. Actual spawning activities were observed by the A.P.I. at the Meshik test fishing site, and at Port Moller. Capelin were also taken offshore on-board the PAT SAN MARIE, and they too were in breeding condition as indicated by their gonad index. Ageing of the capelin is still in progress; different methods are being surveyed from available literature for possible use in the laboratory. Capelin scales were taken in the field, but due to ignorance of proper capelin sampling techniques, all scales were taken from the wrong area; therefore, all scale samples taken from capelin are thought to be unreliable. Otolith data were also collected, and analysis is presently in progress. Length/weight data (along with information gathered so far during the literature review for this species) strongly indicate that spawning capelin are dominated by a single year class, which we've termed age class II (Figures 18, 19 and 20). During aerial census flights large windrows of capelin were observed washed up along miles of beachline in the study area between Cape Sarichef and Smoky Point (Figures 23,24 and 25) On several occasions the A.P.I. was able to request that a landing be made, and several limited samples taken. The vast majority of the capelin stranded on the beach were males; under gonad examination many of these males were not"spawned out", i.e. appreciable quantities of milt being retained in both testes. A spawning school of capelin was observed on 6/12/76 at the Meshik test net site, and the behavior patterns of spawning capelin closely paralleled that of Atlantic capelin (Templeman, 1946) (Saetre & Gjosaeter, 1975).

Boreal Smelt (Rainbow Smelt or American Smelt)

This species (*Osmerus mordax dentex*) was the second most numerous fish captured during the study period (Table I). It was the first forage fish species captured at the Meshik test fishing site, and catches of it persisted throughout the A.P.I.'s residence at the Port Heiden-Meshik facility. Body length, body weight, and otolith weight frequencies of this fish (Figures 8, 9, 10 and 12) demonstrate three primary age categories quite well. Scales were taken from approximately 95 specimens, and to date 45 have been mounted and read and preliminary results can be seen in Figure 11. Kendel (1975) mentions that boreal smelt scales are unreliable for ageing, yet we have found that with proper cleaning and mounting, readings can be realized. Ageing from scales of this species has been accomplished by other investigators (Burbridge, 1969). Otolith reading and mounting is now in progress, also further mounting and reading of collected scales is in progress. Large spawning populations of boreal smelt are present in the Meshik River area. Gonad indexes were very high; males and females with sex products flowing were captured frequently by the ground crews, and spawning activity in the immediate area of capture is tenatively assumed.

Spawning populations of boreal smelt also are present in the Naknek River and its tributaries. Specimens were collected there while spawning, and during the winter a small but active subsistence/sports fishery harvests this species through holes drilled in the river ice near the town of King Salmon. Residents near the mouth of the river seine up quantities of boreal smelt when the animal is supposedly ascending the river in the autumn of the year (Bills, personal communication).

Eulachon (Hooligan, Candlefish)

Eulachon were the fourth most numerous forage fish captured in the study area. A total of 30 specimens were captured, all in the latter days of the field operation. Eulachon weight frequencies (Figure 13), although showing definite modes, are from such a small sample size that no preliminary conclusions may be drawn at this time. Length frequencies have not been completed yet.

Ageing of Eulachon has not yet started; otoliths and scales were collected from each specimen. The A.P.I. intends to weigh the otoliths for Petersen weight frequencies. About one dozen of the scales have been mounted at this time, but no reading has been done. Literature search on Eulachon is completed, but the review of the numerous offprints available on Eulachon hasn't begun.

All Eulachon captured were at the Meshik-Port Heiden study area, and all the specimens were quite ripe and presumed to be beginning their ascent of the Meshik River to spawn. Gastronomical tests were conducted on the freshly captured Eulachon after they were processed, and the table value was determined to be high.

Miscellaneous Species

Other species of finfish were caught during the study. A total of 135 arctic charr were captured (*Salvelinus alpinus*), no efforts were made to distinguish between *S. alpinus* and *S. malma* as such activities were beyond the scope of this project. A few greenling (*Hexagrammidae*) were caught, along with a large number of sculpins (*Cottidae*), again keying the fish to species wasn't done. A very large number of whitebarred pricklebacks (*Poroclinus rothrocki*) were caught in the final ten days of fishing at Meshik-Port Heiden. On several days, they outnumbered all other species captured. About two dozen salmon smolt were caught, all (except one) were coho salmon (*Oncorhynchus kisutch*) and one was a king salmon smolt (*Oncorhynchus twhawytscha*). Six adult sockeye salmon were caught (*Oncorhynchu nerka*), and immediately given to a needy Aleut family for domestic purposes.

Fifteen aerial surveys were conducted between 4/12/76 and 7/12/76. A total of 623 schools were sighted, with a total census observation time of 63 hours. Identification of each school wasn't possible from the air, hence most schools were recorded in the general category of forage fish schools. All schools sighted fell into two distinct habitat groups: 1) schools spotted in the immediate vicinity of open ocean beaches, with gravel/rock substrate type, 2) schools spotted inside bays or inlets with rock/kelp substrate type. All schools spotted seemed to be stationary, i.e. numbers of schools counted on certain days remained fairly constant between actual "southbound" census flights, and "northbound" return flights to the base station. Photography was attempted in order to enhance school size estimation, but the results reiterated the difficulty of photographing stationary objects from an aircraft travelling at 115 knots when the photographer's skills are at the novice level. School size could not be accurately judged by this observer, and it is acknowledged by commercial herring spotters that apparent size of schools cannot be necessarily related to mass (Holmes, 1976, personal communication)

The sighting of schools closely coincided with the volume of fish captured on land (Figure 14), and the preliminary findings strongly indicate that the two primary types of school fish spotted from the air were capelin and herring. On several occasions the observer was able to request that the pilot "dive" on the school of fish, thereby causing immediate scattering of the animals. On three such occasions herring were identified visually. All schools observed were roughly "ball" shaped, which is the normal shape of bait-fish schools. Often school shape would change drastically because of predators actively pursuing fish within the school.

VII. PRELIMINARY INTERPRETATION OF RESULTS

For the sake of interpretive discussion, we'll approach each species separately, with an overall discussion of aerial and general biological characteristics at the end of this section.

Pacific Herring

Pacific herring are a wide spread, yet latent fishery resource between Cape Sarichef and Smoky Point. Age class IV herring dominate the onshore and offshore populations in the groups of fish we've aged thus far. Onshore, class IV fish out number all other age classes, and are nearly the sole contributor to herring populations spawning in Port Heiden and Herendeen Bay. Offshore age class III fish show a strong "ba in Figure 6 and preliminary observations indicate that this year class will make strong recruitment in next year's spawning stocks of herring. Actual age in years is not attempted here, yet it seems obvious that with the present age class distribution (Figures 6 and 7) in offshore and onshore areas, that age class II fish first begin to appear in the spawning population of herring followed by a much stronger entry of class III fish; from these results, preliminary analysis indicates that Pacific herring in the Bering Sea first mature at age class II, and to a lesser extent, class III. Size ranges were much greater offshore than onshore (Figure 5), and it is thought that this is a function of non-spawning activities. It is very doubtful that gear selectivity caused this, as the nets were of varied mesh sizes, and caught all size ranges of other species of forage fish.

In the three areas that support populations of spawning herring in the study area, Port Heiden and Herendeen Bay are the most significant; later data shall enumerate this more clearly, as data is still in the midst of being processed. Port Moller and Port Heiden support hitherto unknown populations of spawning herring. It is thought that Port Moller ranks third in importance, and that Port Heiden needs further field investigations to properly estimate the magnitude of herring spawning in the area. In contrast to the former two areas, Herendeen Bay was thought to be the most important herring spawning site on the north coast of the Alaska Peninsula (Davenport, ADF&G intra-department memorandum, 5/76). Ed King, a local pilot-guide, furnished the A.P.I. with locational information concerning spawning herring in Herendeen Bay, and during aerial census flights he was careful to survey those areas, and with few exceptions, this information proved correct. The mobile field crew was moved within the immediate area of dozens of schools of spawning herring, yet they weren't able to find herring spawn. They were greatly disadvantaged in this search by the smallness of their rubber raft (which was powered by a 2½ horsepower motor), hence, in the windy precipitious bay, such equipment did not meet the demands of such a search.

Herring stocks on the north coast of the Alaska Peninsula appear to be able to support a small sized commercial fishery. A total of 151 schools of fish were tenatively identified as herring on the north coast of the Alaska Peninsula. Calculating a mean of ten English tons per school, that would put the total estimate of herring biomass at 6.6 million kilograms of herring. Herring were differentiated from other species of forage fish by means of habitat. Since herring have long been known to inhabit rocky, kelpy areas, fish schools seen in this habitat type were assumed to be herring; catches at land sites uniformly confirmed this assumption, along with direct observations by the aerial observer. The exception to this was in Port Heiden Bay, where approximately 38% of the total catch was herring (hence a proportional number of schools was selected from the total schools sighted in Port Heiden to determine number of herring schools present).

Boreal Smelt

Boreal smelt seem to be concentrated around the mouths of river systems, and the population of this fish in the Meshik area is large. At the Meshik facility it was the most numerous fish captured, yet few were taken elsewhere, i.e. none offshore and a scattering in Herendeen Bay. A large sample of this species was taken for this study in King Salmon Creek, a tributary of the Naknek River. A subsistence sports level fishery exists in that system for this species, and Meshik residents informed me that they also fished for them through the ice in the winter. Boreal smelt are long lived fish (McPhail and Lindsay, 1971), and age determination done from specimens taken at Meshik confirm this. It seems that three age classes predominate the population, but it cannot be said with any degree of authority what actual age these fish might be until further analysis is completed. Determining age classes can be accomplished from scales, although it cannot be assumed that circuli begin forming during the fish's first summer; it is known that some Osmerids do not begin putting on scales until almost at the end of their first year of life (Pitt, 1958) . Age determination cannot be done until it is definitely known when scale development begins.

Weight frequencies were obtained by weighing smelt otoliths; this method was suggested in Ricker's Fish Production in Fresh Water (1971), and after close inspection of Figures 9, 10 and 11, a visual correlation between the length frequency, otolith weight frequency and age frequency may be seen. Further analysis, mainly through application of the method of least squares, will be conducted for more substantial analysis. For the sake of general comparison growth of boreal smelt was calculated in Lake Superior to be such that it took five calendar years for male and female fish to attain the total length of 218 mm, and 239 mm, respectively (Bailey, M.M., 1964). Comparison of length frequencies between male and female boreal smelt indicate a tendency for females to be larger than males (Figure 9). A very wide size range of smelt were caught at the Meshik test site; almost 20 centimeters separated the smallest specimen from the largest, and it seems evident that the sample range affected from Port Heiden boreal smelt was quite thorough. This thoroughness was primarily due to the fact that this species have dagger-like teeth and become entangled in a gillnet very easily, so easily in fact, that the catch data from Meshik site may be biased in favor of this species.

Boreal smelt (from a sports/subsistence fishery standpoint) are more important than any other forage fish species in the study area. Small fisheries exist in the King Salmon area, and to a lesser degree in the Port Heiden area. A thorough literature search was done on boreal smelt, and a survey of that information base has yet to begin. Because of the many different parameters taken on boreal smelt, combined with a high sample number, a detailed biological profile will be presented concerning this species in the annual report.

Capelin

Capelin are the most widespread forage fish in the study area. They were spotted washed up on beaches from Cape Krenitzin, north to Smoky Point, at Ugashik Bay. The stocks of capelin are predominated by one age class (Figure 8), and as in Atlantic capelin, sexual dimorphism manifests itself in males by: 1) the "hairyness" along the lateral line during the spawning period, 2) pronounced metamorphasis of the fins during spawning, i.e. elongation and rigorization of the musculature at the basal portion of each fin, and 3) larger male body length than females. Female capelin are more gracile than males, and during spawning "waves", catches of females are less numerous than males. These characteristics have all been noted for Atlantic capelin (Templeman, 1946)(Jangaard, 1974).

A total of 472 schools were seen during aerial surveys that are assumed to be capelin. The reason this assumption is made, is that the schools of supposed capelin were seen on every survey, until large windrows of dead capelin were seen washed up on beaches; at this point, shoreline schools of capelin disappeared abruptly. It is assumed the spawning activity ceased at that point, and the fish repaired to their oceanic-pelagic habitat. Ageing of capelin through the use of scales was a failure. Templeman (1948) noted that capelin scales which were to be used for ageing should be taken from the area posterior to the junction of the anal fin with the body, and just below the lateral line. Pitts (1958) noted that he sucessfully aged scales taken only from the posterior two thirds of the animal along the lateral line. Field personnel, directed by the A.P.I., took all capelin scales directly below the dorsal fin, and upon mounting and reading they were found to have nuclei of varying diameters. It was decided that age class values gleaned from these scales would be inaccurate. Female capelin were rarely found that still retained scales, for it has been determined that female capelin lose scales easily owing to a much thinner superficial covering of epidermis over the scales (Templeman, 1948). Otoliths were taken on approximately 50 capelin, and presently the mounting and reading of them is in progress. On two occasions the A.P.I. examined capelin (supposedly "spawned out") that had been washed up on a beach at Port Moller, and at a beach near Meshik. At Port Moller on 6/7/76 the observer-pilot team affected a landing on an open beach near long windrows of capelin (Figures 23, 24 and 25); the observer decided to select a 50/50 sample of male and females; after one half hour of sorting through hundreds of animals, he found only six females; the remainder were males.

At Meshik the same phenomenan occurred; as the capelin rode in on the crest of the waves, the A.P.I. along with several young volunteers, scooped up the fish. When these were sampled, it was found that 21 were males and two were females; although these two sampling routines were spontaneous and unplanned, it can be seen that an extremely lopsided sex ratio on the Port Moller beach was reiterated by actual spawning animals in the surf at Meshik Beach. Jangaard (1974) discusses the fact that capelin "school" according to sex, the males frequently schooling much closer to the spawning beach than the females. When the females leave their school and swim towards the beach, males accompany them (often one on each side of her), where they ride a crest of a wave in, and then spawning occurs. It was also mentioned that sex ratios of captured capelin often are strongly biased by location of the catch, as well as means of capture; i.e. if the fish were seined offshore from the beach, more females were present in the sample and if cast nets were used in the surf, the reverse was true.

The biomass of capelin in the study area is very high; variation in school size was marked, and it would be an extremely conservative estimate to state that there were at least 10-15 metric tons of capelin in each school. (Experienced forage-fish aerial spotters agree that one ton of fish wouldn't be visible at 1,000 feet, Norm Holmes, personal communication.) Although the former statement is by nature speculative, it is obvious that the capelin resource in the Bering Sea is a major latent fishery, and that (as a forage fish) it is of crucial ecological importance to those marine fauna that are piscivorous. Very large capelin fisheries exist in the Atlantic and Barents seas; 1.6 million tons of capelin were harvested in the Barents Sea by the Norwegian fishing fleet, along with 37 thousand tons (metric) by the U.S.S.R. (Jangaard, 1974). Although this study isn't attempting to conclude that the capelin resources are comparable with those of the Barents Sea, it does hope to illuminate that capelin are a highly marketable species, and the Bering Sea stocks of capelin are definitely of commercial-ecological importance, even though that importance (to a great degree) has not been realized.

Eulachon

Very little interpretive discussion can be written about this species at this time, as very little work has been completed on them, also sample size is very low. Eulachon were expected to be a large contributor in the catch results, and we feel that if the field crews were to have stayed out beyond 7/5/76, catches of Eulachon would have been much higher (e.g. all catches of this species occurred very late in the field season). According to local residents, Eulachon supposedly ascend the Sandy River (near Cape Kutuzof) in hordes. Since no contemporary villages are near Sandy River, it seems evident that Eulachon are of negligible importance to the human population of the area.

The results from the aerial survey do not leave much room for further interpretation or comments, it is only through a correlation between land site data/observations and aerial surveys that even partial meaning may be gathered from the aerial portion of this study. Obviously is is quite likely that an unknown number of the schools were neither herring or capelin; in a few cases bottom shapes might have accidently been identified as schools, but, by in large, the integrity of the observational data during aerial survey is sound.

Although the determination of herring-forage fish utilization by coastal residents was one of the primary objectives of this study, it was this activity that unfortunately received the least amount of attention. There are seven year round settlements in the study area. The A.P.I. lived in one of them for eight weeks, and had frequent discussions with people in three of the others. During this time he asked residents questions concerning forage fish utilization, especially herring, and respondents reported that herring were present only in transient numbers, yet it seems most local residents under age fifty weren't cognizant of the large population of spawning herring in Port Heiden Bay. The A.P.I. landed at False Pass, Alaska, specifically to interview long term residents on the occurrance of herring in Bechevin Bay. Unfortunately, all the adult inhabitants were intoxicated. Although no forage fish were ever sighted in Bechevin Bay during the 15 aerial surveys, it would be interesting to know if a historical run of herring existed in the bay, as the habitat type is by far the best in the entire area between Cape Sarichef and Smoky Point. "Hooligan" (capelin) are a very marked social occurrance in the spring of the year in the Port Heiden/Nelson Lagoon native settlements. Although the run is short lived, it signifies the oncoming summer and the certain termination of severe climatic conditions. Native harvests of capelin have been described by Jangaard (1974), but the natives of Meshik-Port Heiden area supplement this by the use of four wheel drive ATVs and three-wheeled "Honda" trail bikes. On the evening when the "hooligan" run, the entire village's assortment of motor vehicles sets out for the beach. Larids by the thousands follow the offshore schools of capelin as they swim towards the beach, and harbor seals by the dozens can be seen offshore, presumably feeding on the fish prior to their spawning activities for the evening. This signifies to the residents that the run is imminent. Abruptly the fish begin pouring in on the crests of the wave, and the harvest begins with cast nets, dip nets, buckets, and often times the fish are simply picked up by hand. Although the value of such a fisheries resource cannot be determined in dollars and cents, it is quite evident that its human value is quite high.

VIII PROBLEMS ENCOUNTERED

1. Aerial Surveys

a. Length of study area made it very difficult to do the entire area within a single day.

b. Money alloted wasn't sufficient to do the survey in multi-engine planes, hence increasing the chance of mishap (i.e. the A.P.I. was forced down once due to bad fuel in one tank).

c. The primary air charter company used was not very reliable, and often long waits were involved during periods of good weather.

d. Camera equipment was not suited for aerial use.

2. Field Investigations

a. Almost totally unacceptable gear was purchased from a Seattle supplier; the material used was weak, and apparently rotten. Rugged sampling gear is needed to work this study area.

b. Weak support lines between the study area and the Kodiak OCS center for the transportation of supplies, and the shipment of preserved specimens and data.

c. Better field station facilities should be acquired, specimens and data may be more advantageously processed, and a good logistic center for the field camps established (i.e. radios operated and maintained).

d. Lack of cooperation with some professional personnel resident in the study area; e.g. a staff fisheries biologist with the State constantly informed the air charter operator/owner, along with its numerous employees, that OCSEAP herring-forage fish work was a waste of funds, and that scientific personnel involved were incompetent.

e. Lack of personnel.

3. Laboratory Analysis

a. Improper fixatives for female gonads.

b. No drier to quickly dessicate eggs.

c. No balance fine enough to weigh samples.

IX. RECOMMENDED CHANGES

1. All gear to be purchased from the Memphis Net and Twine Company.

2. The use of a multi-engine plane to conduct aerial surveys.

3. Exclusive air-charter contract for all aerial surveys.

4. More than one person do all the aerial surveys in areas 1-5

5. Additional personnel for groundtruth gathering:

a. Two more technicians for an additional ground crew.

b. One more technician/biologist to make an adequate subsistence survey. Perhaps changing base station to either King Salmon, or Cold Bay, preferably Cold Bay.

6. Proper chemicals purchased to prepare large volume of Gilson's solution.

7. Purchase of a dissicator.

8. Purchase of a Mettler analytical balance.

X. ESTIMATE OF FUNDS EXPENDED (AREAS 1-5)

Line Item	Amount Budgeted	Amount Spent (to 8/13/76)
200	.80 K	4.04 K
300	16.20 K	14.20 K
400	8.80 K	5.30 K
500	2.75 K	2.50 K

Amount remaining (1-5): 8.61 K

Table I. Catch by species by area.

Area	Herring	Capelin	Boreal smelt	Eulachon	Misc.	Total
Port Heiden	205	608	804	30	197	2,144
Port Moller		28	1			29
Herendeen Bay	253	5	11		84	353
Seal Islands		2			85	87
			Total onshore catch			2,613
Offshore catch by Batch # (See Table II.)						
#1	139					139
#2	421					421
#3	89					89
#4	286					286
#5	255					255
#6		102				102
			Total offshore catch			1,292
		Total fish caught onshore and offshore				3,905

Table II. Offshore trawling stations by M/V PAT SAN MARIE, NMFS charter, May-June 197

Batch #	Area Code	Depth	Date Caught	Latitude Longitude	Geographic Location
1	Tow #103 Station E/D - 9/10	40 fathoms	5/21/76	56°12'N 162°32'W	30 mi NW of Cape Leontovich
2	Tow #85 Station I/J - 22/23	49 fathoms	5/17/76	54°56'N 165°26'W	30 mi NW of Cape Sarichef
3	Tow #113 Station G/F - 13/14	28 fathoms	5/23/76	56°47'N 159°46'W	30 mi NW of Seal Island
4	Tow #136 Station k - 5	23 fathoms	6/10/76	58°22'N 165°14'W	100 mi SW of Cape Newenham
5	Tow #85 Station F - 3	44 fathoms	5/20/76	56°38'N 166°27'W	90 mi E of Pribilofs
6	Tow #112 Station G/F - 13/14	15 fathoms	5/23/76	56°50'N 159°30'W	20 mi W of Stroganoff Point

Table III. Gonad maturity index.

Stage	Key Characteristics
I	Virgin herring. Gonads very small, threadlike, 2-3 mm broad. Ovaries wine red. Testes whitish or grey brown.
II	Virgin herring with small sexual organs. The height of ovaries and testes about 3-8 mm. Eggs not visible to naked eye but can be seen with magnifying glass. Ovaries a bright red color; testes a reddish grey color.
III	Gonads occupying about half of the ventral cavity. Breadth of sexual organs between 1 and 2 cm. Eggs small but can be distinguished with the naked eye. Ovaries orange; testes reddish grey or greyish.
IV	Gonads almost as long as body cavity. Eggs larger varying in size, opaque. Ovaries orange or pale yellow; testes whitish.
V	Gonads fill body cavity. Eggs large, round; some transparent. Ovaries yellowish, testes milkwhite. Eggs and sperm do not flow, but sperm can be extruded by pressure.
VI	Ripe gonads; eggs transparent; testes white; eggs and sperm flow freely.
VII	Spent herring. Gonads baggy and bloodshot. Ovaries empty or containing only a few residual eggs. Testes may contain remains of sperm.
VIII	Recovering spents. Ovaries and testes firm and larger than virgin herring in Stage II. Eggs not visible to naked eye. Walls of gonads striated; blood vessels prominent. Gonads wine red color. (This stage passes into Stage III.)

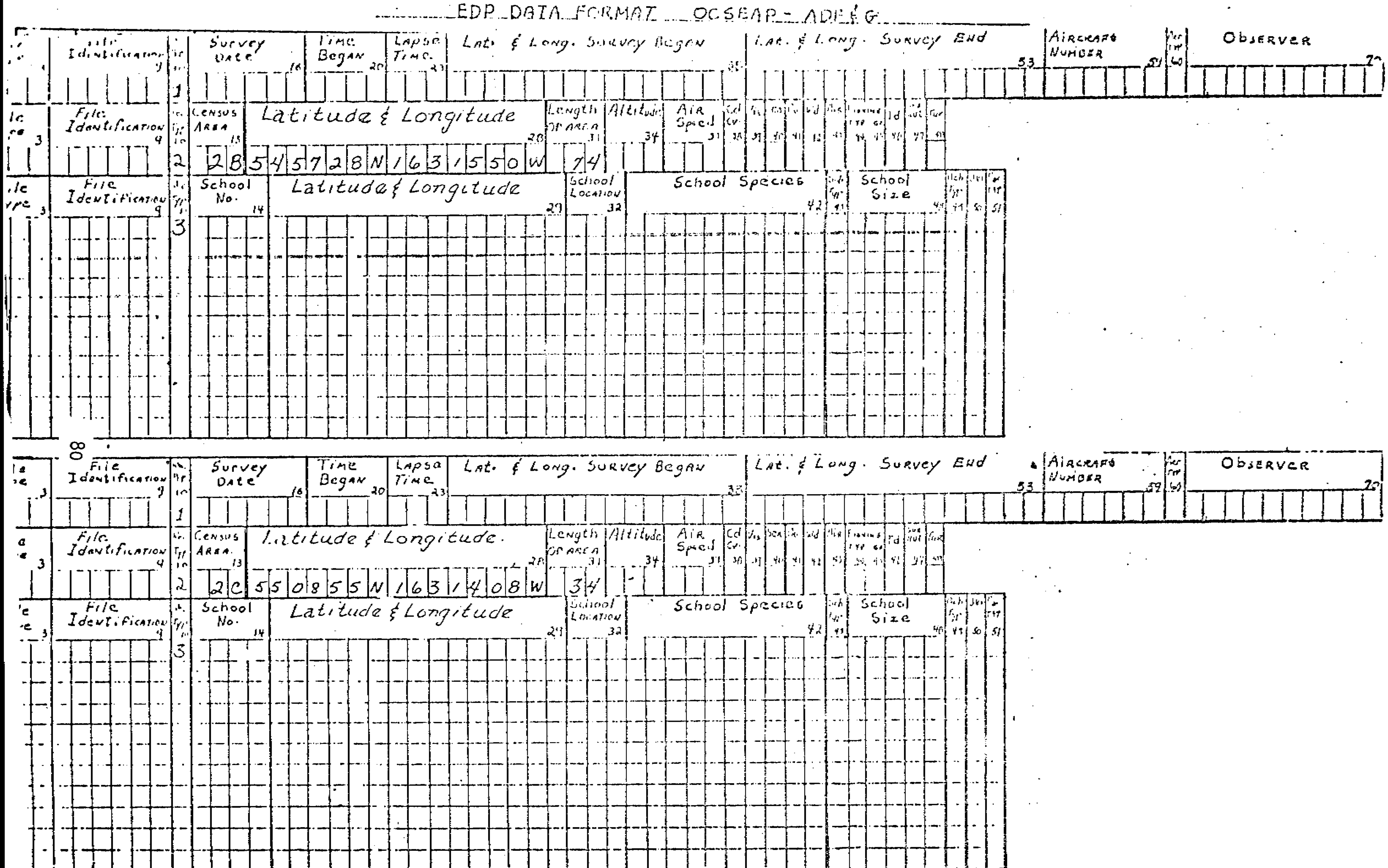


Figure 1. Aerial Survey Form.

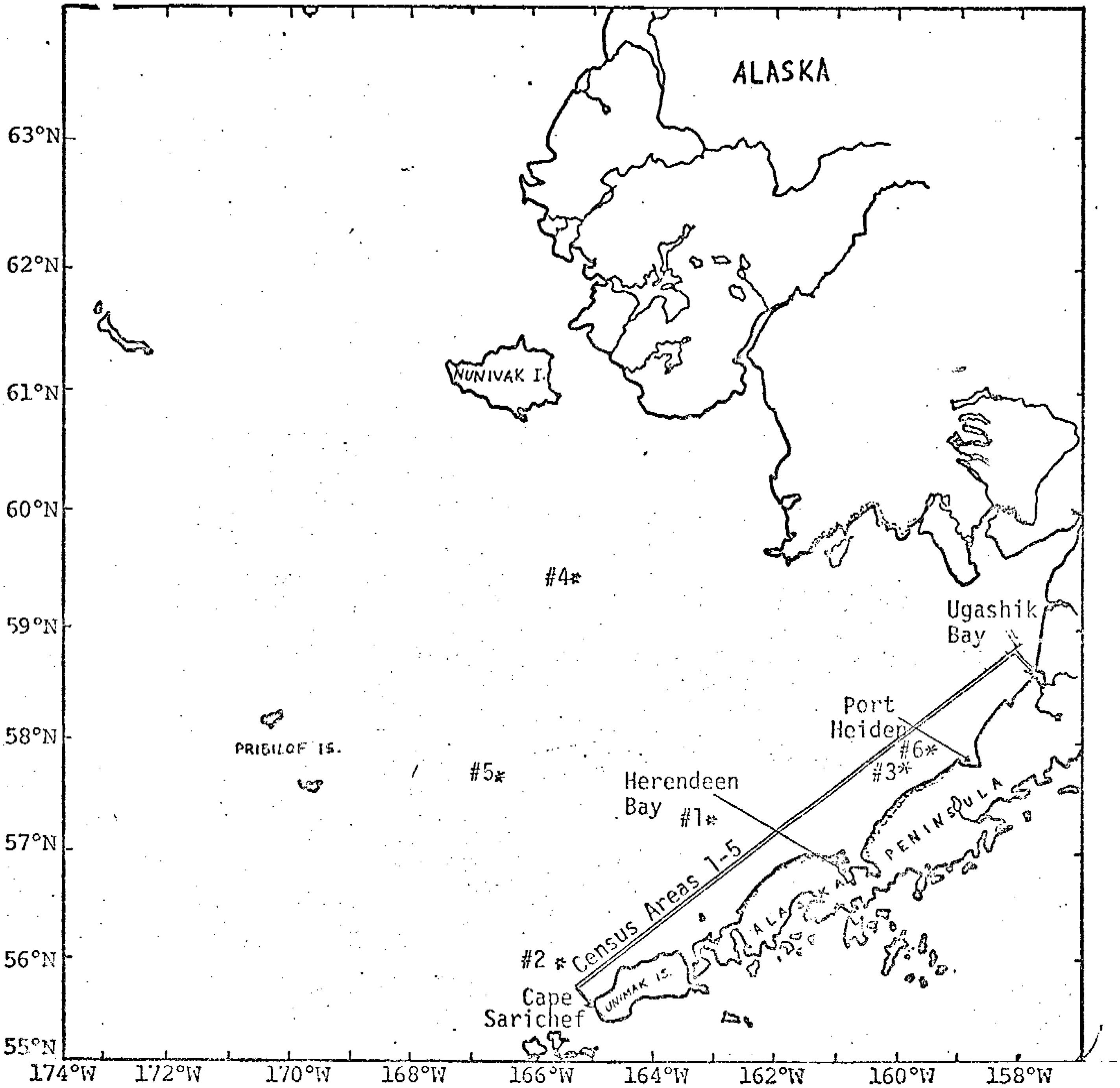


Figure 2. Map of Alaska Peninsula showing offshore sampling sites and onshore census area where aerial surveys and groundtruth sampling was done.

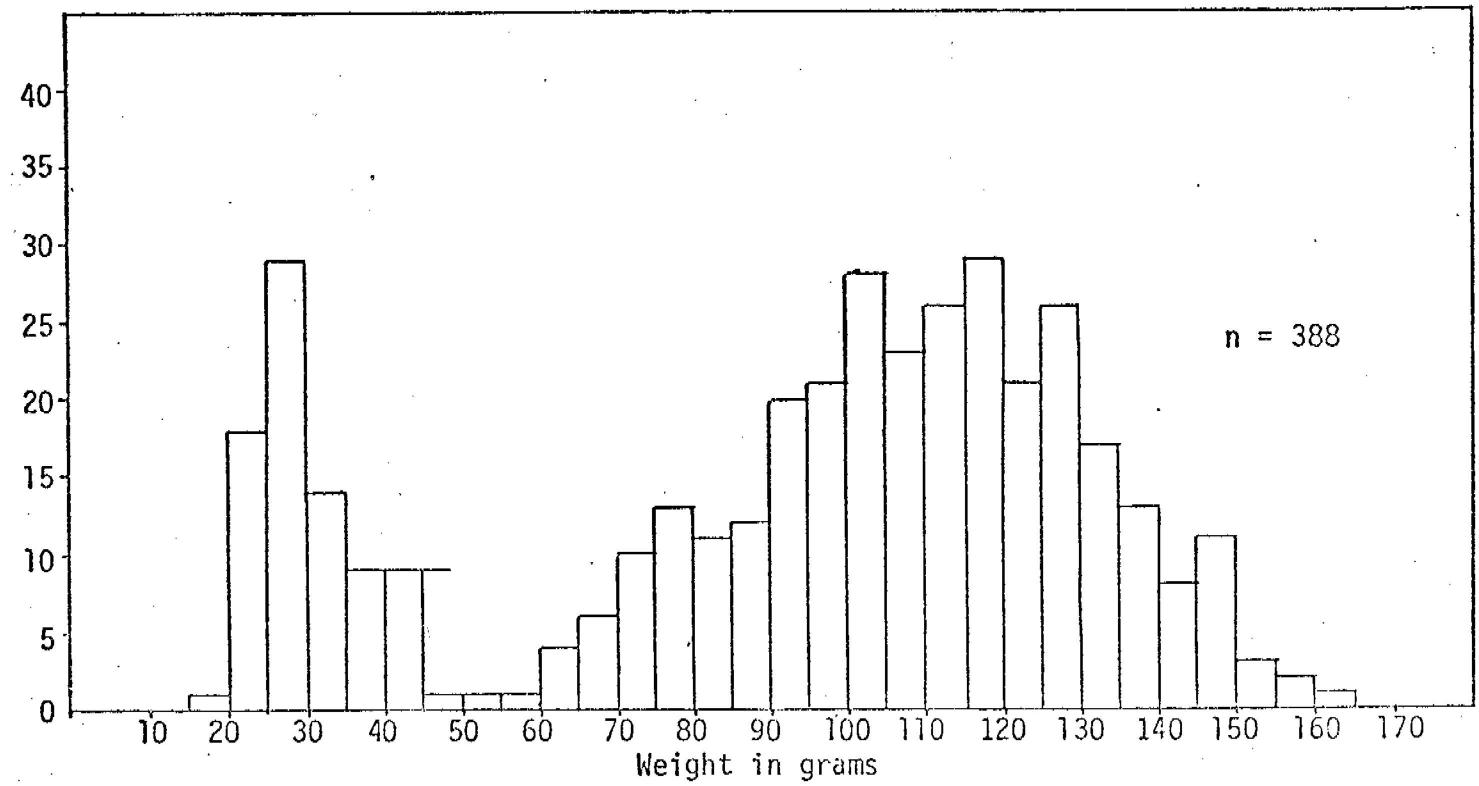


Figure 5a. Preliminary weight frequencies of offshore herring showing individuals falling within a range of 0-180 grams.

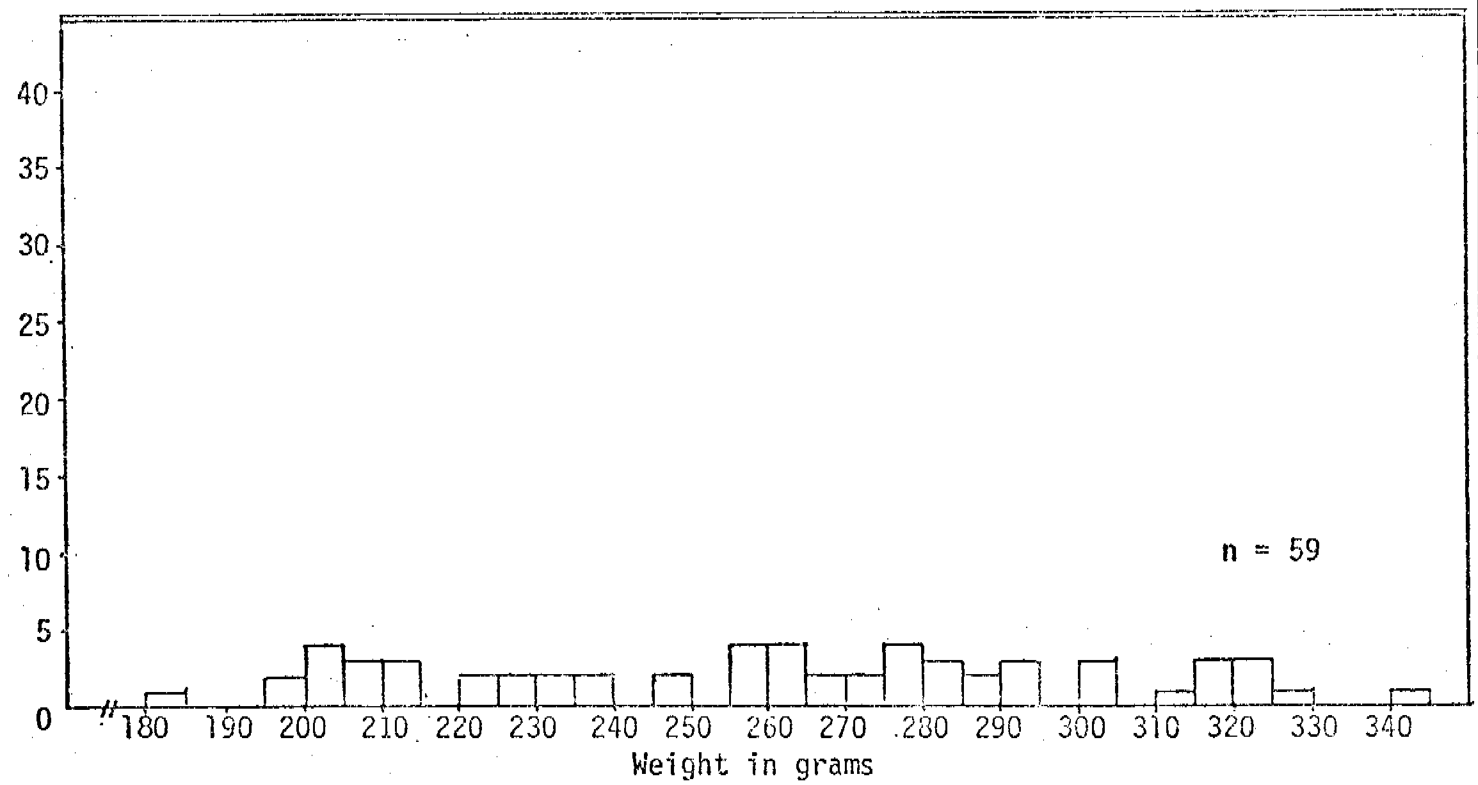


Figure 5b. Preliminary weight frequencies of offshore herring showing individuals falling within range of 181-350 grams.

Figure 5.

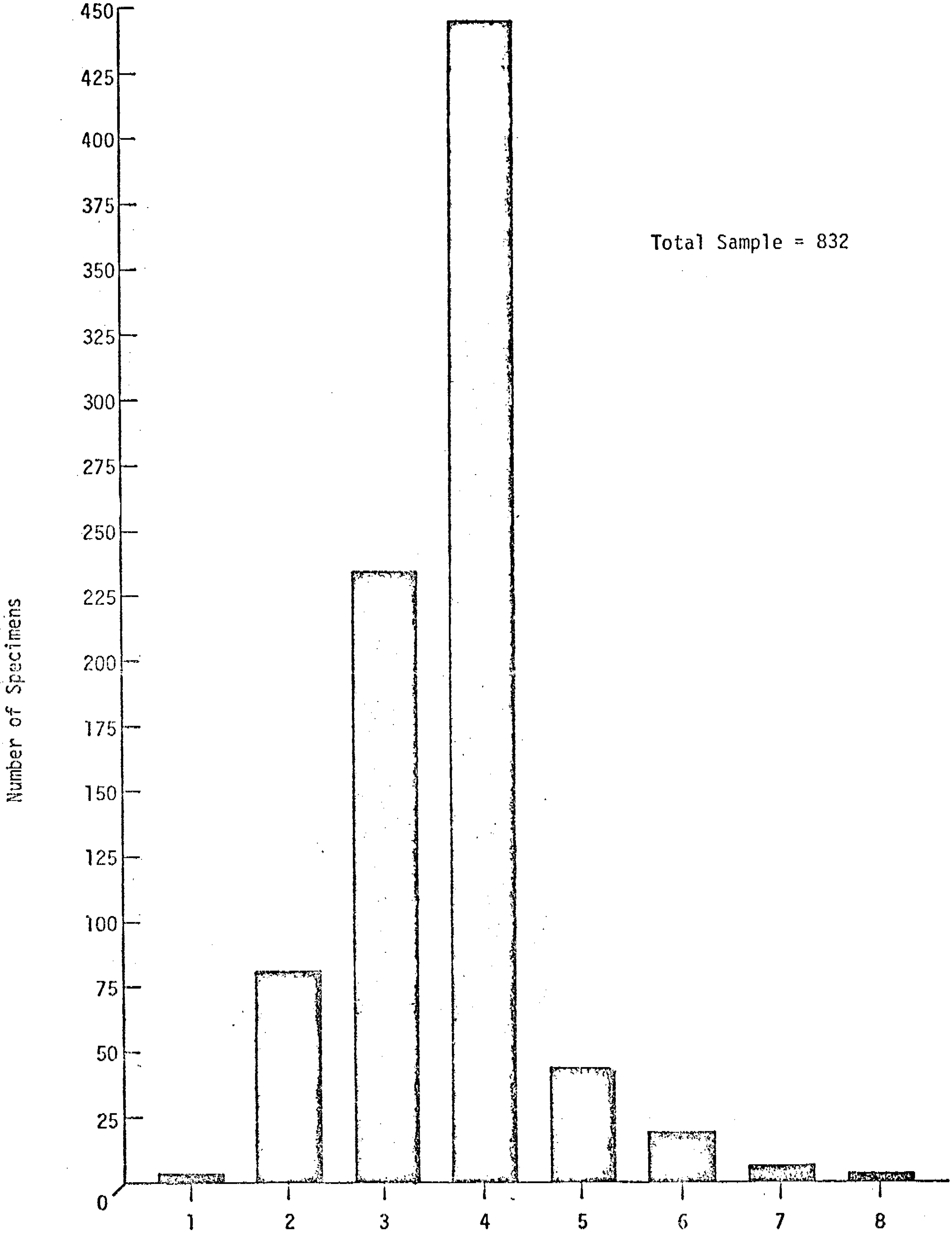


Figure 6. Graph showing number of specimens per age class sampled from offshore sites in Bering Sea; May-June, 1976.

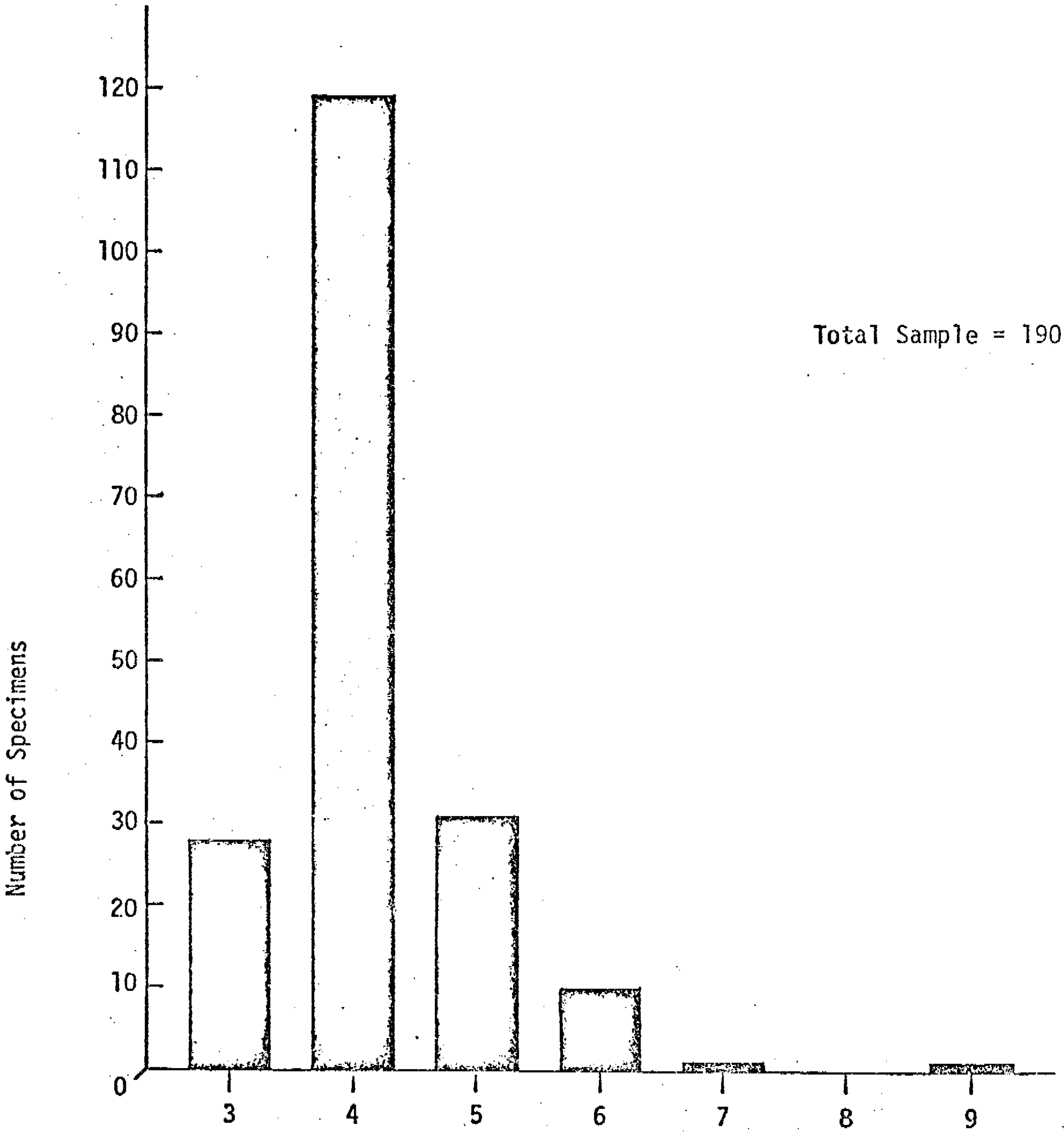


Figure 7. Graph showing number of specimens per age class at onshore sites north coast Alaska Peninsula, May-June, 1976

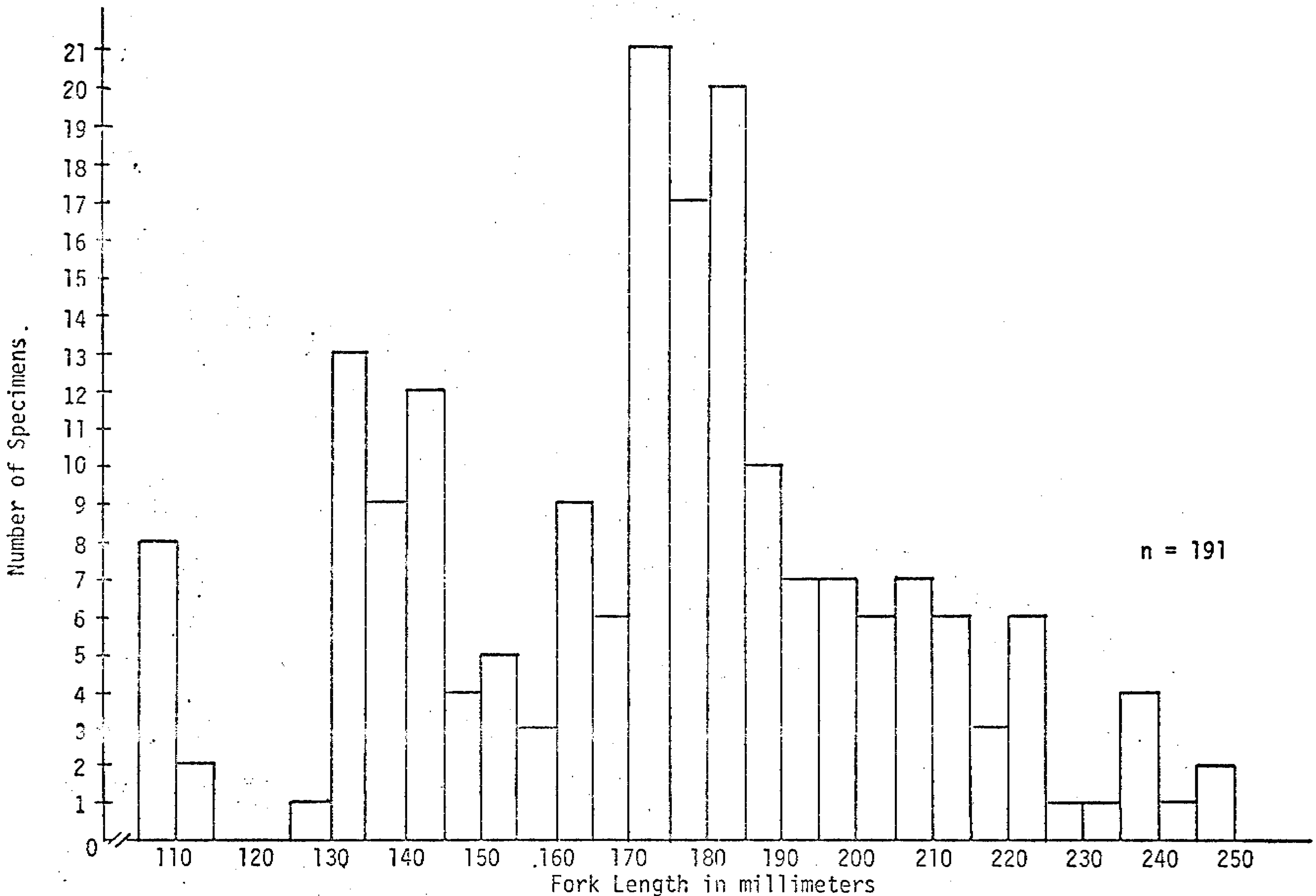


Figure 8. 1976, Census areas 1-5 overall length frequency, boreal smelt.

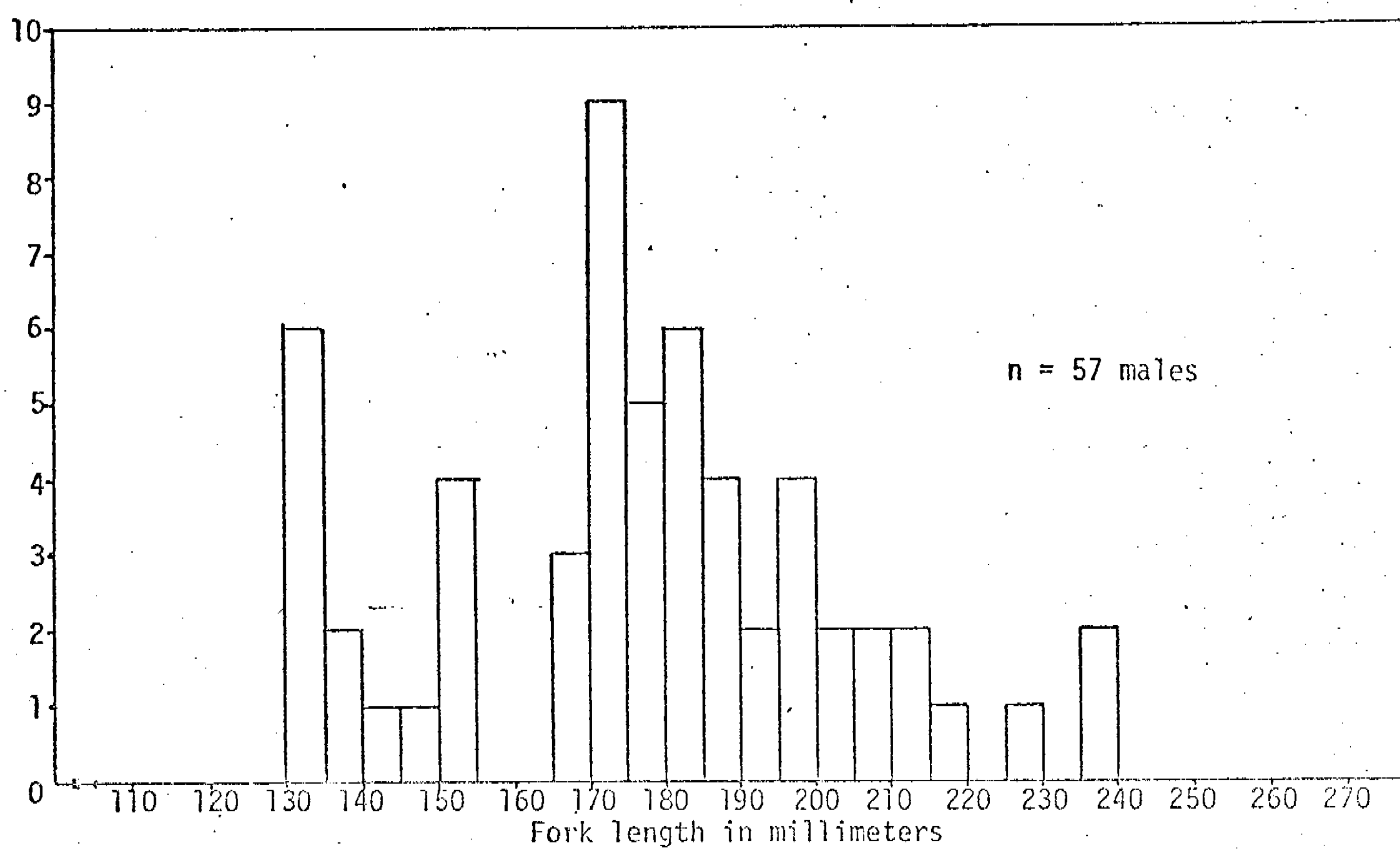


Figure 9a. Length frequencies of male boreal smelt caught in Areas 1-6 (including King Sal River) May-June 1976.

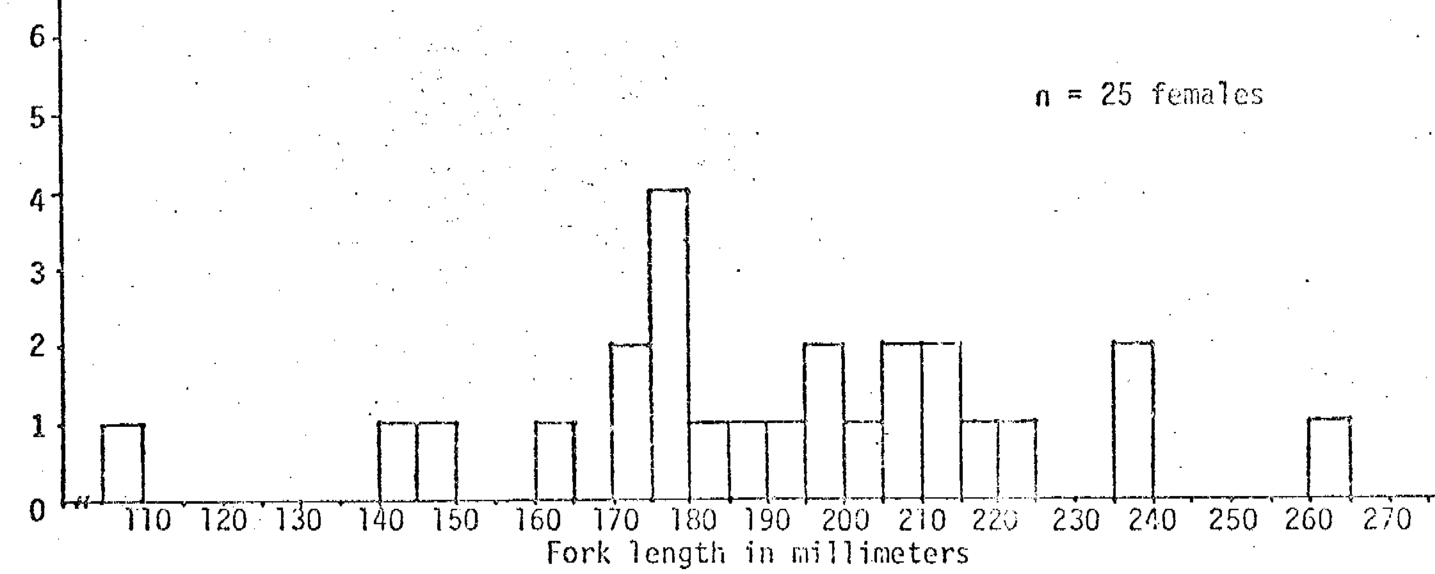


Figure 9b. Length frequencies of female boreal smelt caught in Areas 1-6 (including King River) May-June 1976.

Figure 9.

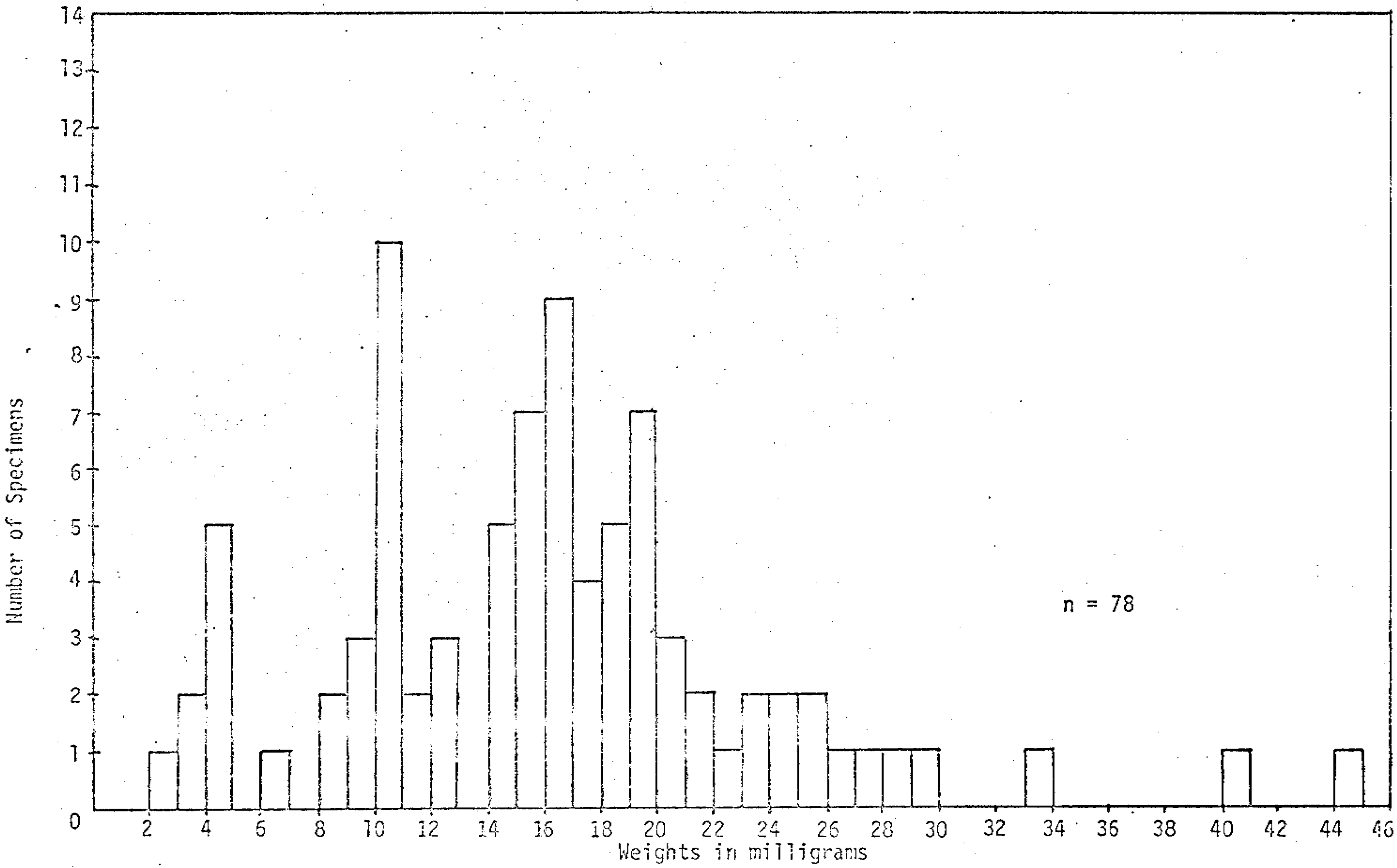


Figure 10. Boreal smelt - otolith weight frequencies.

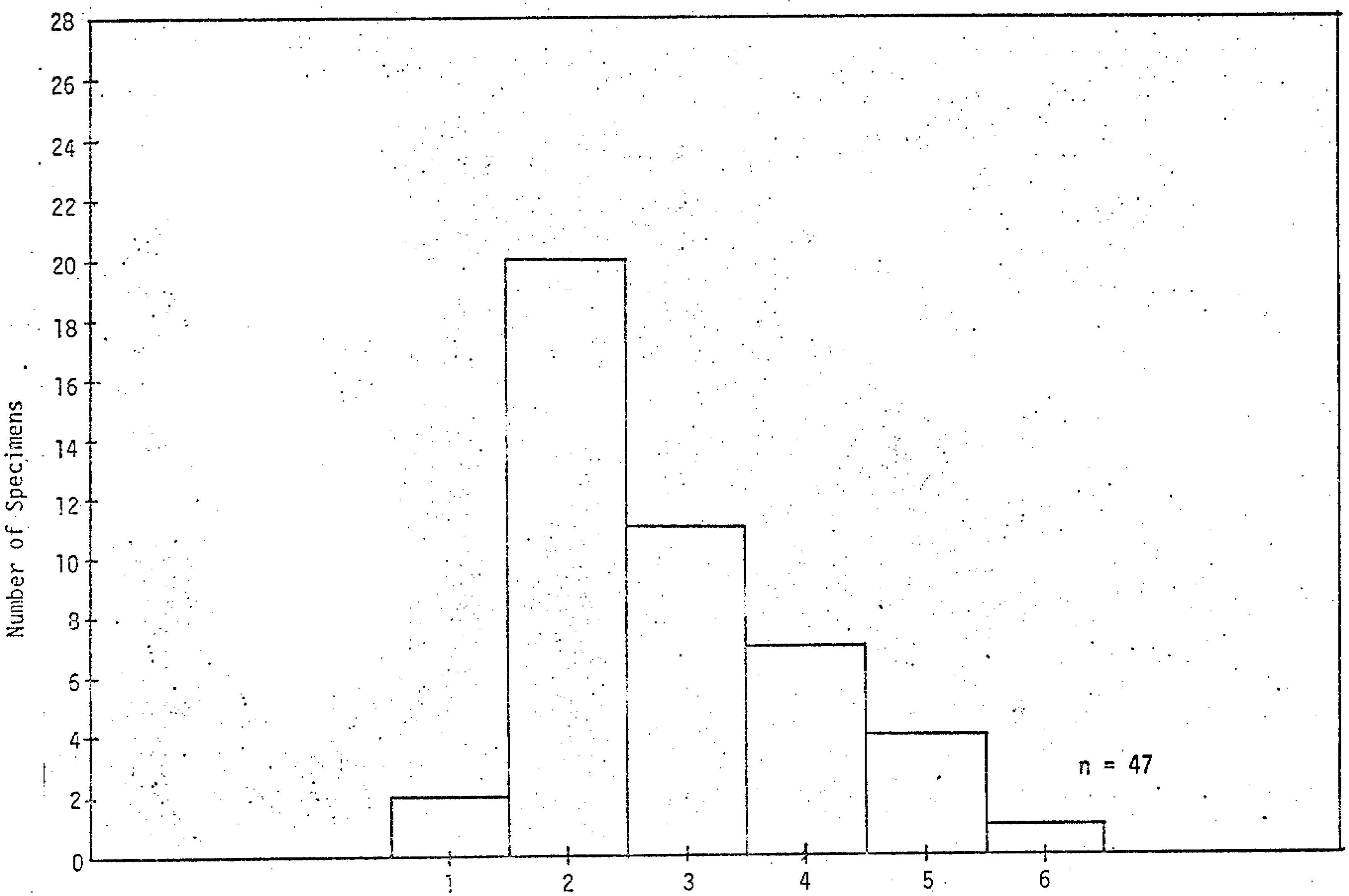


Figure 11. Age Frequencies - Boreal Smelt

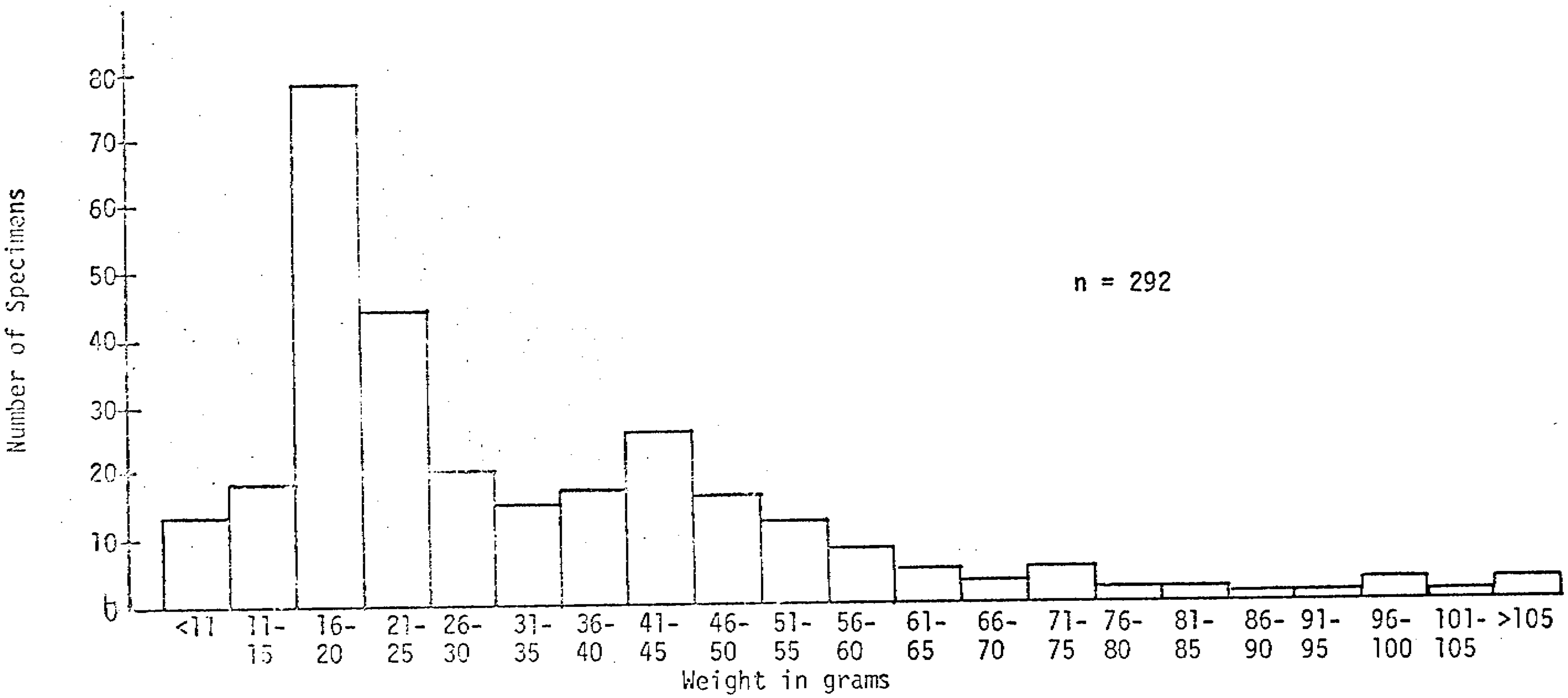


Figure 12. Preliminary weight frequency - boreal smelt

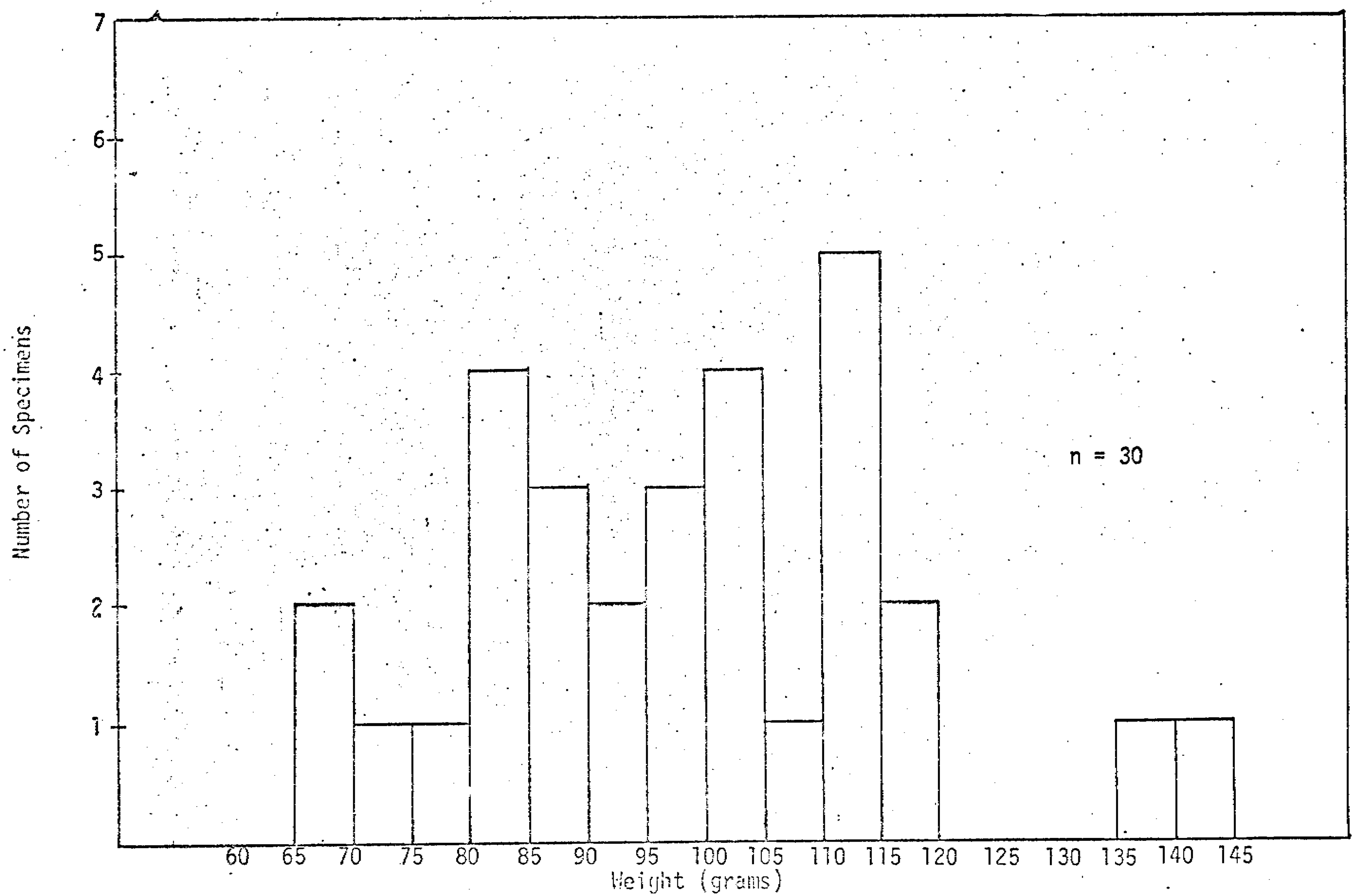


Figure 13. Eulachon weight frequencies.

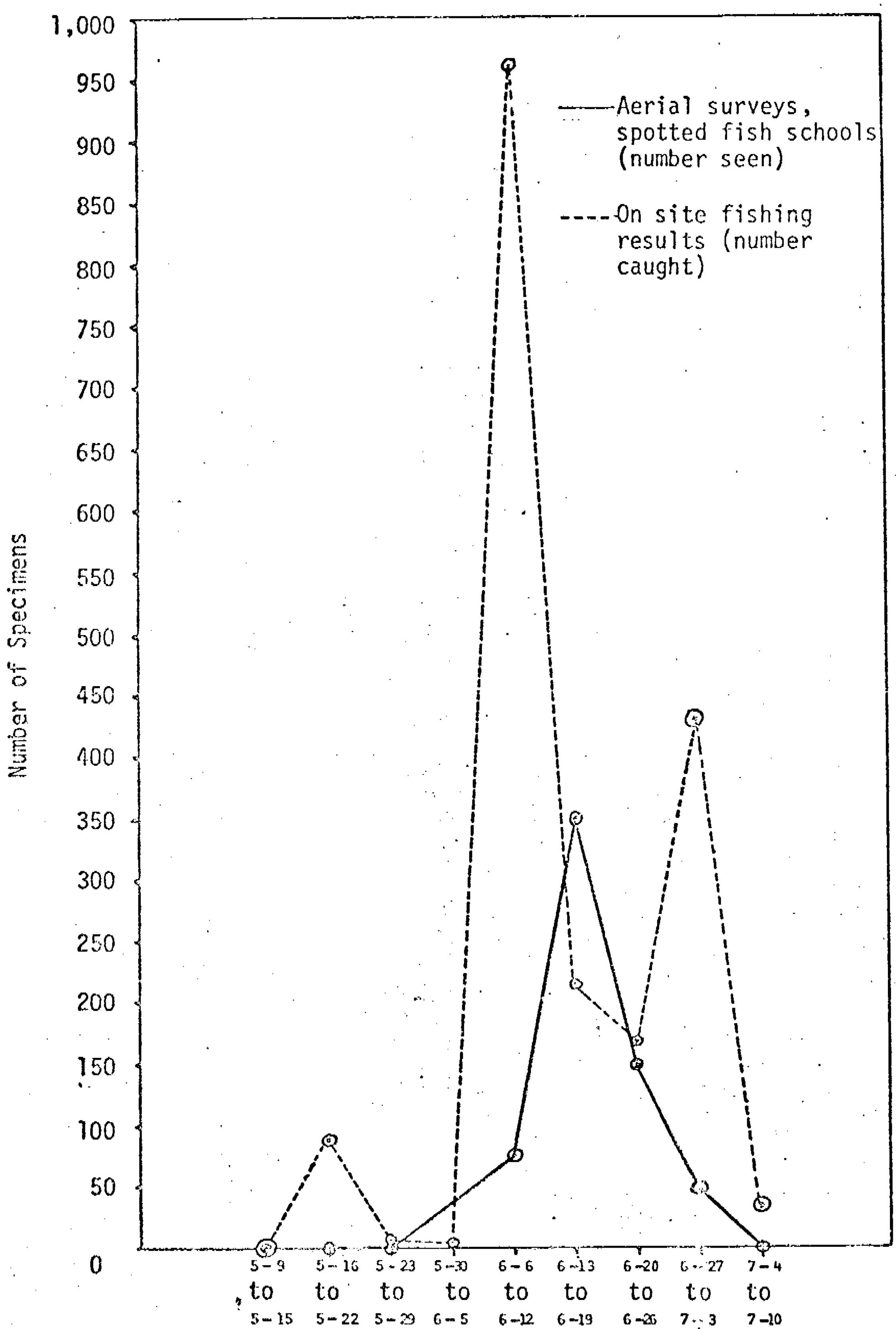


Figure 14. Temporal abundance - forage fish (comparative) OCSEAP Areas 1-5

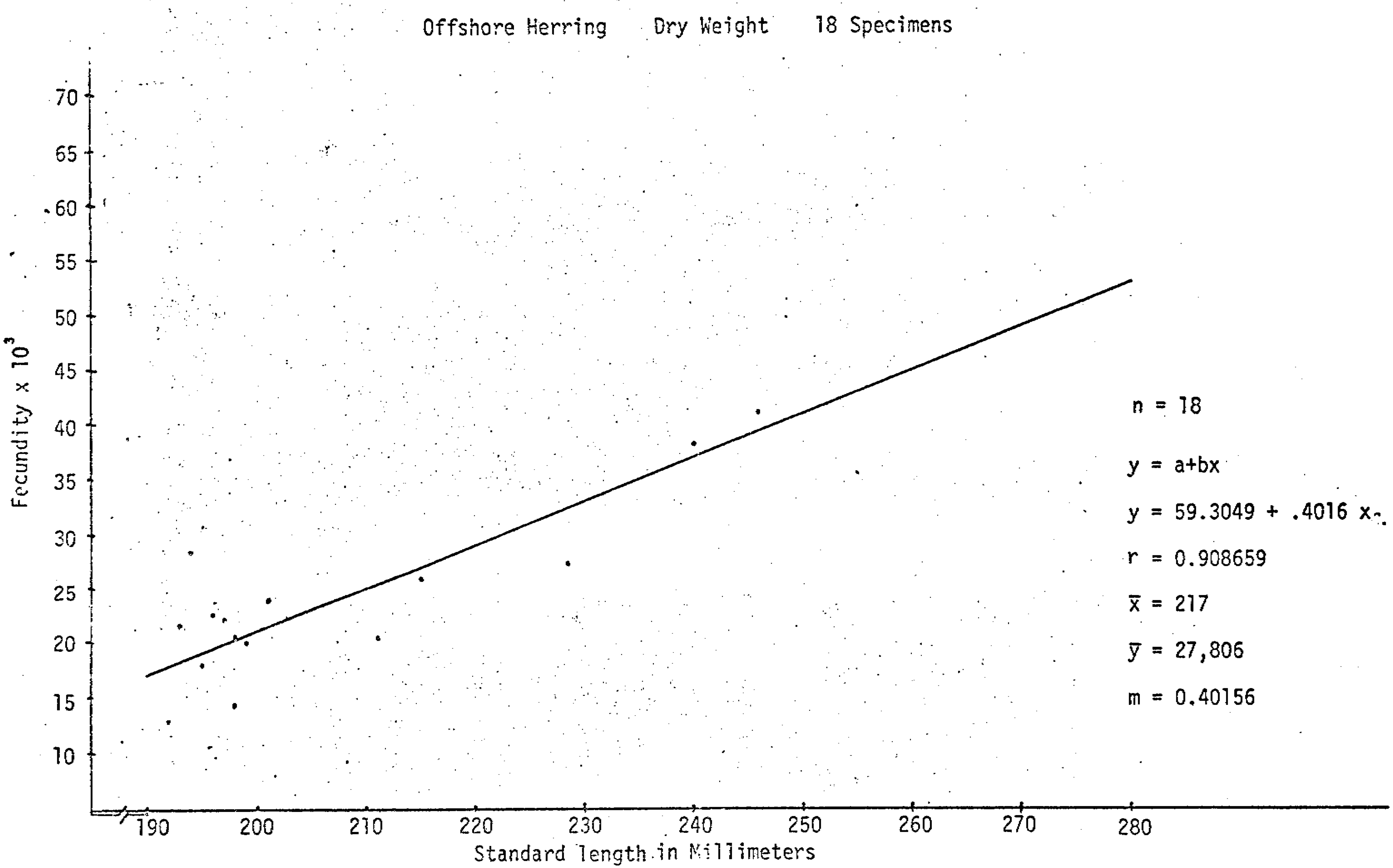


Figure 15. Graph showing relationship between fecundity and length of female Pacific herring (*Clupea pallasi*) taken from offshore sampling sites #1 and #2 (See map Figure 2) in the Bering Sea. Dry weight analysis.

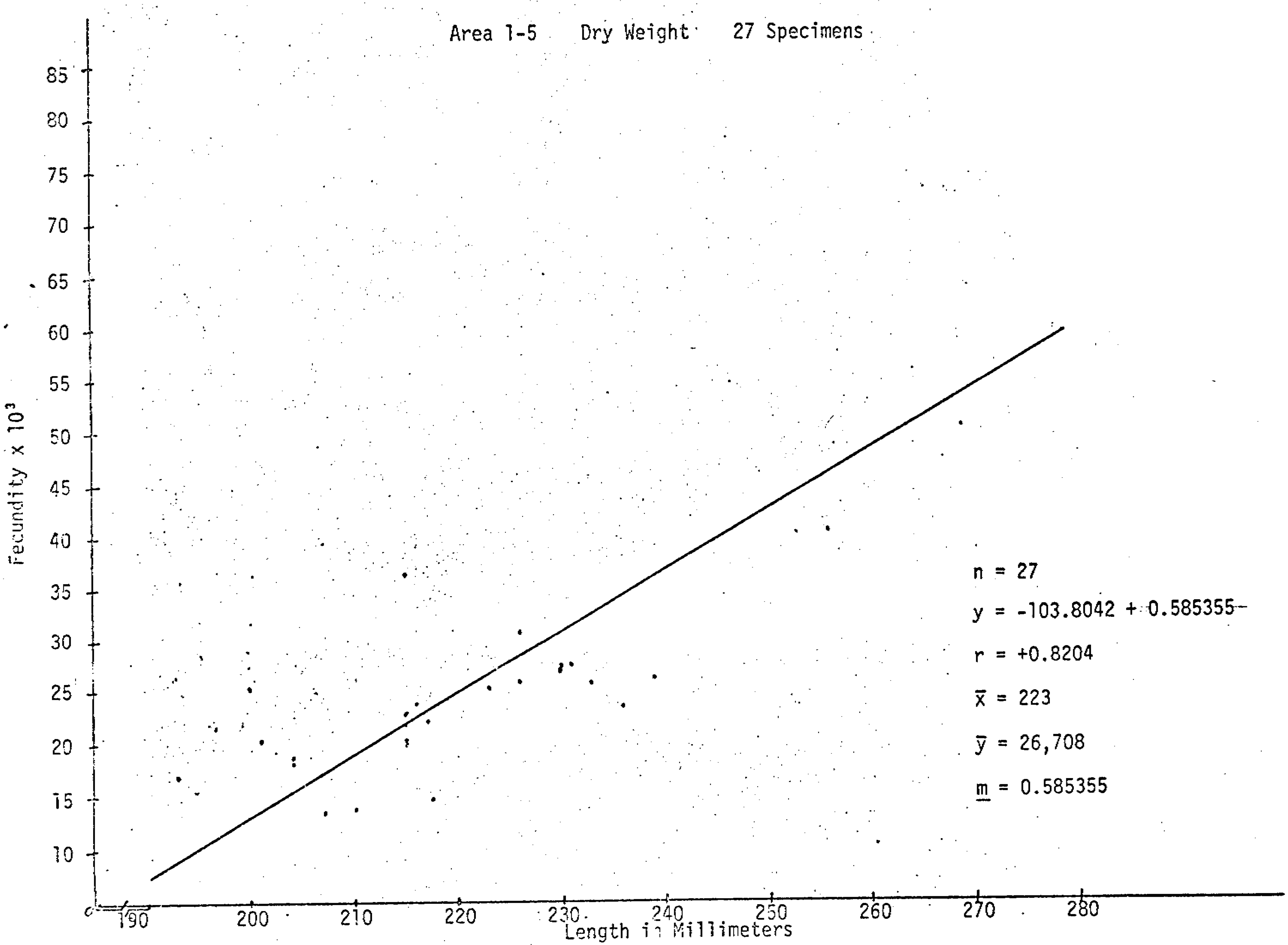


Figure 16. The relationship of fecundity and body length of the Pacific herring (*Clupea pallasi*) from onshore

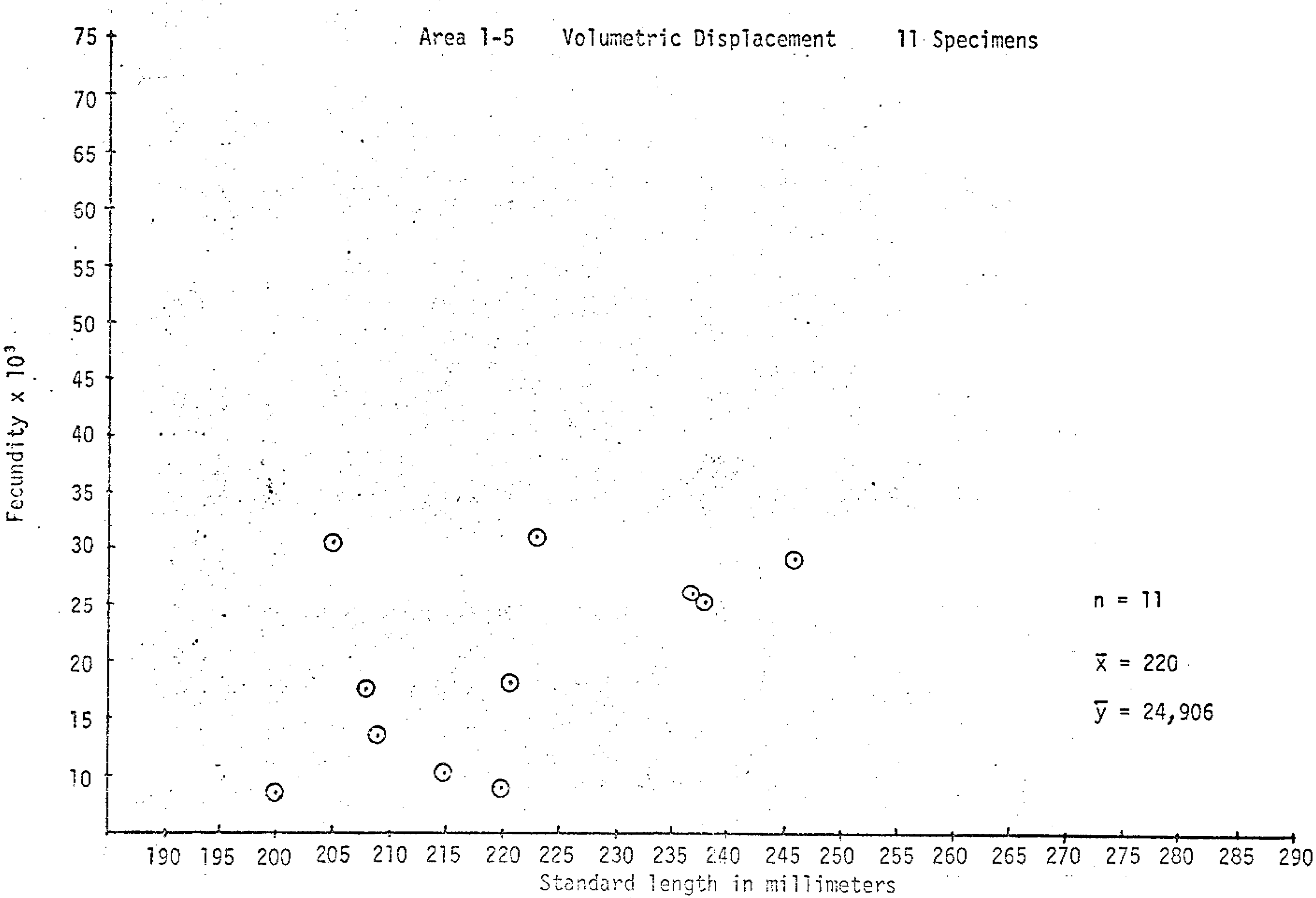


Figure 17. Volumetric displacement data on fecundity

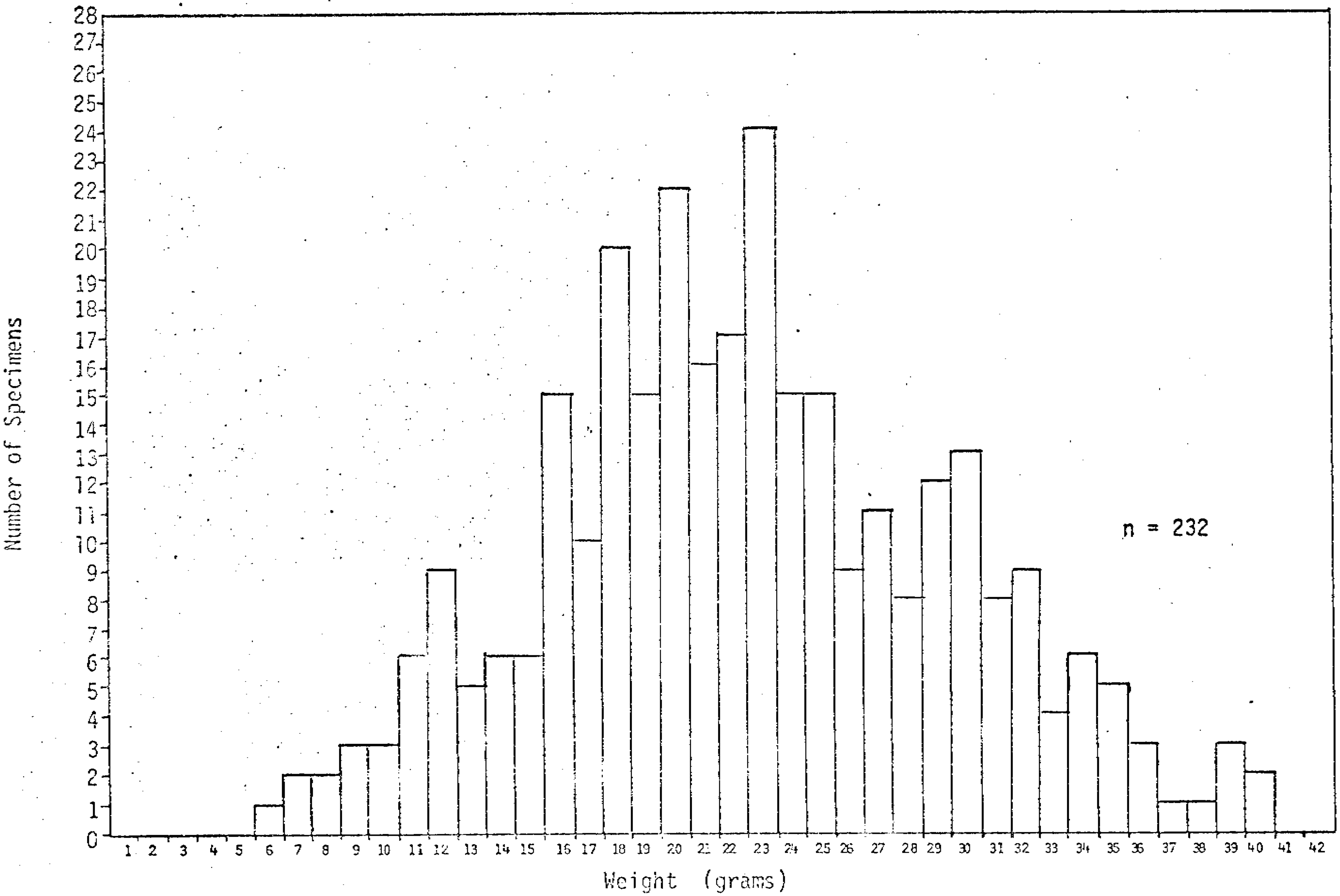


Figure 18. Weight frequencies of capelin caught in Areas 1-5, Cape Sarichef to Smoky Point, May-June 1976.

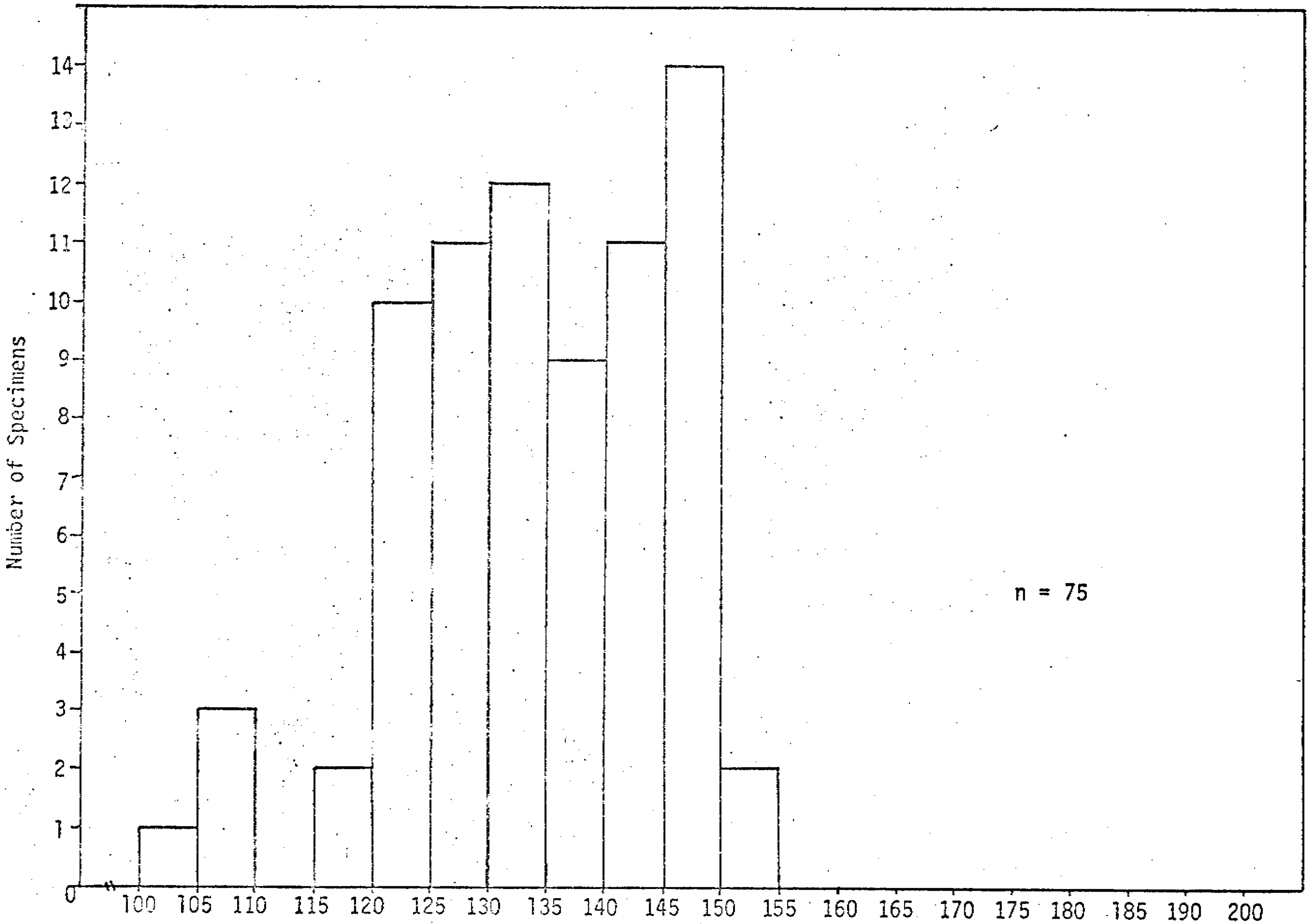


Figure 19. Graph showing length frequencies of female capelin sampled in Areas 1-5 at various onshore sites from Cape Sarichef to Smoky Point, Alaska Peninsula, May-June 1976.

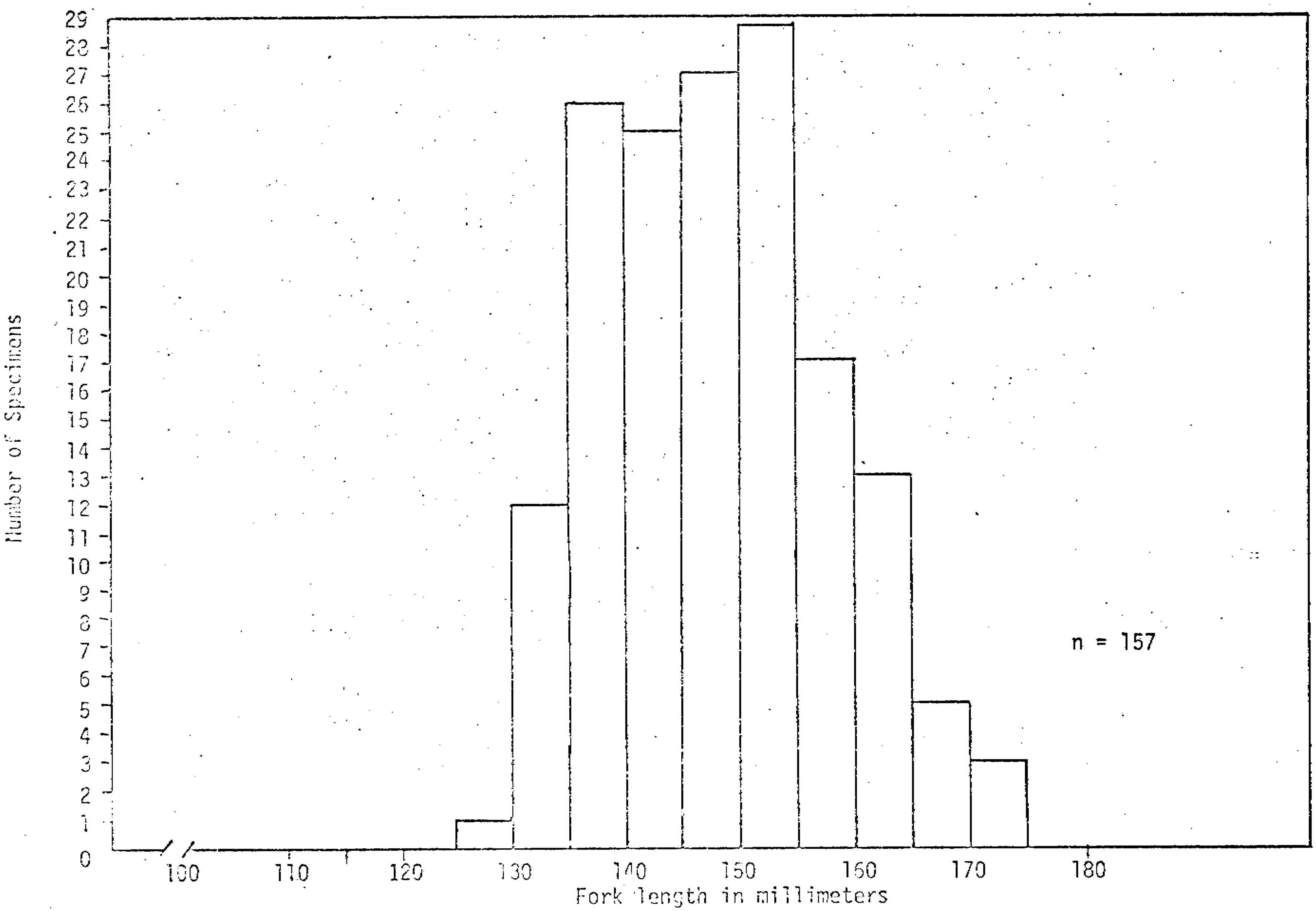


Figure 20. Male capelin length frequency - Cape Sarichef to Smoky Point, Areas 1-5 - 1976.

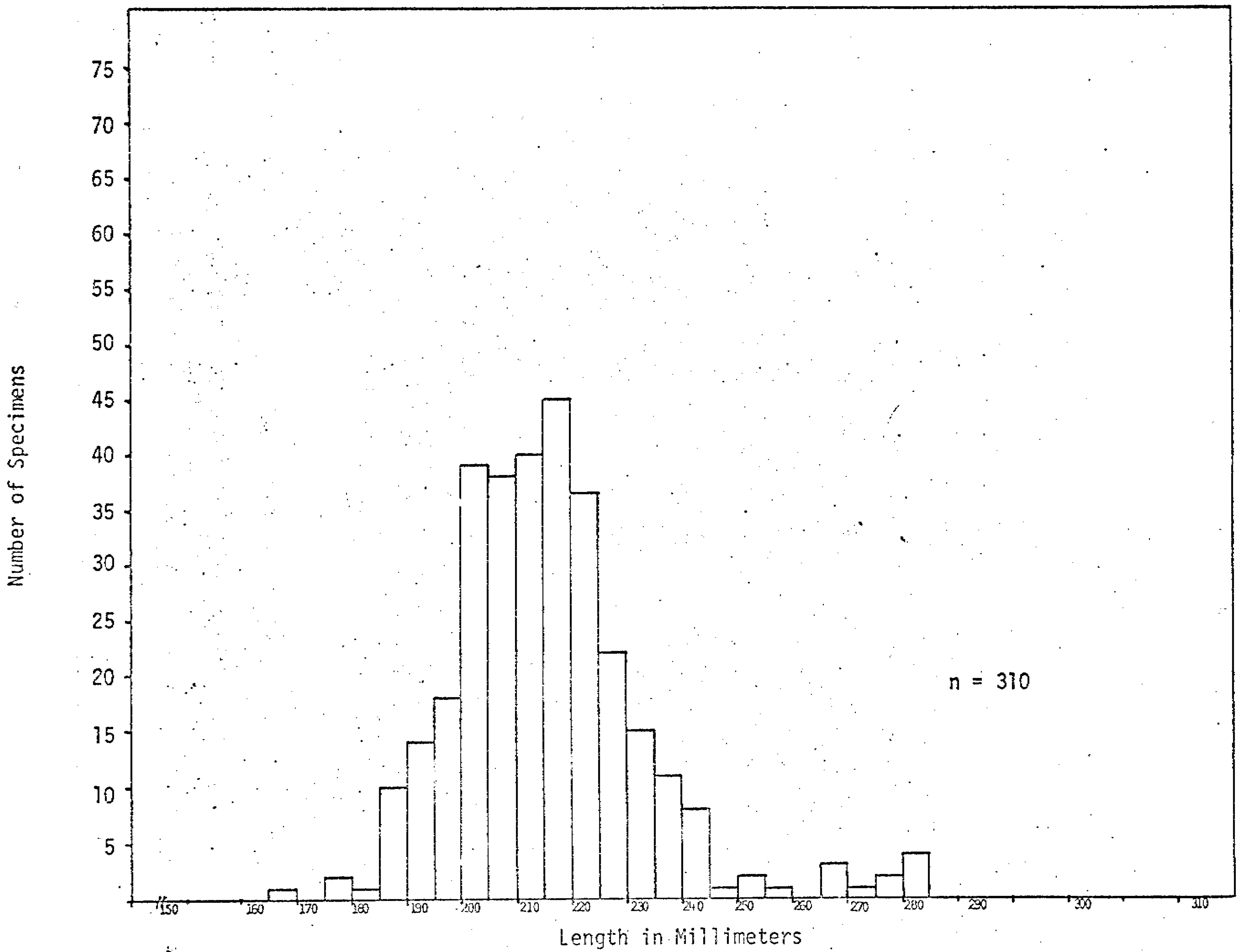


Figure 21. Length frequencies of onshore herring; Port Heiden and Herendeen Bay catches, May-June, 1976. (Standard length)

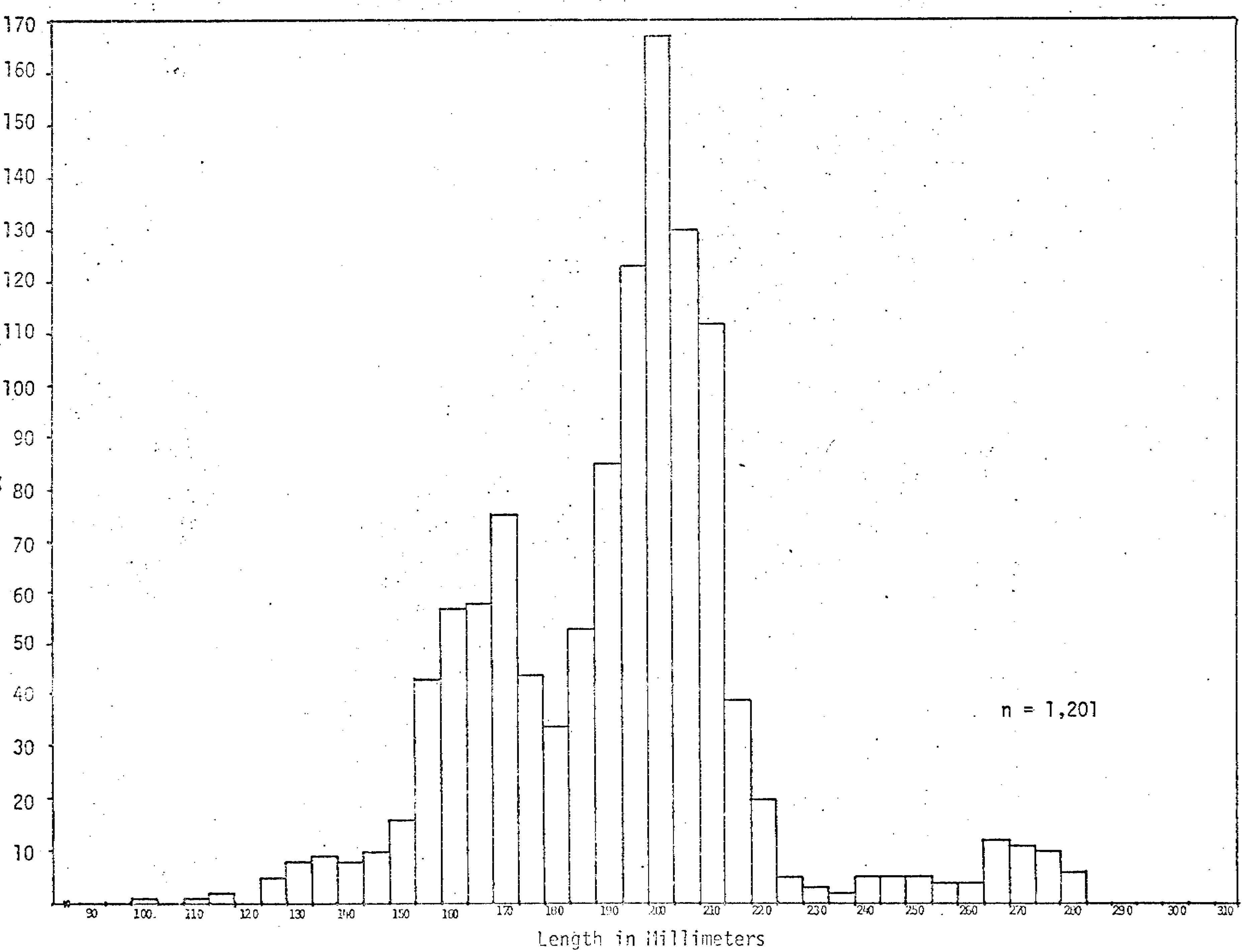


Figure 22. Length frequencies of offshore herring populations in Bering Sea, May-June 1976. (Standard length)

Figure 25. Capelin on beach. Port Moller, Alaska 1976
Warner

Figure 23. Capelin on beach. Port Moller, Alaska 1976
Warner

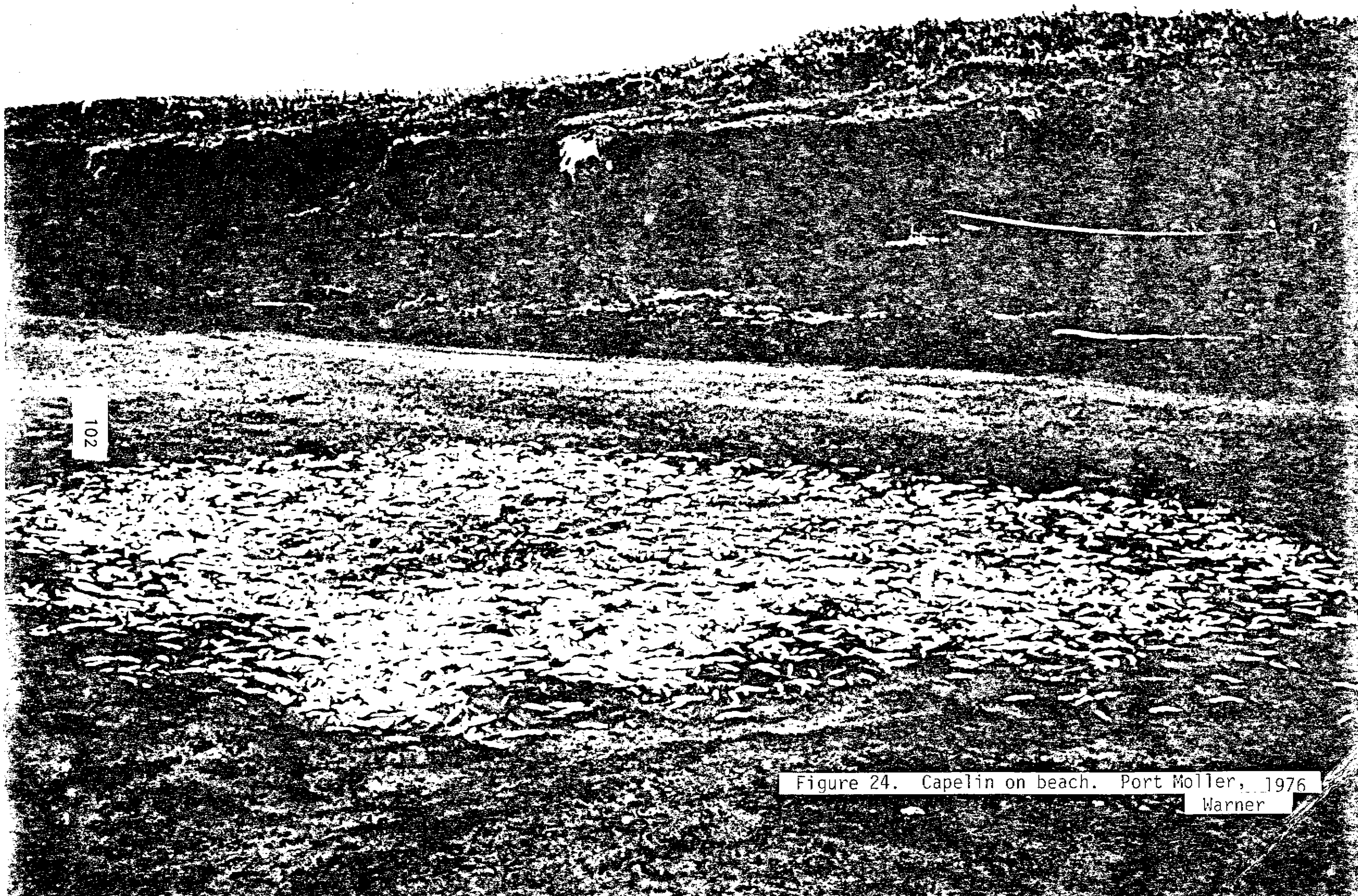


Figure 24. Capelin on beach. Port Moller, 1976
Warner

Research Unit # 19E

Pelagic and Demersal Fish Assessment in the Lower Cook Inlet Estuary System

James E. Blackburn
Alaska Department of Fish and Game
P.O. Box 686
Kodiak, Alaska 99615

September, 1976

Completion Report for Period July 1 - September 30, 1976

Prepared for:

National Oceanic and Atmospheric Administration
Environmental Research Laboratories
Boulder, Colorado

Introduction - Task Objectives

This report describes activities, progress and some preliminary results on Cook Inlet Pelagic and Demersal Fish Studies, Research Unit 19E, during July through September 1976. Methods, results and preliminary interpretation of results presented in the interim report which covered through the end of July is not repeated.

The study area for this project includes lower Cook Inlet from the Forelands to 59°N latitude and west of 152° west longitude, south of Pt. Bede on the Kenai Peninsula (Figures 1 and 2).

Task objectives of this project are listed below.

A. Determine the spatial and temporal (May-September) distribution, relative abundance and inter-relationships of the various pelagic and demersal finfish and shellfish species in the study area.

B. Determine when, where, at what rate and in what relative abundance pelagic fish species (primarily salmonids) migrate into and through the study area.

C. Determine the growth rate and food habits of selected pelagic and demersal fish species.

D. Survey the literature to obtain and summarize an ordinal level documentation of commercial catch, stock assessment data, distribution, as well as species and age group composition of various shellfish species in the study area.

E. Survey the literature to inventory and characterize salmon spawning streams as well as timing of fry and smolt migrations.

F. Obtain basic oceanographic and atmospheric data to determine any correlations between these factors and migrations and/or relative abundance of various pelagic and demersal fish and shellfish species encountered.

Field or Laboratory Activities

Sampling consisted of a basic routine which was duplicated each month. The M/V BIG VALLEY was utilized from the 1st to the 5th of each month for otter trawling and from the 6th through the 15th for purse seining. During the purse seine time period the Boston Whalers with beach seines and townets were ferried to and from the west side of lower Cook Inlet where the crews camped on the beach and were supported by the M/V BIG VALLEY. During the 16th through the following 5th, beach seining and townetting were conducted in Kachemak Bay and along the east side of lower Cook Inlet from the Boston Whalers. During September, gillnets were used in place of the power purse seine.

Personnel involved in the data collection and their role were Jim Blackburn, Principal Investigator, Wes Bucher, Assistant Principal Investigator, and staff personnel Dave Anderson, Bob Mielke, Steve Pint, Don Seagren, and Phil Smith.

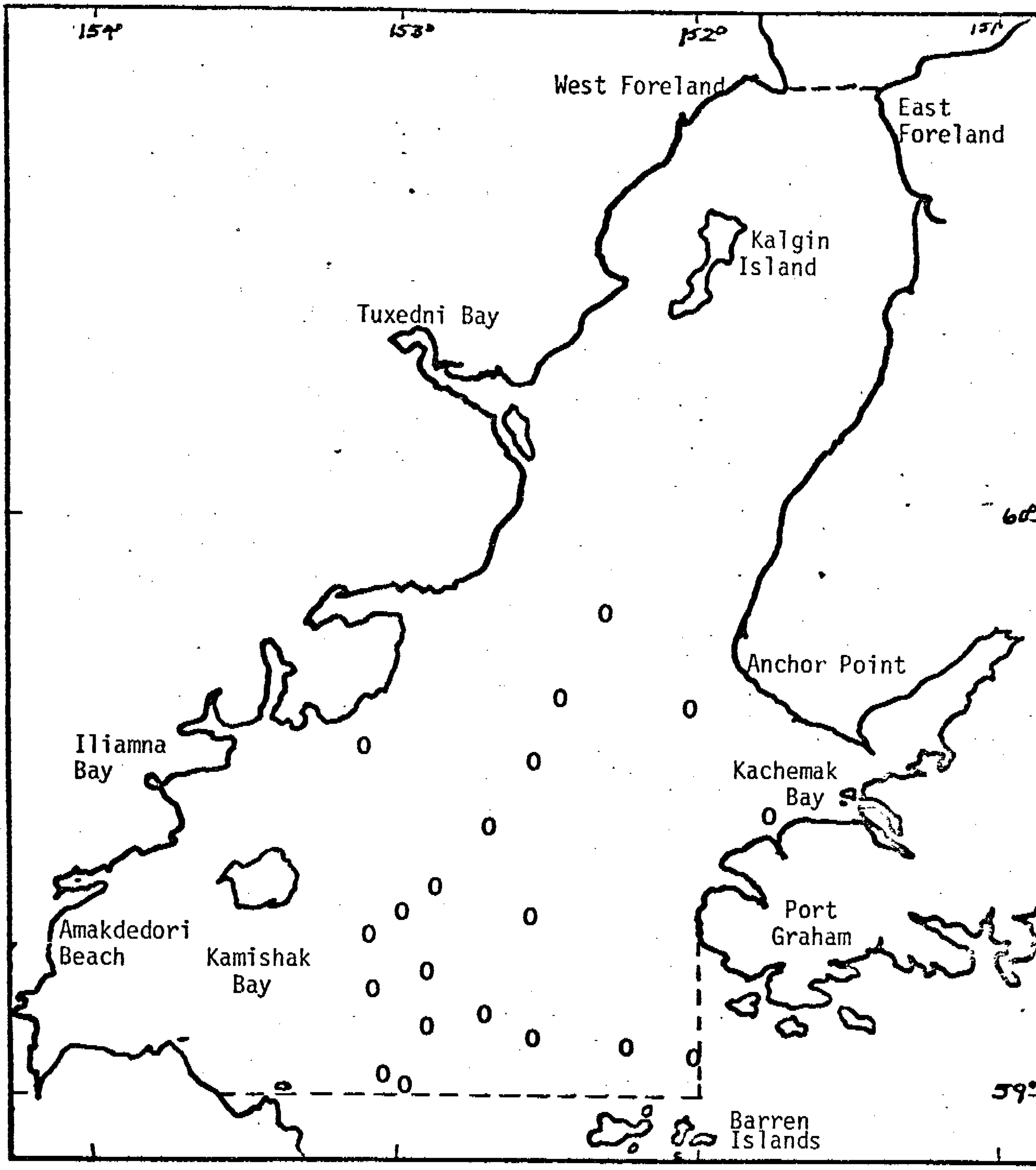


Figure 1. Lower Cook Inlet showing the boundaries of the study area (dashed lines) and otter trawl stations (0). Beach seine and townet samples were taken along both shorelines, from Amakdedori Beach to Tuxedni Bay on the west and along the entire eastern shoreline.

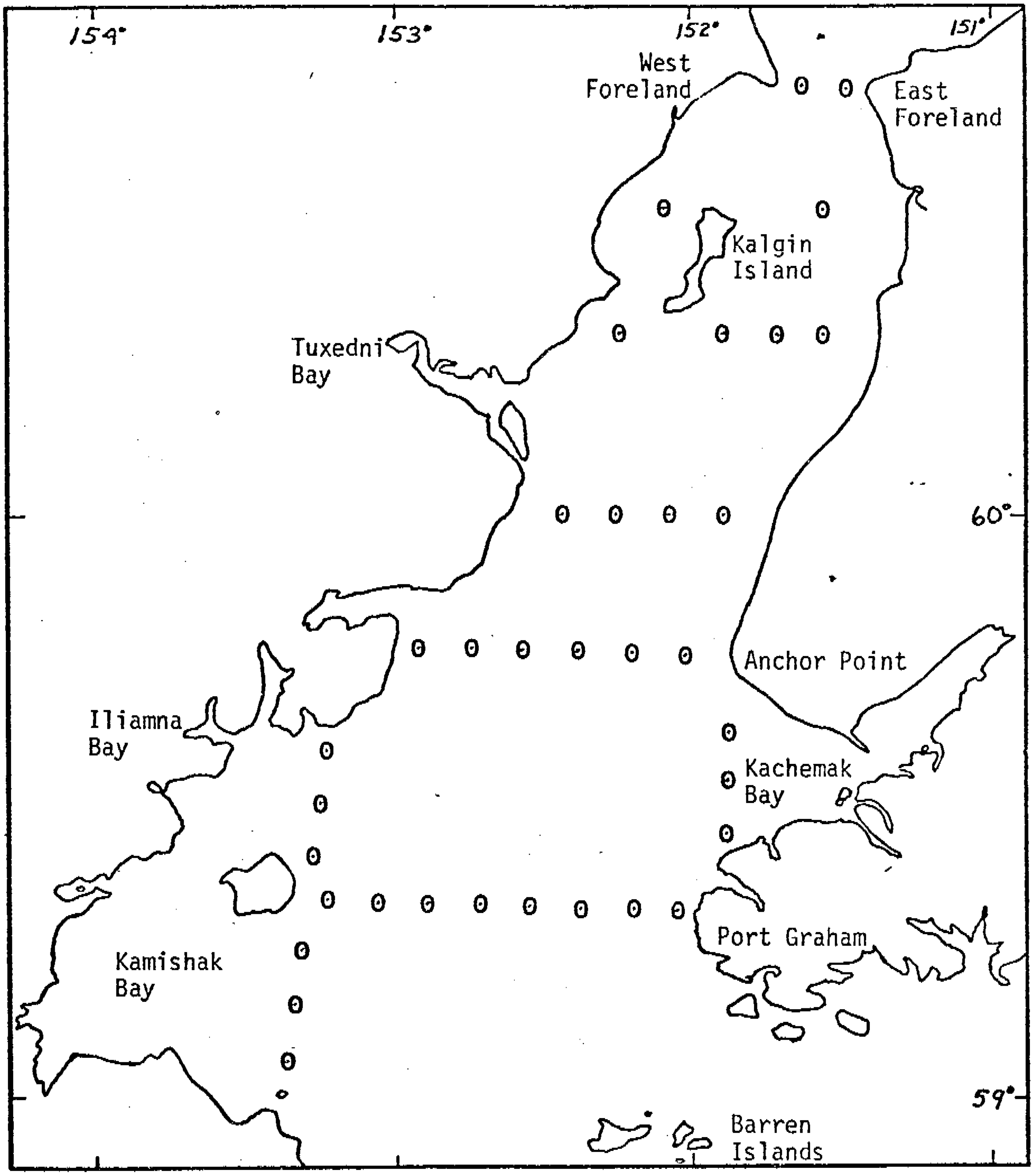


Figure 2. Lower Cook Inlet showing the power purse seine sampling stations.

Samples collected were as follows: Otter trawl hauls, July 17, August 21 and September 15; townet hauls, July 71, August 62, September 54; beach seine hauls, July 66, August 65 and September 57; power purse seine sets, July 13 and August 10; gillnet sets, September 8.

Results

In August, 21 otter trawl hauls were completed with satisfactory gear performance on 19. In September 15 otter trawl hauls were completed with satisfactory gear performance on 14. Catch in every month has consisted almost entirely of flounders, crustacea, cod and sculpins (Table 1). Predominant species in August by weight were walleye pollock (*Theragra chalcogramma*), tanner crab (*Chionoecetes bairdi*), Irish Lord (presumably yellow Irish Lord, *Hemilepidotus jordani*), rock sole (*Lepidopsetta bilineata*), king crab (*Paralithodes camtschatica*) and Pacific halibut (*Hippoglossus stenolepis*). September catch data is not yet available for analysis.

Otter trawl mean total catch in August continued a trend to increase over June and July. Walleye pollock catches show the most dramatic increase, with catches of 0.7, 10.0 and 24.2 Kg/20 minute tow in June, July and August respectively (Table 1). Arrowtooth flounder (*Atheresthes stomias*), Irish Lord, and rock sole catches show similar increases.

Distributional features are a little more clear than previously. Largest catches of cod were in the center of the inlet in June at 59°34' and 59°42'. In July samples were taken further south and largest cod catches were south of 59°15'. Catches of cod in July and August were much smaller in the more northern area where greatest catches occurred in June. In August the largest catches of cod remained south of 59°1 and had a distinct trend for greater catches on the western side of the inlet.

Catches of crustaceans in each month tended to increase toward a station of 59°13'N, 152°55'W and one station north of Seldovia at 59°29'N, 151°44'W, always produced large catches. Catches of flounders in June were largest at three stations near the mouth of Kachemak Bay and at one station near the center of the inlet at 59°42'N, 152°25'W. Catches of flounders in July were greatest on the west side of Cook Inlet south of Chinitna Pt., however, the areas sampled during June and July were quite different. In August, many of the areas sampled in both June and July were resampled. Catches of flounders were considerably smaller in August in the areas where greatest catches occurred in June. In general the catch of flounders in August increased over the July catch south of 59°22'N, and decreased north of this latitude.

A total of 62 townet hauls were made in August. The predominant taxa and number of hauls in which they occurred were: Pacific sandlance (*Ammodytes hexapterus*) 23; Pacific herring (*Clupea harengus pallasi*) 8; pink salmon fry (*Oncorhynchus gorbuscha*) 7; Pacific sandfish (*Trichodon trichodon*) 6; chinook salmon fry (*Oncorhynchus tshawytscha*) 5; and capelin (*Mallotus villosus*)5 (Table 2).

The three areas separated for analysis, Kachemak Bay, east side of Cook Inlet between Anchor Pt. and the Forelands, and the west side of Cook Inlet from Kamishak Bay to Tuxedni Bay do not show clear differences in a frequency of occurrance of most species (Table 2). Pacific herring were markedly more frequent on the east side and capelin only occurred on the east side and in Kachemak Bay.

Table 1. Preliminary tabulation of otter trawl catch in kilograms per haul in lower Cook Inlet in June, July and August 1976.

	June	July	August
Flounders	19.8	25.1	40.1
Crustacea	14.7	27.3	32.5
Cod	10.1	20.5	31.2
Sculpins	7.5	11.1	23.8
Tanner crab	9.9	23.2	23.2
Pacific cod	9.4	6.2	7.0
Halibut	8.6	5.2	8.6
Butter sole	5.7	6.4	4.1
King crab	4.4	4.1	8.6
Yellowfin sole	1.9	7.0	4.7
Rock sole	1.8	2.6	10.4
Walleye pollock	0.7	10.0	24.2
Arrowtooth flounder	0.4	3.0	7.6
Great sculpin	3.7[1]	3.3[1]	7.2
Irish Lord[2]	0.9[1]	5.2[1]	15.2
Total Catch	53.4	84.6	137.4

[1]Conservative figures; all individuals may not have been identified
[2]Originally identified as brown Irish Lord, now believed to be yellow Irish Lord

Table 2. Percent of townet samples containing taxa by area and time in lower Cook Inlet, May, June, July and August, 1976.

	Kachemak Bay May 20-29	Kachemak Bay June 22-July 7	West side of Cook Inlet July 7-12	East side of Cook Inlet July 20-22	Kachemak Bay July 15-28	Kachemak Bay South August 3-5	West Side August 9-13	East Side August 19-22	Kachemak Bay North August 24-27
Pink salmon fry	46	58	6	59	34		19	12	9
Chinook salmon fry		17	37	6			6	25	
Coho salmon fry			6	6					
Sockeye salmon fry			6				6		
Dolly Varden				6					
Pacific sandlance	54	42	12	18	8	12	12	81	40
Greenling juvenile	46	42	44	29	13		12		4
Capelin smelt				41		12		19	4
Pacific herring			6	59	5			44	4
Lamprey				35					
Pacific sandfish				12		12	6		18
Prickleback	8			6				6	
Cod				6		25		12	
Sculpin	15				5				
Wolffish					3				
3-spine stickleback		8			3				9
Unidentified fish					8			12	9
Number of Hauls	13	12	16	17	38	8	16	16	22

Pacific sandlance were markedly less frequent in all areas between July 7 and August 13. The frequency of occurrence of pink salmon fry noticeably decreased in August. No other time trends are apparent.

A total of 65 beach seine hauls were made during August and fish were captured in 63. Sculpins were captured in 34 hauls, Dolly Varden (*Salvelinus malma*) were captured in 32 hauls, greenling juveniles (*Hexagrammidae*) were captured in 26 hauls, Pacific sandlance were captured in 25 hauls and pink salmon fry were captured in 18 hauls (Table 3). Pacific herring were considerably more frequent on the east side than elsewhere.

Ten round hauls were made in August with the power purse seine with satisfactory gear performance on nine hauls. A total of 94 fish were captured; 56 Pacific herring, 36 chinook salmon juveniles, one pink salmon juvenile and one Pacific sandlance.

In September gillnets were used in place of the power purse seine. Eight sets were made with satisfactory gear performance on seven. A total of 18 Pacific herring, one pink salmon fry and one chinook salmon fry were captured.

Preliminary Interpretation of Results

Trawl catches seem to be exhibiting more consistent patterns as the number of samples and amount of time encompassed increases. Shifts in the distribution of some taxa, especially flounders, suggest migration which may be associated with spawning. This feature will require a more detailed examination of the data. Further interpretation is not prudent at this time.

Problems Encountered/Recommended Changes

When the power purse seine was employed several difficulties were encountered that precluded achievement of objectives. The net is very large and is capable of tremendous drag in the water. When the net was set in modest winds, approximately 15 knots, the drag was sufficient that the skiff could not pull its end to the M/V BIG VALLEY, forcing us to abort the haul. Later, when the net was successfully set in similar winds, the drag of the M/V BIG VALLEY with its crab tanks full of water was sufficient to collapse the net before it could be pursed. Any fish that may have been in the net would have been forced out the bottom.

The greatest problem was fouling the net on the bottom of the boat. Although the net was always set with the boat downwind of the net, and the skiff was used to pull the boat away from the net, the net frequently drifted around the bow and stern and repeatedly became fouled in the propeller, resulting in gear damage and lost time.

Some problems were encountered that may have been avoided if the crew had been more experienced. The weight of the net was sufficient to bend the 1¼" diameter stainless steel clothespin used to support the purse rings; the webbing was

Table 3. Percent of beach seine samples containing predominant taxa by area and time in lower Cook Inlet, May, June, July and August 1976.

	Kachemak Bay May 21-June 8	West Side June 10-13	Kachemak Bay June 18	East Side June 21-24	Kachemak Bay June 21-30	West Side July 8-12	East Side July 20-21	Kachemak Bay July 26-27	Kachemak Bay August 3-5	West Side August 9-13	East Side August 19-21	Kachemak Bay August 24-28
Dolly Varden	64	75	62	67	61	88	69	75	64	60	45	36
Sculpins	64	33	75	33	77	72	31	68	71	53	36	48
Greenling juveniles	45	17	37	25	77	40	77	64	21	33	73	40
Pink salmon fry	45	42	62	33		64	8	43	50	67		4
Chinook fry		8	37	33	46	8	15	21	29			
Pacific herring			12	58	8	28	31	7		20	54	16
Snake prickleback		8	12	42	31		23	21		7	9	
Pacific sandlance		8	62		31	16		11	14	40	54	44
Starry flounder	9	17		25	23	28	15		7	20	27	4
Rock sole		8	12		31	24	15	11	36	20		
3-spine stickleback	45	17		8	8			21	7	13		16
Number of Hauls	11	12	8	12	13	25	13	28	14	15	11	25

incessantly fouled in the purse rings when the net was pursed; purse rings would not line up to allow the clothespin to slip through; and splices in the purse line wouldn't pass through the blocks.

The webbing of the net was not small enough to retain many of the small salmonids. Only one salmonid less than 100 mm was captured and only three less than 125 mm were captured. Also, fish would become entrapped in the folds of webbing as the net was brought aboard and would not be noticed. Some fish were found in the pile of webbing on deck but it is likely that others were not found, and with small catches this becomes a substantial source of error.

These factors together prevent the attainment of the task objectives for pelagic fish. However, the scope and limitations of the project have not been considered. Each month ten days were available for purse seining to cover 3,000 square miles. During these ten days, a beach seine and townet crew had to be ferried to and from the west side of Cook Inlet, resupplied with fuel and food and contact had to be maintained for safety. Assuming that three sets could be made each day and eight days could be worked, 24 sets were possible. This intensity of sampling is insufficient to meet project objectives.

The changes to the data codes this summer were helpful. However, we were frustrated when we tried to obtain changes in coding and formatting. The Principal Investigators should have direct contact with the individual or office that has the authority to change formats and change or add codes.

The field definitions and codes for the data format system are both insufficient and scattered. (Is mesh code stretch measure or bar measure?) Not until the sampling season was nearly over did we understand Haul or Set Number and Sequence Number. The definitions of data fields should be fleshed out so they are understandable. If field definitions are purposefully left vague so that the individual investigator has flexibility, this should be clear and if they are firm and inflexible, this should be clear. The code definitions are scattered throughout a bundle of loose pieces of paper randomly assembled in a punched binder. The pages entitled "Record Format Description" contain some of the codes and definitions while other loose pages contain codes for other fields. A third set of loose pages contains the decimal locations. All this should be either placed on Record Format Descriptions as much as possible or removed from it and placed in a code definition section. Consolidate the definitions.

The loose piece of paper system prevents understanding how the pieces of the puzzle fit together. If the whole format and coding system were assembled in a booklet of loose replaceable numbered pages, at least, one could tell which office generated which piece of paper.

The definitions of several of the fields are duplicated. The otter trawl is described piecemeal in Record Type 2, and then portions of the description are collectively recorded as Bottom Trawl Gear Code and Bottom Trawl Gear Accessories Code in Record Type 1. This generates confusion and problems. The collective codes were the ones that required changing during the field season. The duplications should be eliminated

Preliminary Audit of Expenses to Date

A.	Personnel		54.1[1]
	Permanent	18.2	
	Temporary	35.9	
B.	Travel and Subsistence		3.0
C.	Contractual Services		75.8
D.	Commodities[2]		30.1
E.	Equipment		14.2
		Total	177.2
		10% overhead	16.3
		GRAND TOTAL	193.5

[1]Includes benefits
[2]Includes expendable fishing gear, i.e. trawls and seines

STATE OF ALASKA

JAY S. HAMMOND, GOVERNOR

DEPARTMENT OF FISH AND GAME

COMMERCIAL FISHERIES DIVISION

P. O. Box 686
Kodiak, Alaska 99615

October 7, 1976

Mauri J. Pelto
Outer Continental Shelf Energy Program
Juneau Project Office
P.O. Box 1808
Juneau, Alaska 99802

Dear Mauri:

Enclosed is the Razor Clam Density and Distribution (R.U. #24) fourth quarterly report. As indicated earlier, and due to nonrenewal of full year funding for FY 77, razor clam studies, a contract extension has been approved to provide for data analysis and subsequent final report wrap-up. This report will be submitted no later than December 1, 1976.

Sincerely,

Rodney J. Kaiser
Management Shellfish Biologist
Kodiak

cc: Pete Jackson

QUARTERLY REPORT

Contract No.: 03-5-022-69
Research Unit No.: 24
Reporting Period: July 1 - September 30, 1976
No. of pages: 48

Razor Clam (*Siliqua patula*, Dixon) Distribution and Population Assessment Study

Rodney J. Kaiser

Daniel Konigsberg

Alaska Department of Fish and Game
Division of Commercial Fisheries
P.O. Box 686
Kodiak, Alaska 99615

September 30, 1976

INTRODUCTION

As the development phase of oil and gas exploration in the Gulf of Alaska proceeds towards production, petroleum-related impact in the coastal intertidal regimes will undoubtedly occur. These effects exerted on distribution and density of marine organisms and the habitat they occupy will be significant in some areas.

Much of the focus of OCSEAP assessment and reconnaissance survey programs in NEGOA and WGOA has been to establish the baseline knowledge necessary to evaluate changes in specie occurrance, distribution and habitat variation as a result of the oil development. In line with this critical need for information, OCSEAP priorities shifted intertidal and coastal studies to the WGOA early in 1976.

This study originated to develop baseline data for open surf-swept sandy beach habitat. The initial objective was to study a target specie *Siliqua patula* (Pacific razor clam) within this habitat type. A redefining of goals by OCSEAP planners in March 1976 expanded project planning to a "reconnaissance and assessment" of all bivalves and other invertebrates present within this single habitat type.

Project goals were set to supplement ongoing NMFS studies of intertidal rocky and muddy habitats. Prominant exposure of organisms inhabitating open and relatively flat sandy beaches to oil-related effects demonstrated a need for information.

TASK OBJECTIVES

Project objectives of this study are to determine invertebrate organisms occurring, their density and distribution within the tide levels of the low tide terrace, and substrate characteristics (composition and size) in which they live.

Various phases of other OCSEAP projects interface with this study such as the low level aerial reconnaissance photography of intertidal habitats, their location, specific slope, cover and makeup by area. This will aid in exact definition of the amount of habitat available. Additionally, data gathered will correlate with field groups from Auke Bay Fisheries Laboratory (Juneau) studying organisms inhabiting muddy or rocky substrates.

Specific objectives are to gather information of bivalve density, distribution, age and growth (razor clams only), and habitat on beaches from Yakutat Bay at 139° west longitude to Unimak Bight on the Alaska Peninsula. Specific goals are:

1. Investigate selected sandy beach areas and identify each organism's location with regard to the extent of the specie's existance, density, and habitat.
2. Collect and identify all bivalves at each location and assess density, length and age composition (razor clams only) of each tide level for the entire low tide terrace.
3. Collect core samples of the substrate by tide level at each beach site to investigate substrate composition and grain size.

4. Combine past and current razor clam data for the Gulf of Alaska areas to assist in formulating the biological parameters of this baseline study.

Secondary objectives include collection of incidentally captured invertebrates, investigation of razor clam samples for levels of paralytic shellfish poisoning (PSP) and recording of environmental parameters at each study site.

II FIELD ACTIVITIES

Scientific Party: Daniel Konigsberg, Fisheries Biologist, ADF&G, Kodiak
Christopher Phillips, Fisheries Biologist, NMFS, Auke Bay
Jesus Briones, Fisheries Technician, ADF&G, Kodiak

Methods:

At each beach surveyed a transect was established within an area of average density of the *Siliqua patula* population as determined by foot surveys and visual observations. Tide level stations were deployed at each integral tide level (...-2', -1', 0, +1', +2'...); the location of the lowest station being dependent upon daily tidal regimens and the upper limits of the *Siliqua patula* habitat determining placement of the final station.

Two methods were used at each station to investigate the invertebrate population. a 21 x 3 meter plot was marked along an axis of 90° to the beach exposure direction and a clam shovel was used to capture all bivalves that "showed". These molluscs were then identified in the field and the shells saved for ageing and cataloging. Three subplots of 1/3 m^2 were randomly located within the tide level station plot and excavated to a depth of .30 meters (one foot)(Figure 1). The substrate (101.6 liters of sand for each 1/3 m^2 subplot) was washed through a screen of 1.59 mm fiberglass mesh (Figure 2). The invertebrates from this sample (primarily bivalve molluscs, polychaetes and nemeridians) were preserved for laboratory identification (Figure 3). Notation was made of the presence of amphipods and incidental organisms such as *Ammodytes hexapterus*, the Pacific sand lance.

A rectangular sediment core sample 20 cm X 51 mm was taken at each tide level station and labeled for laboratory analysis (Figure 4).

Various environmental parameters (barometric pressure, air and water temperature, sea state, cloud cover and salinity) were recorded at each beach station.

Topographical maps were used as aids in mapping beaches in regard to the extent of the *Siliqua patula* habitat.

Activity I

A. Field trip schedule: June 25 - July 2. Charter aircraft (Kodiak Western, Amphibious Grumman Goose and Dehavilland Beaver).

B. Sample localities: Alaska Peninsula; Big River Beach, Hallo Bay and Kukak Bay.

C. Data collected:

i) Five tide level stations (-2', -1', 0', +1', +3') were examined at Big River for bivalves and annelids. A total of 304.8 liters of substrate were seived at each tide level station for invertebrate analysis. Core samples were collected from the -3', -2', and -1' tide level stations only.

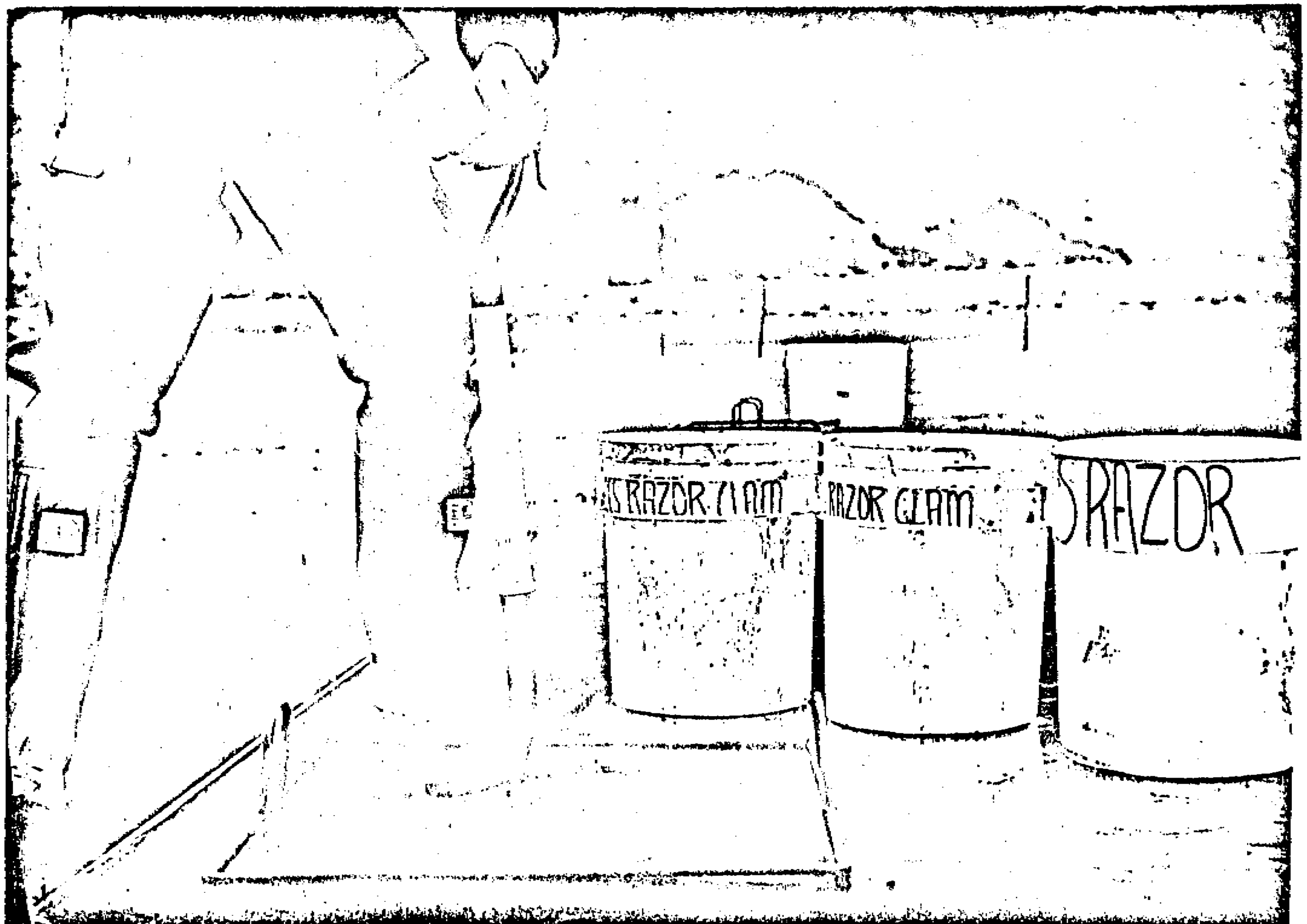


Figure 1. Subsampling technique with the 1/3 m^2 frame in place within the tide level station plot.

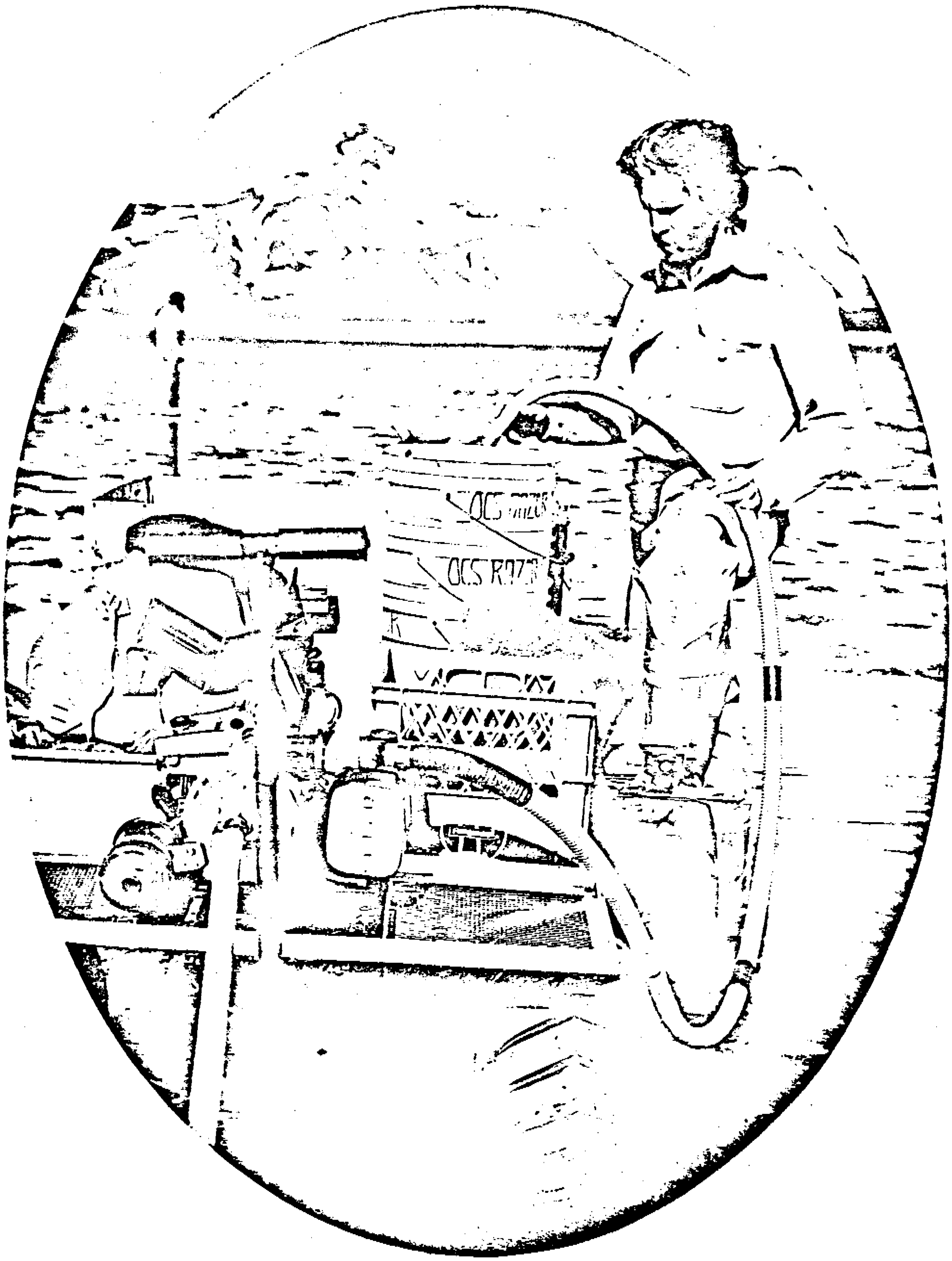


Figure 2. Christopher Phillips washing the subsample using the pump mounted on the sampling wagon.

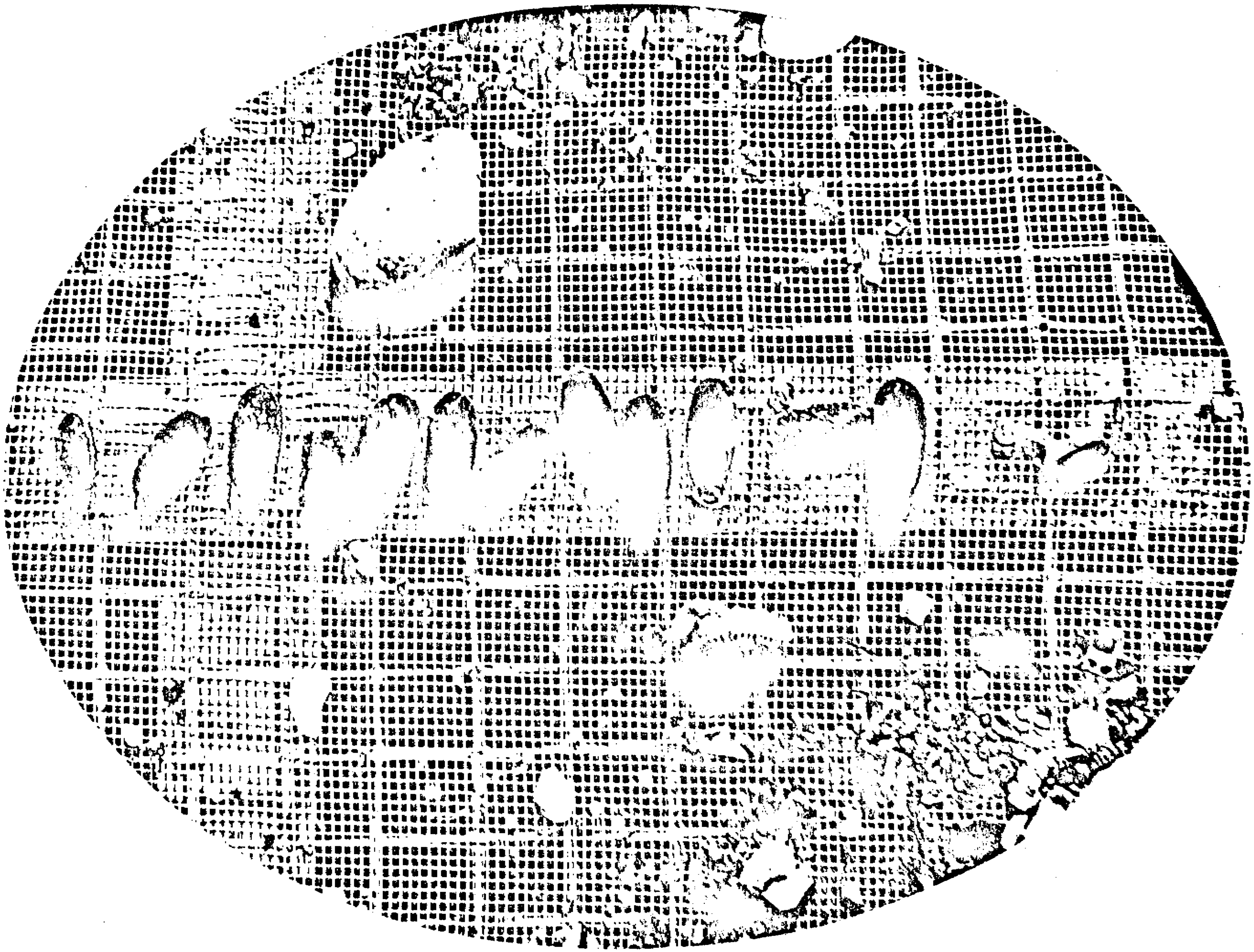


Figure 3. Juvenile *Siliqua patula* after subsample has been washed.

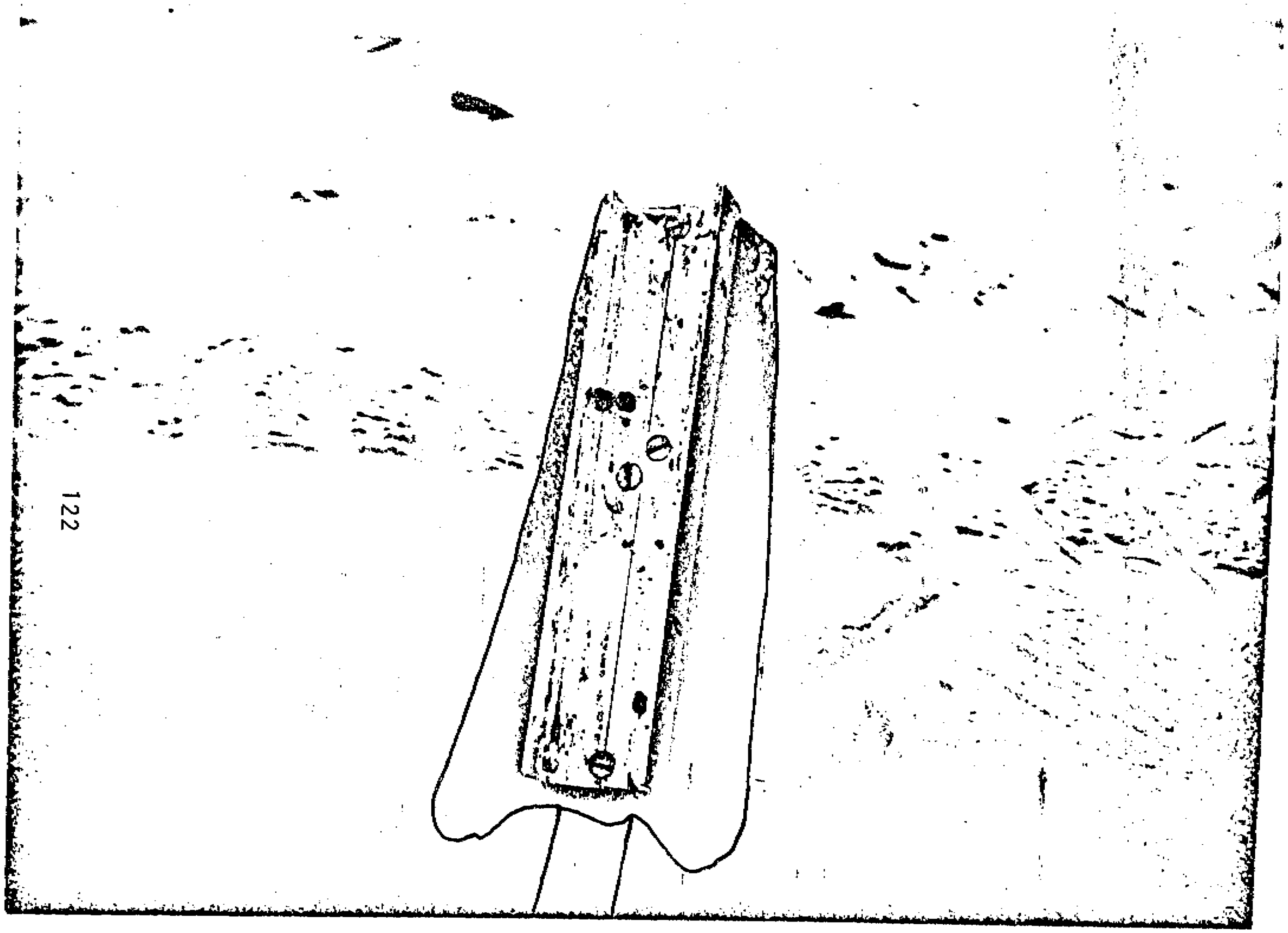


Figure 4. Sediment core sampler fastened onto clam shovel.

ii) Eight tide level stations (-2', -1', 0, +1', +2', +3', +4', +5') were examined at Hallo Bay. A total of 304.8 liters of sand were screened at the -2' tide level. High gravel content made it difficult to continue sampling all three subplots. Therefore, at the -1' tide level only 203.2 liters of sand were seived, and only 101.5 liters of sand at the 0, +1, +2 and +3 foot tide level stations. Core samples were taken at seven tide level stations (-3', -2', -1', 0, +1', +2', +3').

iii) Ten tide level stations (-2', -1', 0, +1', +2', +2'´, +3', +4', +5', +6', +7') were examined at Kukak Bay. Except for the -4' tide level station in which 203.2 liters of substrate were seived, 304.8 liters were screened for invertebrate analysis at each tide level station. Sediment core samples were taken from 13 tide level stations (-2', -1', 0, +1', +2', +2'´, +3', +4', +5', +6', +7', +8', +9').

Activity II

A. Field trip schedule: July 9 - July 15. Charter aircraft (Kodiak Western, Amphibious Grumman Goose).

B. Sample locations: Kodiak and Trinity islands; Bumble Bay and Tugidak Island.

C. Data collected:

i) Six tide level stations (0, +1', +2', +3', +4', +5') examined for bivalves at Bumble Bay (Figure 5). Because of the high gravel content of the substrate only 33.83 liters of substrate were sieved at each tide level station. Core samples were taken at seven tide level stations (-1', 0, +1', +2', +3', +4', +5').

ii) Five tide level stations (-1', -.5', 0, +.5', +1) were dug for "shows" at Tugidak. Only 203.2 liters of sand were sieved at the -1' tide level and 304.8 liters of sand were screened from the -.5', 0, +.5', and +1' tide level stations. Core samples were taken from each of the five tide level stations.

Activity III

A. Field trip schedule: July 9 - July 15. Charter aircraft (Kodiak Western, Amphibious Grumman Goose, Cessna 206 on floats) and ADF&G salmon survey vessel (M/V SMOLT).

B. Sample locations: Alaska Peninsula; Dakavak Bay and Katmai Bay.

C. Data collected:

i) Seven tide level stations -1', 0, +1', +2', +3', +4', +5') were dug at Dakavak for bivalve "shows". A total of 304.8 liters of sand were dug and screened at the -1, 0, +1, +2 and +3 foot tide level stations. Core samples were collected from the -2', -1', 0, +1', +2', +3', +4' and +5' tide level stations.

ii) Inclement weather limited sampling at Katmai to foot surveys in which only one *Siliqua patula* was observed showing and was promptly captured.

Activity IV

A. Field trip schedule: August 6 - August 15. Charter aircraft (Kodiak Western, Amphibious Grumman Goose) and ADF&G salmon survey vessel (M/V SMOLT).

B. Sample localities: Alaska Peninsula; Kashvik Bay and Little Alinchak Bay.

C. Data collected:

i) Seven tide level stations (-1', 0, +1', +2', +3', +4', +5') were examined for bivalve shows. A total of 304.8 liters of substrate were dug and screened at the -1', 0, +1', +2' and +3' tide level stations. A total of 101.5 liters of sand were seived at the +4' and +5' tide levels. Core samples were taken at the -2', -1', 0, +1', +2', +3', +4' and +5' tide level stations.

ii) No razor clam habitat was found at Little Alinchak Bay or at the two beaches south of the bay. However, excellent habitat was found in Alinchak Bay proper.

Activity V

A. Field trip schedule: August 23 - August 29. Charter aircraft (Kodiak Western, Amphibious Grumman Goose and a Cessna 206 on floats).

B. Sample locality: Alaska Peninsula; Alinchak Bay, north beach.

C. Data collected:

i) Four tide level stations +1', +2', +3', +4') were dug for bivalve shows. A total of 304.8 liters of sand were screened at the +1', +2' and +3' tide level stations and 135.3 liters were screened at the 4' tide level station. Core samples were obtained at the 0, +1', +2', +3' and +4' stations.

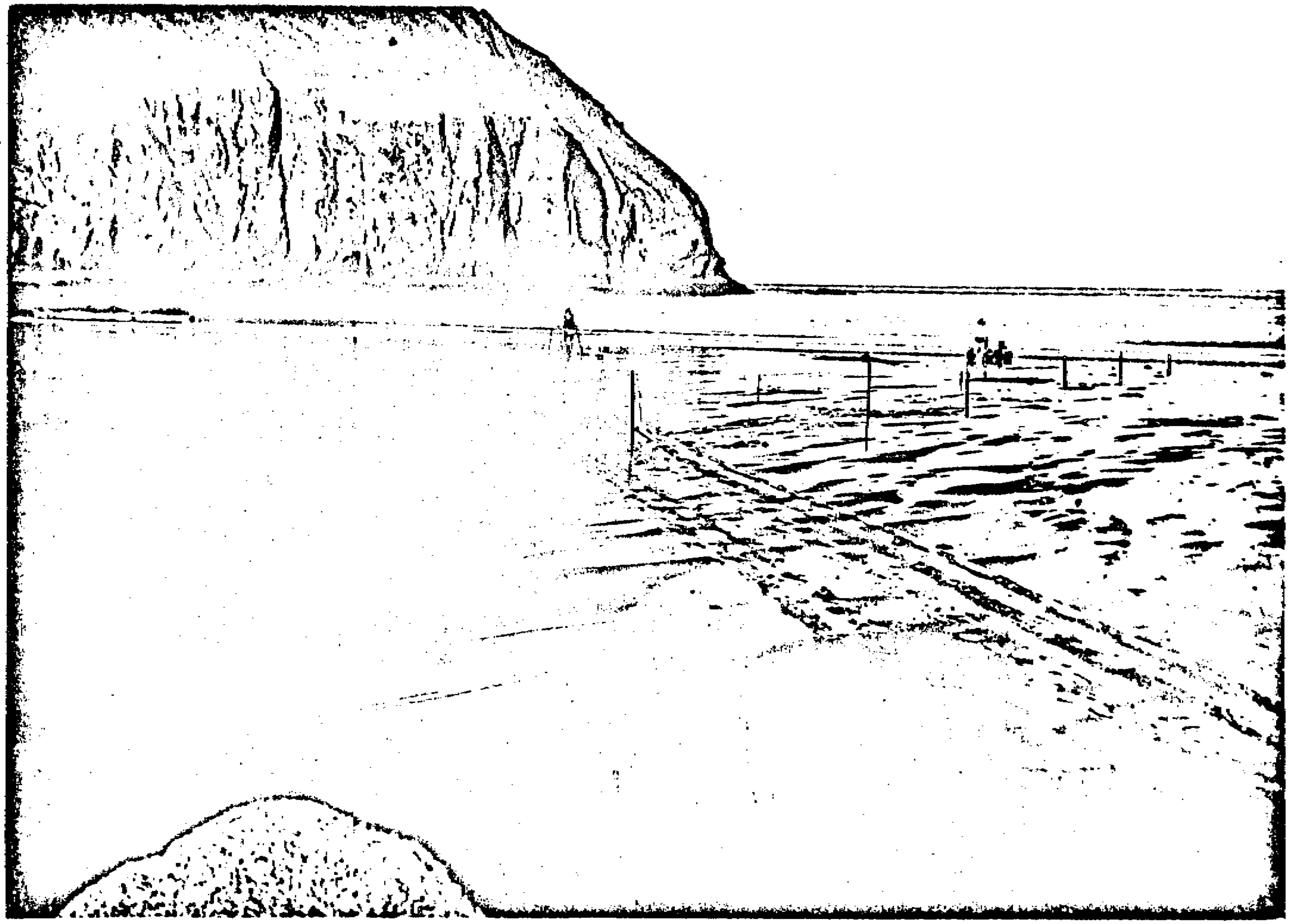


Figure 5. Tide level station lay out at Bumble Bay. Note stakes indicating tide levels (0, +1', +2', +3', +4', +5'), sampling wagon in right corner and technician setting boundaries of tide level station plot.

III LABORATORY ACTIVITIES

A. Invertebrate analysis: all organisms collected with the subsample screening were preserved at the beach in a 10% solution of formaldehyde. Systematic identification was done in the lab by Christopher Phillips and a voucher collection was verified by George Mueller at the University of Alaska.

B. Substrate Analysis: The core samples were air dried in the lab on plastic plates. A Tyler mechanical sieve shaker was used to run the following series of U.S.A. Standard Testing Sieves.

ASTM E 11 Specification #	Opening in mm	Corresponding ϕ grain size retained in sieve	Definition of particle size
5	4.00	< -2	pebble
10	2.00	-2 to -1	granule
18	1.00	-1 to 0	very coarse san
35	.50	0 to 1	coarse sand
60	.25	1 to 2	medium sand
120	.125	2 to 3	fine sand
230	.063	3 to 4	very fine sand
bottom pan	-	> 4	silt

IV RES'LTS AND DISCUSSION

A. Beach mapping: Salient physical characteristics of the nine beaches studied are listed in Table 1 and shown in Figures 6-15. The latitude and longitude were determined at the station site so that it would be possible to return at a later date and transect the same area. Since the invertebrate populations of bivalves, and to a lesser extent the annelids, are non-migrant and fairly stable it would, therefore, be possible to monitor the same populations over a period of time and correlate changes to natural fluctuations and/or the negative impact of oil-related development.

The visually observed extent of the razor clam habitat as determined by foot surveys was used to define the length of the beach investigated. The entire exposed sandy beaches within the bays of Big River, Bumble Bay, Kashvik and Alinchak were investigated and found to be favorable *Siliqua* habitat (to varying degrees). Generally speaking, the population of molluscs are of average density near the center of a given beach. The very low and very dense populations are usually located at the ends of the beaches where "end" is defined as the mouth of a major river or the actual termination of the sandy substrate against the rocky cliffs. In Hallo Bay, only the beaches southwest of the Ninagiak River were delineated as the beach east of the river was found to be primarily a hard shell habitat and unsuitable for *Siliqua*. Within this bay there is an excellent population of *Siliqua patula, Siliqua alta, Tellina lutea alternidentata, Spisula polynyma,* and *Mya (sp)* located on the sandy beach stretching from Ninagiak Island north along the exposed reefs.

Time was available for exploration of only one bay within the Kukak Bay system. The entire sandy beach within this particular bay was found to be *Siliqua patula* habitat. The possibility exists of other bays within Kukak containing razor clams.

The beach to the east of the Dakavak River, while visually appearing to be of the same substrate as the western beach,was found to be a totally unfavorable *Siliqua* habitat (i.e. no live *Siliqua* found and no shell accumulation in the drift zone). The eastern Katmai beach investigated was found to be a poor habitat with a very sparse population of *Siliqua patula.* Extremely rough seas and weather limited the work at this station site to foot surveys. The beach was of a very steep slope and had more volcanic ash than any beach investigated. The area exposed during ~~a~~ low tide was no more than 150 meters from a tide level of -0.91 meters to the high tide swash. The western Katmai beach segment appeared from the air to be much more favorable *Siliqua* habitat.

Weather again limited the exploration of Alinchak Bay. Only the northern beach was examined in detail. However, high winds from the most severe storm of the season kept the tide from going out to the predicted low tide levels. The beach south of the Alinchak River and north of Little Alinchak Bay had a less dense population of *Siliqua patula* probably because of the lack of a major river system.

Logistics were a limiting factor in the investigation of Tugidak Island. The Zodiak raft was not taken on this trip. After preliminary foot surveys it became apparent that the major razor clam populations were on sand bars located

Table 1. Location of station and some physical characteristics of eight Alaska Peninsula and Kodiak Island area sandy beaches studied July 1 - August 30, 1976.

Beach	Station #	Approximate Lat - Long	Exposure direction of beach (magnetic degrees)	Estimated length of beach *Siliqua* habitat	Width of beach at station (m)[1]	Slope distance from +1 to -1 foot tide level (m)
Big River	B6	58°35'40" N 153°52'10" W	76°	3.22	900 (-4)	131.83
Hallo Bay[2]	B7	58°20'10" N 154°04'15" W	64°	6.84	676.66 (-3)	172.52
Kukak[3]	B8	58°21'20" N 154°06'10" W	90°	1.28	598.93 (-2)	51.82
Bumble Bay	B9	57°16'50" N 154°40'30" W	201°	1.61	108.97 (-1)	26.67
Tugidak	B10	56°30'40" N 154°28'40" W	153°	?[4]	73.15 (-1)	23.62
Dakavak[5]	B11	58°03'40" N 154°41'10" W	150°	2.4	179.07 (-2)	20.57
Katmai[6]	B12	58°01'10" N 154°54'58" W	146°	4.02	-	-
Kashvik	B13	57°56'40" N 155°05'35" W	108°	2.01	1798.92 (-1)	917.75
Alinchak[7]	B14	57°49'50" N 155°20'10" W	106°	1.61	735.79 (-1)	156.06

[1] Beach width measured from high tide swash to the low tide level indicated in feet within parenthesis.
[2] The beach studied and measured is that beach area between Hallo Creek and Hook Creek.
[3] Only one beach within an un-named bay within the Kukak Bay system was investigated.
[4] Extent of razor clam habitat is unknown.
[5] Measurements refer to the beach west of the major river in Dakavak Bay.
[6] No transect was established at Katmai Bay. Measurements refer to beach east of the Katmai river.
[7] Measurements refer to the northern most beach within Alinchak Bay.

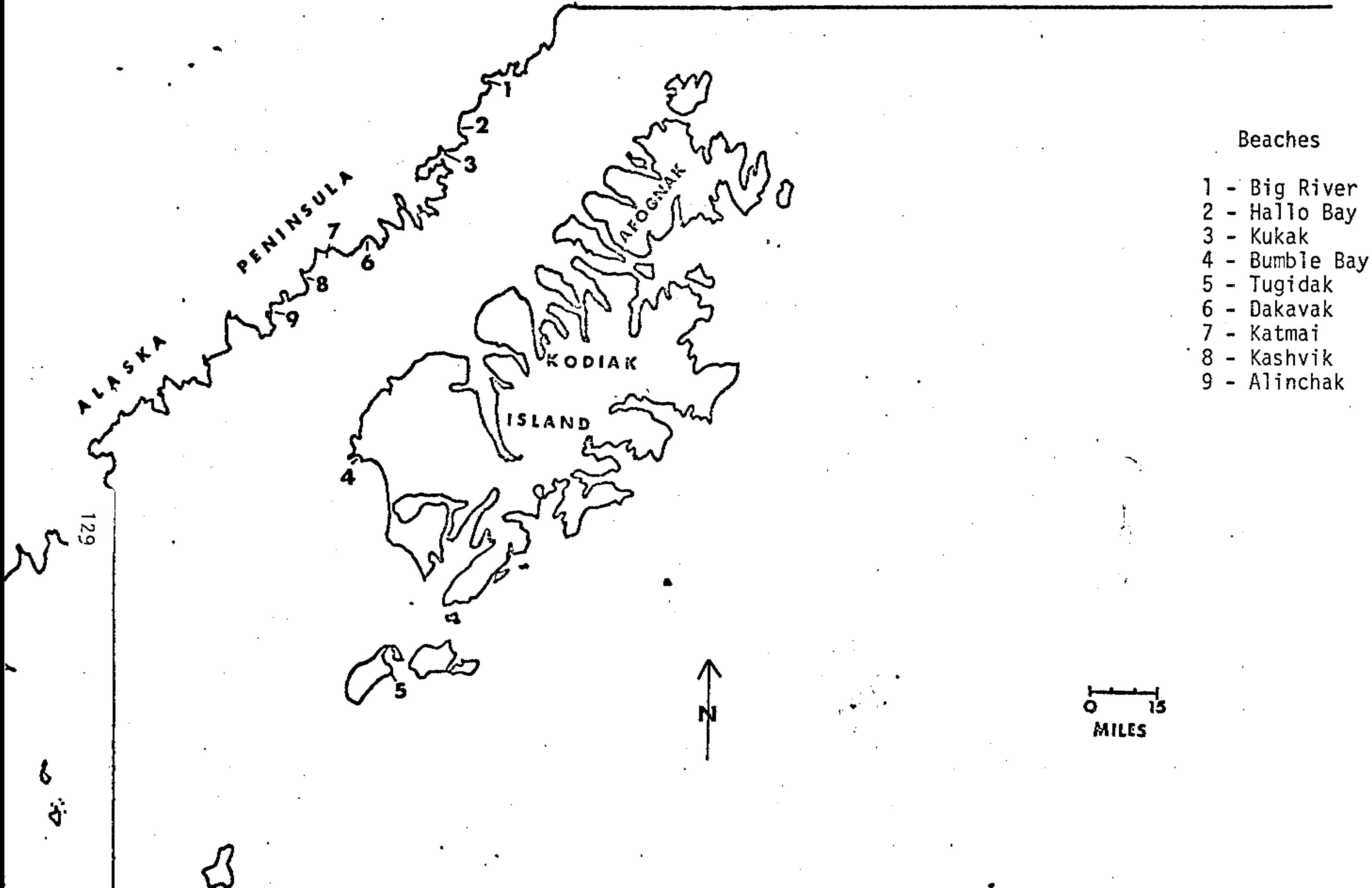


Figure 6. Location of beaches investigated July 1 - August 30, 1976.

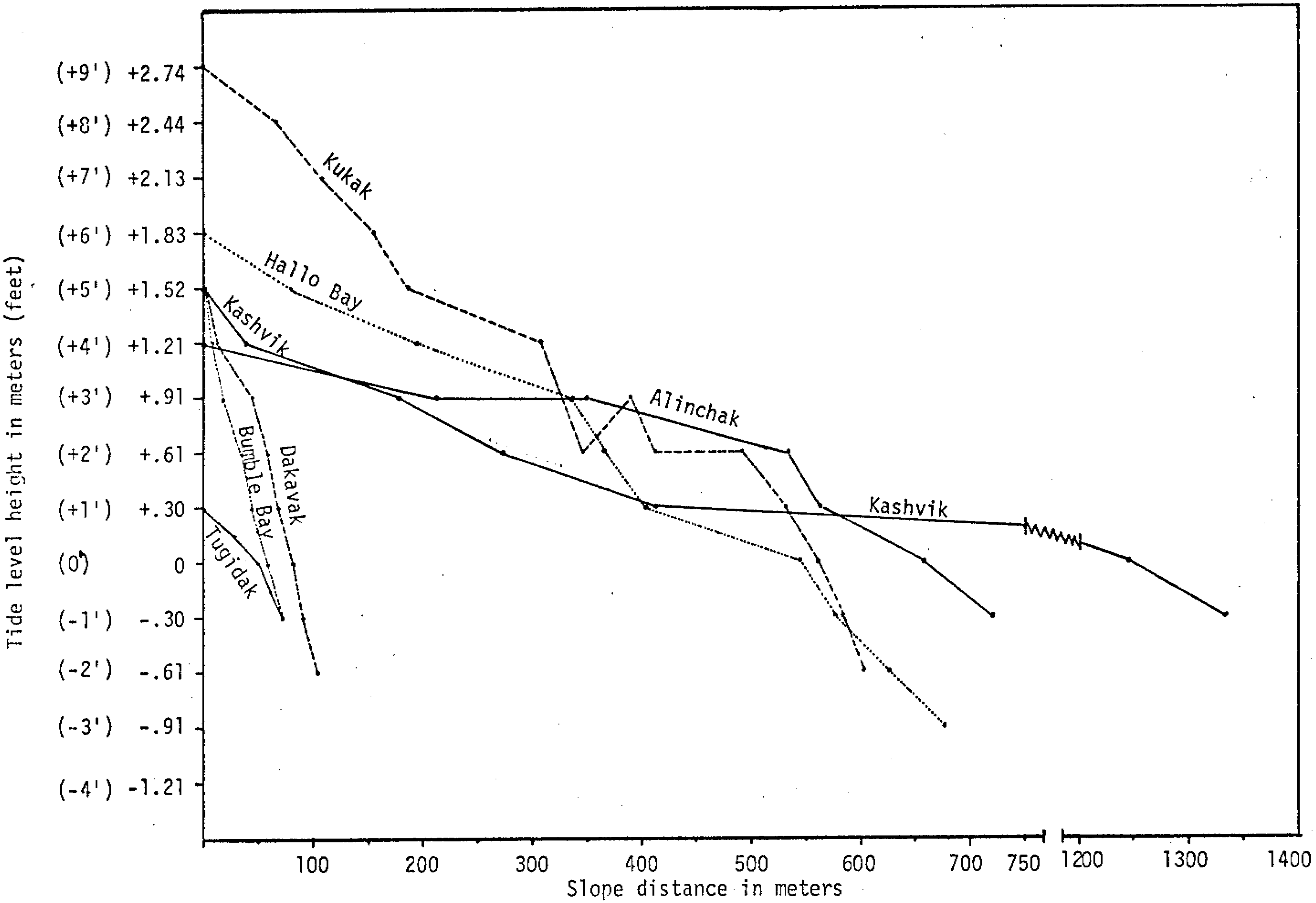


Figure 7. Slope and profile for seven beaches as determined at station site during July-August, 1976 on the Alaska Peninsula and Kodiak Island.

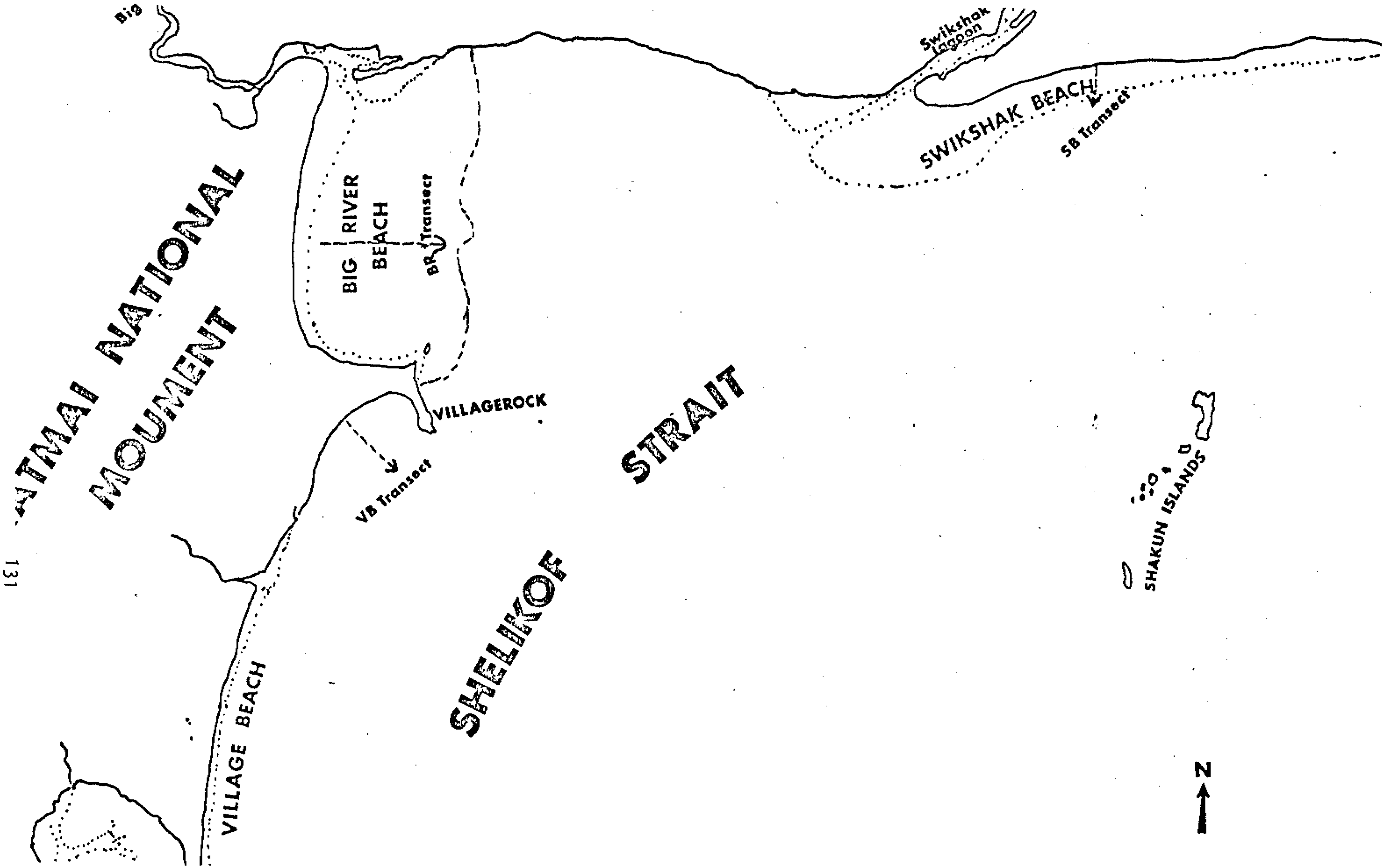


Figure 8. Station site B-6

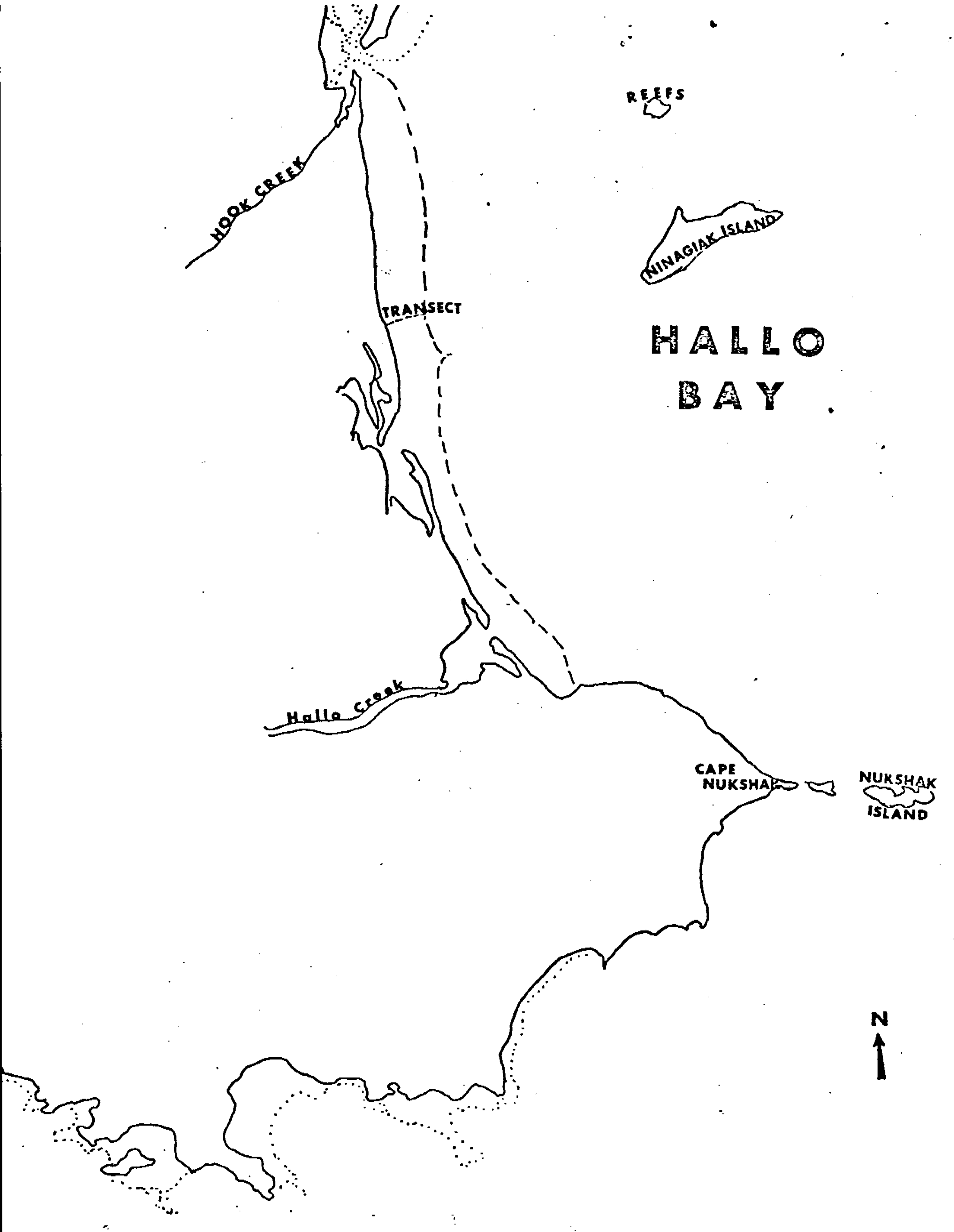


Figure 9. Station site B-7.

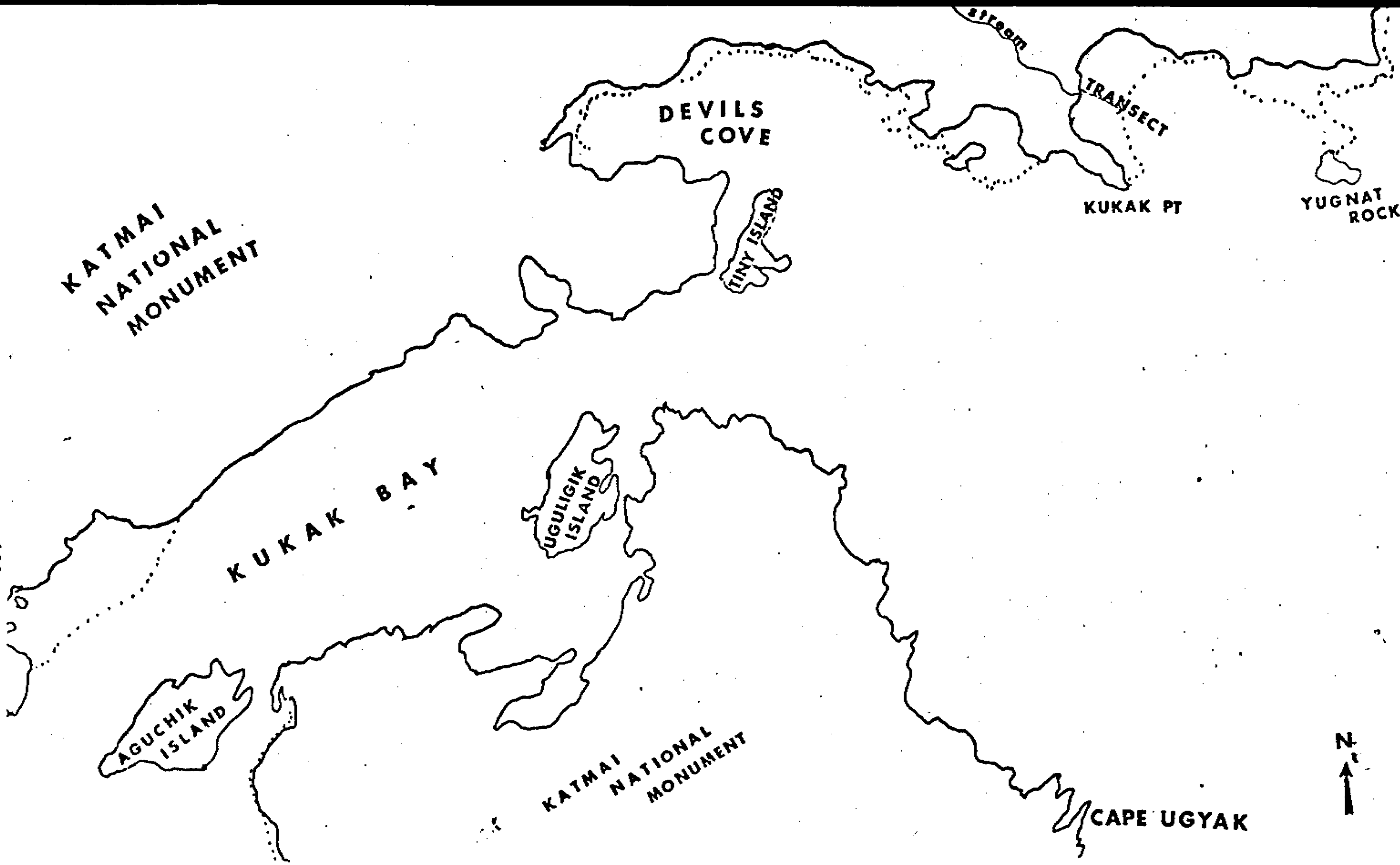


Figure 10. Station site B-8.

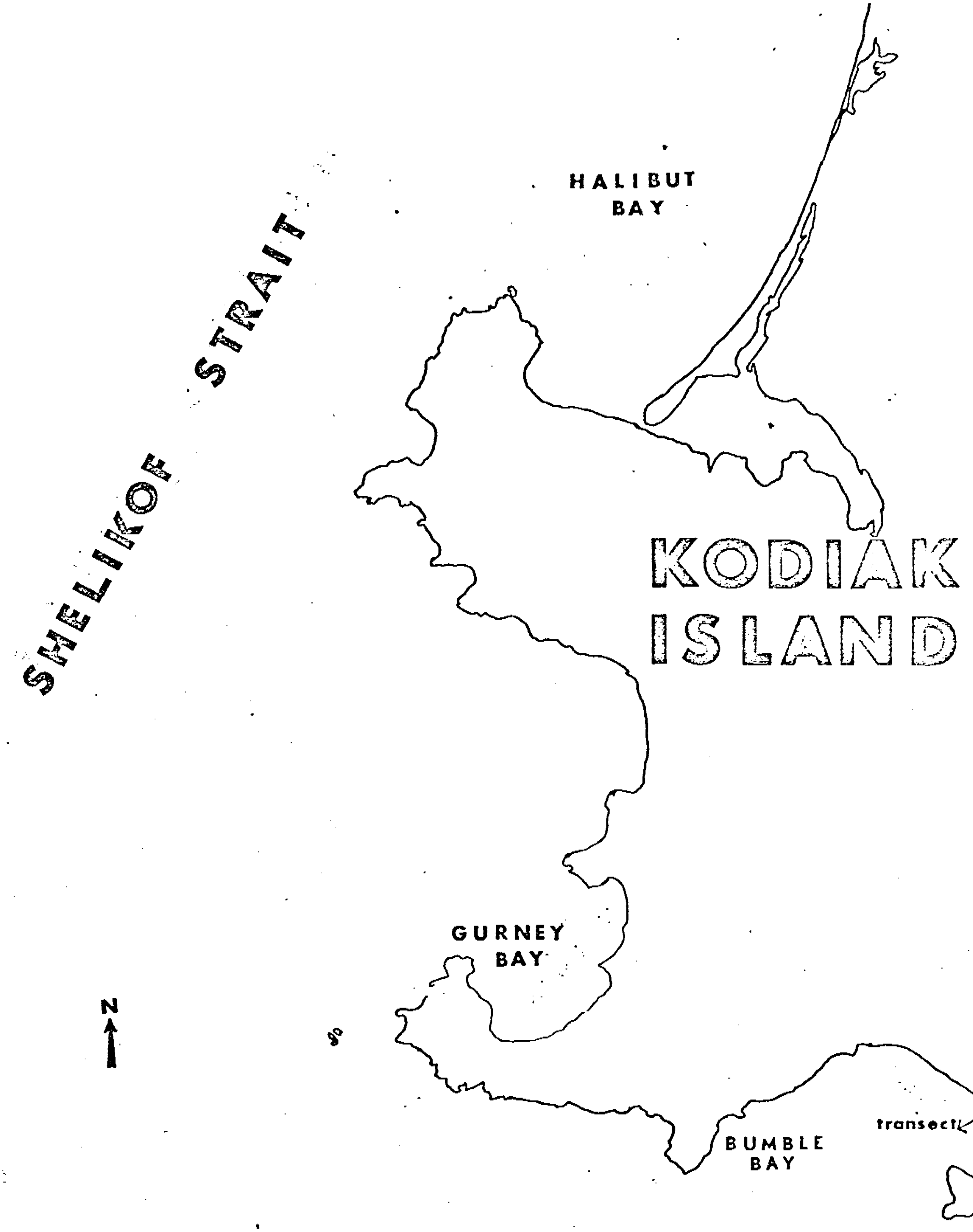


Figure 11. Station site B-9.

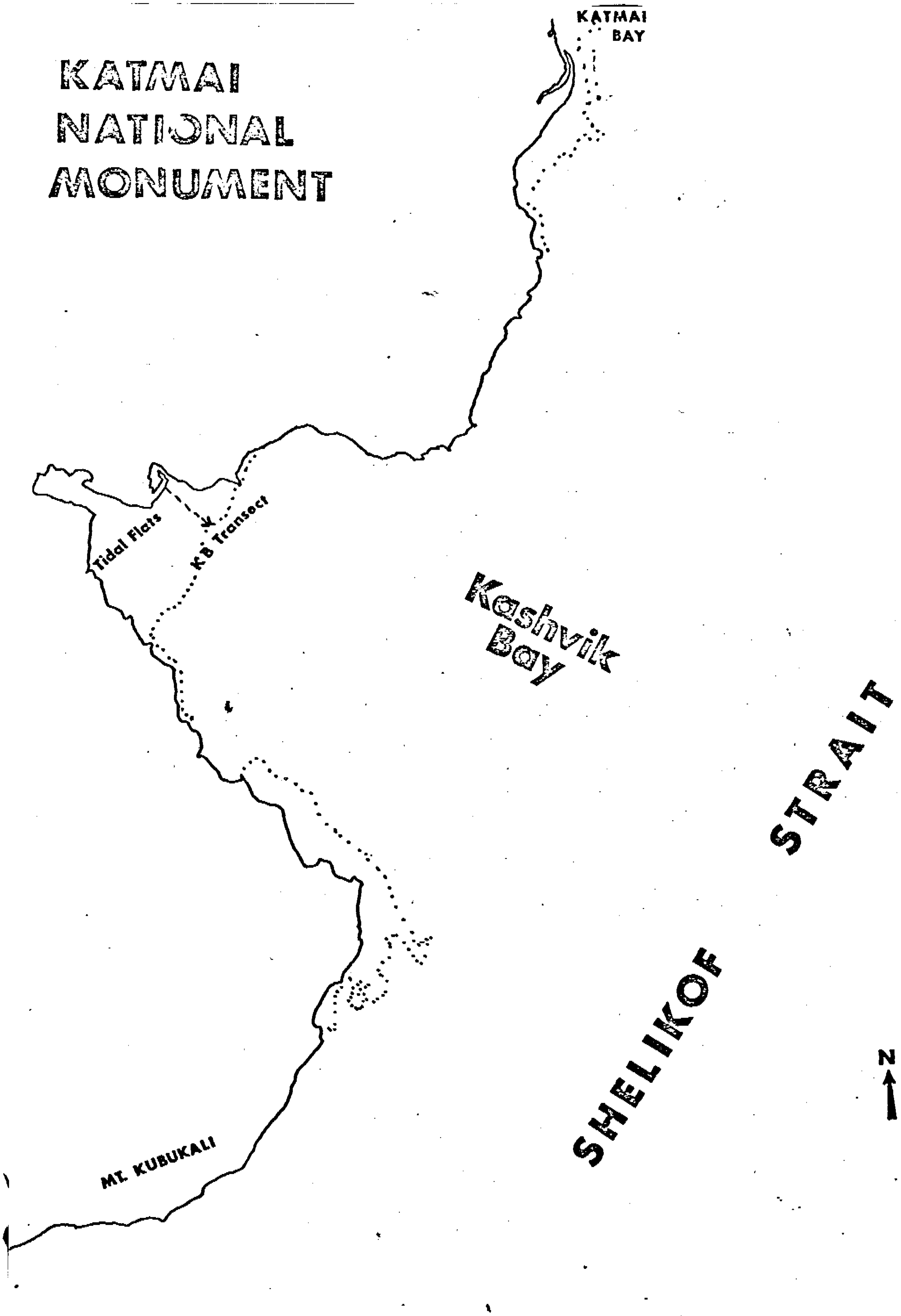


Figure 14. Station site B-13.

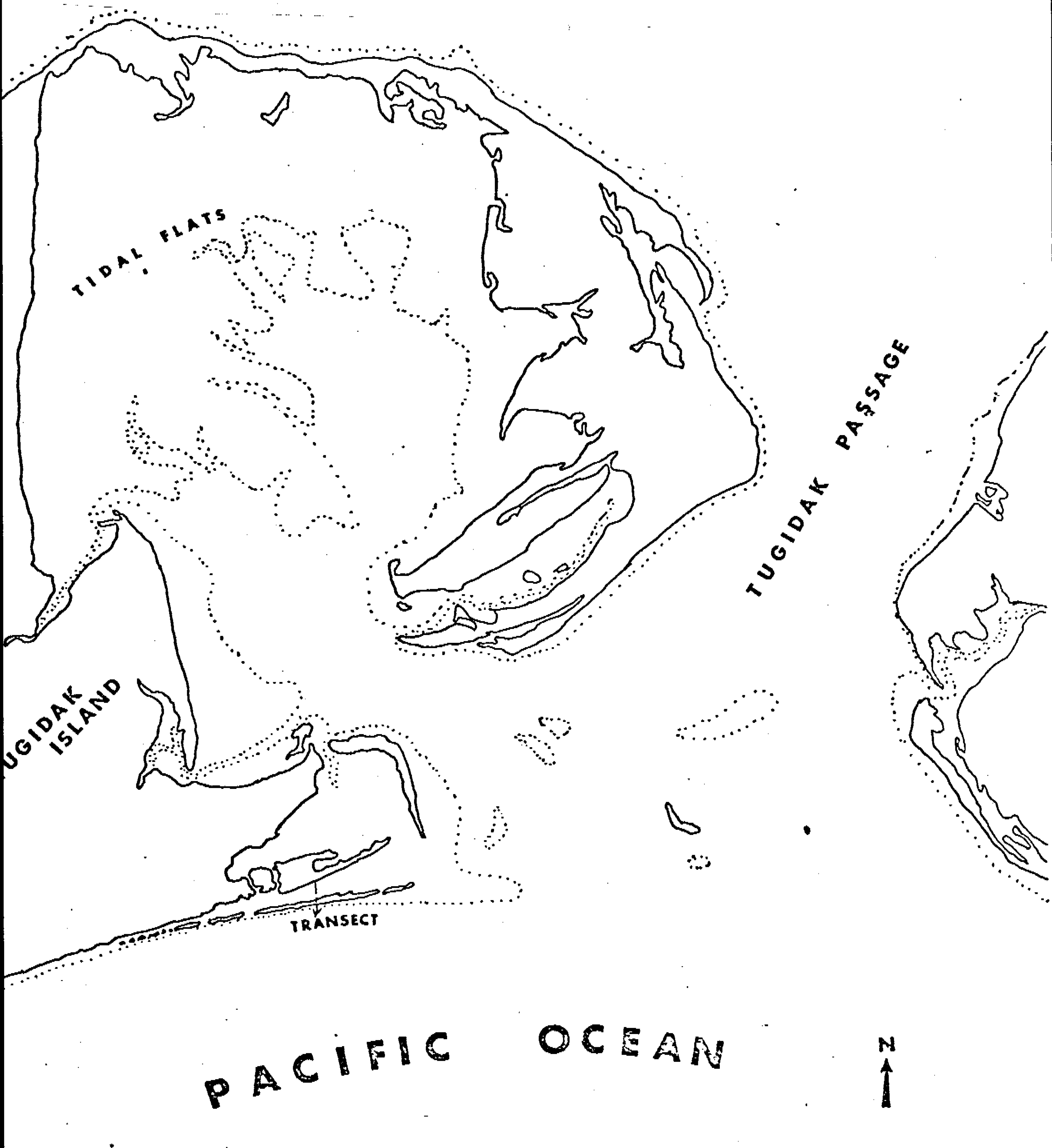


Figure 12. Station site B-10.

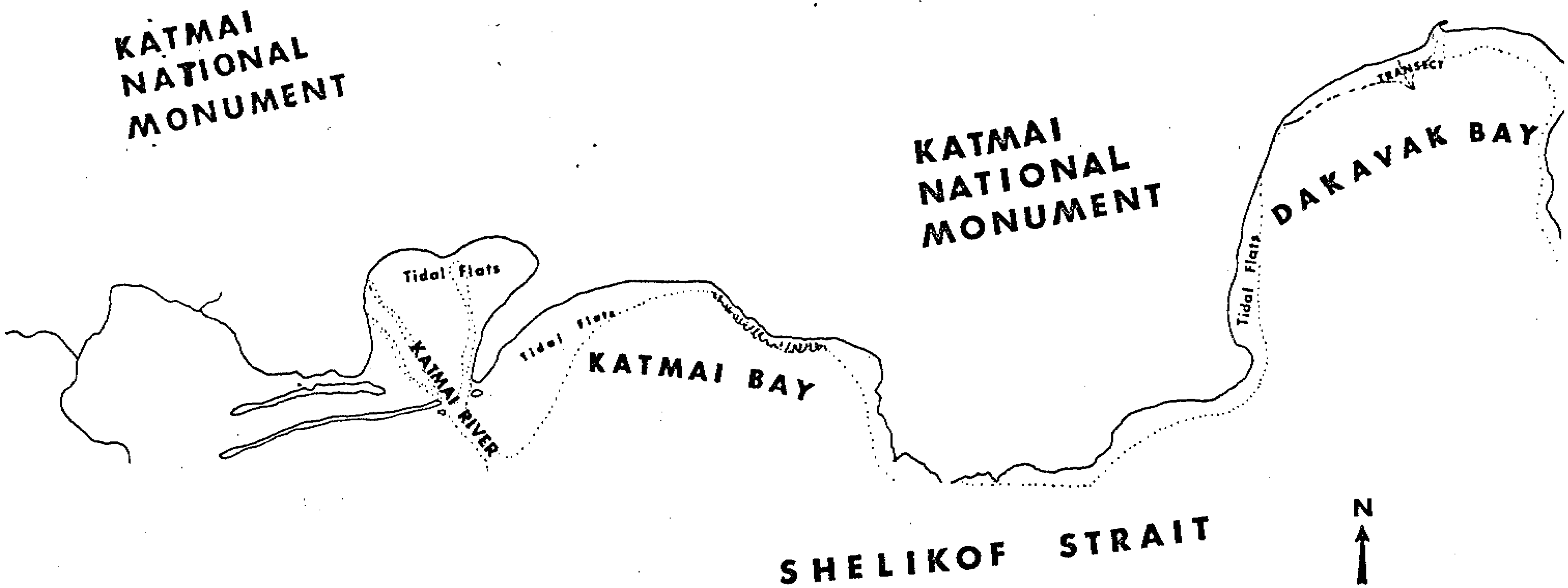


Figure 13. Station sites B-11 and B-12.

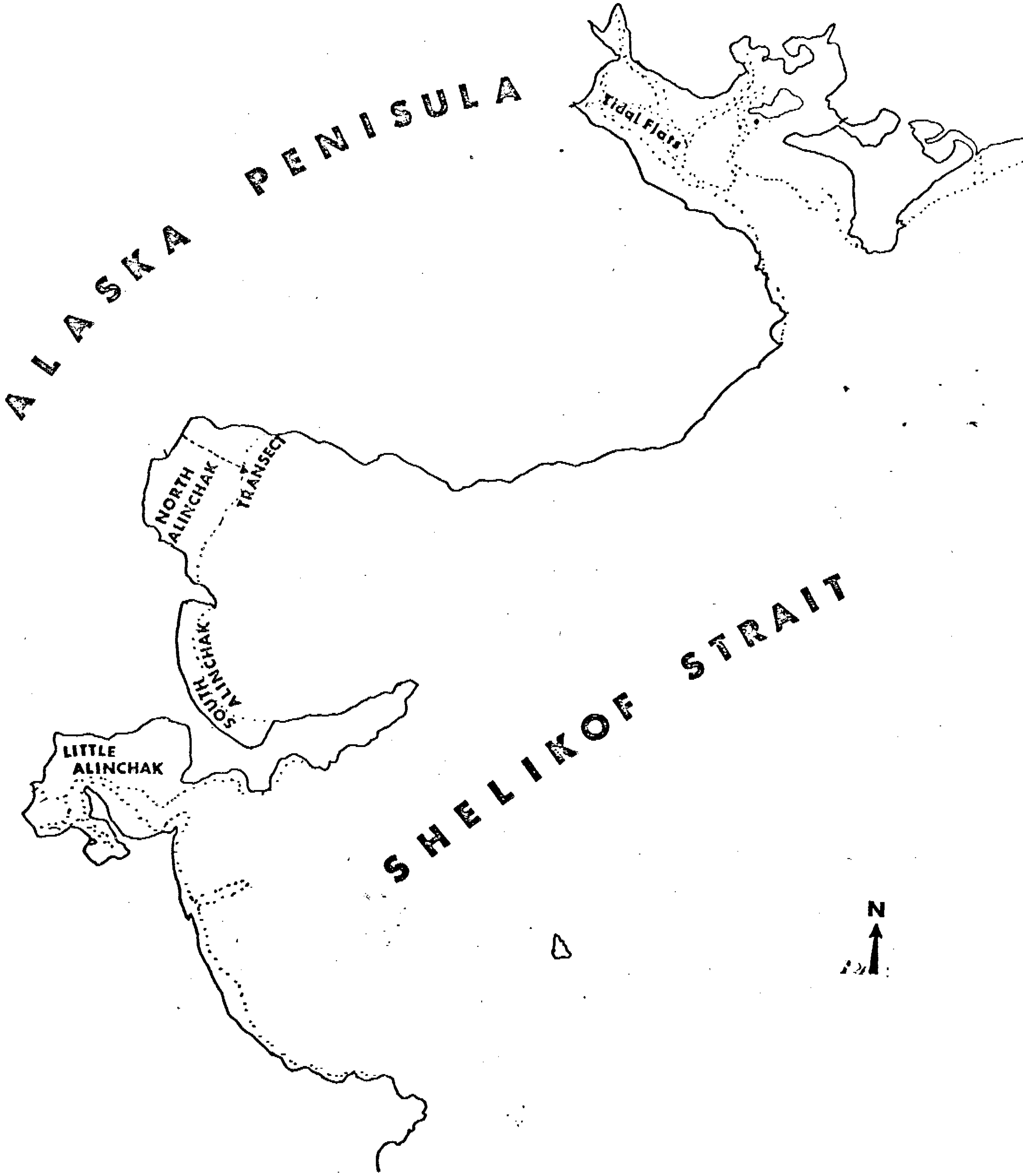


Figure 15. Station site B-14.

in the center of the Tugidak passage. The bars were visible only at a low tide of -0.61 meters. The shell accumulation in the drift zone was quite dense. The only accessible bivalve populations inhabited a narrow beach (of unknown length and possibly circling the island). Upon examination, this beach proved to be sparsely populated, it seems unlikely that the shells on the drift zone could have originated from this location. It seems likely that a large dense population of razor clams and other bivalves exists on the bars in Tugidak passage and possibly a large subtidal population as well.

B. Substrate analysis: The predominant sediment size within the low tide terrace for all beaches investigated was fine sand (Table 2). This appears to be the most favorable grain size classification for *Siliqua* habitat. For example, at Bumble Bay where the percentage of fine sand was only about 30% there was a very sparse razor clam population and a low species diversity of other bivalves and annelids. In fact, Bumble Bay had the highest gravel content, the least complex and least dense invertebrate population and what appears to be a very slow growth rate for *Siliqua patula*.

Kukak Beach has a preponderance of fine sand and exhibits a wide species diversity and dense bivalve populations up to the higher tide levels (+1.22 and +1.52 meters). At Kashvik Bay, the medium sand predominates at the .091 meter tide level station. There is a distinct decline in bivalve populations at this level and above, probably directly related to the substrate size. Time has not allowed a more detailed analysis of the data in Appendix Table 1.

C. Bivalve analysis: Bivalves were captured using two different techniques (Table 3). The majority of the bivlaves were captured with a shovel in the tide level station plots (Appendix Table 2). All the bivalves were located by their "shows". It is interesting and valuable to note that each species has a characteristic "show" which can be learned and identified.

The second technique utilized the sampling wagon to wash a 1/3 m^2 subsample from the subplot sites and retain the bivalves and annelids on top of the sampling screen. Generally speaking, the bivalves captured in this fashion were either juveniles of *Siliqua patula* and *alta*, *Spisula polynyma* and *Clinocardium nuttallii* or were bivalves whose length at maturity is small (approximately 50 mm or less) such as *Macoma (sp)* (Appendix Table 3). These juvenile and small molluscs are difficult to capture by pinpoint digging unless the tide level station plot is very dry and there are not many large molluscs showing. The presence of many large bivalve shows makes it difficult to perceive the pinprick like shows of the small clams. The tide level station plot was used primarily to sample the adult populations of *Siliqua patula* and *alta, Spisula polynyma, Clinocardium nuttallii,* and *Mya arenaria* (Tables 4-7). The subplots and the sieving technique were used to investigate the juveniles of these species and the *Macoma* populations.

The most abundant species studied was *Siliqua patula*, then *Macoma lama, Spisula polynyma* and *Siliqua alta* (Table 3). Big River beach has the densest population of razor clams, followed in decreasing order by Hallo Bay, Kashvik, Kukak, Alinchak, Dakavak, Tugidak and Bumble Bay. If one rates the beaches in regard to species diversity and abundance the order is changed somewhat to give prominance to Hallo Bay, then Kukak, Big River, Kashvik (note: this ranking is based on a subjective evaluation based on preliminary analysis of data and field experience).

Table 2. Percentage amount of predominant grain size by tide level for sediment core samples taken on the Alaska Peninsula and Kodiak Island area beaches, July 1 - August 30, 1976.

	Tide level in feet												
Beach	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9
Big River	A[1] 78%	A 71%	A 66%										
Hallo Bay	A 57%	A 59%	A 57%	A 56%	B[2] 42%	A 57%	B 33%						
Kukak		A 73%	A 83%	A 83%	A 85%	A 80%	A 72%	A 83%	A 81%	A 83%	A 73%	A 51%	A 56%
Bumble Bay			A 30%	A 43%	A 32%	A 30%	A 35%	C[3] 35%	C 36%				
Tugedak			A 90%	A 86%	A 86%								
Dakavak		A 75%	A 75%	A 72%	A 76%	A 62%	A 55%	A 66%	A 58%				
Alinchak				A 50%	A 52%	A 56%	B 64%						
Kashvik		A 76%	A 71%	B 72%	B 37%	A 65%	B 54%	B 46%	B 46%				

[1] A indicates a grain size between .25 mm and .125 mm corresponding to ϕ size designation 2 to 3 and defined as fine sand.

[2] B indicates a grain size between .50 mm and .25 mm corresponding to ϕ designation 1 to 2 and defined as medium sand.

[3] C indicates a grain size between 1.00 mm and .50 mm corresponding to ϕ size designation 0 to 1 and defined as coarse sand.

Table 3. Identification and total numbers of bivalve molluscs captured by beach. July 1 - August 30, 1976 on the Alaska Peninsula and Kodiak Island.

Beach	# of tide level stations examined	*Siliqua patula*	*Siliqua alta*	*Spisula polynyma*	*Clinocardiom nuttallii*	*Macoma lama*	*Macoma balthica*	*Macoma loveni*	*Macoma calcarea*	*Macoma yoldiformis*	*Tellina lutea alternidentata*	*Mya arenaria*	*Prototheca stamenae*
Big River	5	211	2	11	2	11	0	0	0	0	3	0	0
Hallo Bay	8	63	3	21	5	64	16	2	1	0	2	20	0
Kukak Bay	10	123	28	37	16	150	3	0	0	3	2	0	1
Bumble Bay	6	4	0	0	0	0	0	0	0	0	0	0	0
Tugidak	5	57	0	0	0	0	0	0	0	0	0	0	0
Dakavak	7	50	0	0	0	0	0	0	0	0	0	0	0
Kashvik	7	120	0	4	0	19	11	0	0	0	0	0	0
Alinchak	4	85	2	0	0	1	0	0	0	0	0	0	0

Table 4. Number of *Siliqua patula* dug from each tide level station plot, July 1 - August 30, 1976.

Beach	-3 (-0.91)	-2 (-0.61)	-1 (-0.30)	0 (0.00)	+1 (+0.30)	+2 (+0.61)	+3 (+0.91)	+4 (+1.22)	+5 (+1.52)	+6 (+1.83)	+7 (+2.14)	+8 (+2.44)
	Tide level in feet (meters)											
Big River	-	60	52	43	41	-	10	-	-	-	-	-
Hallo Bay	10	5	20	9	13	0	0	0	0	-	-	-
Kukak	-	-	6	4	10	19	23	26	9	0	0	0
Tugidak	-	-	8	12	1	-	-	-	-	-	-	-
Dakavak	-	-	4	12	16	11	5	1	0	-	-	-
Kashvik	-	-	43	36	26	2	0	0	0	-	-	-
Alinchak	-	-	-	-	29	51	0	-	-	-	-	-
Bumble Bay	-	-	-	1	2	1	0	0	0	-	-	-

Table 5. Mean length in mm of *Siliqua patula* dug from each tide level station plot, July 1 - August 30, 1976.

Beach	-3	-2	-1	0	+1	+2	+3	+4	+5
	Tide level in feet								
Big River	-	142	143	157	124	-	129	-	-
Hallo Bay	128	131	110	127	125	-	-	-	-
Kukak	-	-	133	147	106	117	120	116	90
Bumble Bay	-	-	-	99	125	121	-	-	-
Tugidak	-	-	110	118	122	-	-	-	-
Dakavak	-	-	127	134	131	132	123	120	-
Kashvik	-	-	117	112	107	97	-	-	-
Alinchak	-	-	-	-	28	98	-	-	-

Dash (-) indicates tide level was not examined.

Table 6. Number of all *Siliqua alta* dug from each tide level station plot, July 1 - August 30, 1976.

Beach*	Tide level in feet (meters) -2 (-0.61)	-1 (-0.30)	0 (0.00)	+1 (+0.30)	+2 (+0.61)	+3 (+0.91)	+4 (+1.22)	+5 (+1.52)	+6 (+1.83)	+7 (+2.14)	+8 (+2.44)
Big River	1	0	1	0	-	0	-	-	-	-	-
Kukak	-	0	3	1	4	3	4	1	1	0	0
Alinchak	-	-	-	0	2	0	-	-	-	-	-

*No *Siliqua alta* found in tide level station plots at Hallo Bay, Bumble Bay, Tugidak, or Dakavak

Table 7. Mean length in mm of all *Siliqua alta* dug from each tide level station plot, July 1 - August 30, 1976.

Beach	Tide level in feet -2	-1	0	+1	+2	+3	+4	+5	+6
Big River	12	0	51	0	-	0	-	-	-
Kukak	-	21	20	29	27	56	16	31	-
Alinchak	-	-	-	0	17	0	-	-	-

Dash (-) indicates tide level was not examined.

D. Invertebrate analysis (other than bivlave molluscs): The capture of polychaetes and nemeridians was done exclusively by the subsampling method (Table 8). Although these organisms were encountered while digging bivalve mollusc "shows" they were not then captured. The quantity of annelids captured was dependent upon the density of the resident population and the number of subsamples taken. If the percentage of coarse sand and gravel was large then the sieving process was retarded. In order to stay above the tide it was often impossible to sieve the required 304.8 liters of sand from each tide level station. For instance, it took a very long time just to wash 33 liters of substrate at Bumble Bay, therefore, Table 8 should be read with special note paid to the volume of sand sieved before comparisons are drawn on the respective beach habitats. A detailed description of the organisms encountered by tide level is given in Appendix Table

The most frequently encountered annelids were *Scolelepis squamatus, Haploscoloplos elongatus* and *Ophelia assimilis*. Two representatives of *Nemertea* were encountered: *Nemertea (sp)* and *Cerebratulus californiensis*. During the subsampling specimens of *Eohaustoridae (sp)* were captured and noted as were occasional specimens of *Ammodytes hexapterus*, the Pacific sand lance.

V PROBLEMS ENCOUNTERED AND RECOMMENDED CHANGES

Severe weather conditions proved to be the limiting factor in terms of the amount of work accomplished. At Katmai and Alinchak bays the field survey activities were considerably reduced. Unfortunately there's little that can be done with regards to the vagaries of the weather. August weather has for the last three field seasons limited the bivalve research in the Gulf and will no doubt continue to do so.

This project has not been refunded for further research. It has not been possible to survey all the beaches from Unimak Bight to Yakutat known to have populations of *Siliqua patula* as originally outlined in the project proposal. In fact, the beaches of Ocean Bay, Rolling Bay and the Trinity Islands which front the Kodiak Island oil lease lands are in need of further research. These locations were visited this field season, however, weather and logistical problems made it impossible to gather the necessary baseline data. Rather than return later in the field season, it was decided to re-examine the three sites during May of 1977. This is no longer possible and it should be strongly emphasized that these beaches do not have even the minimum amount of baseline data gathered to aid in monitoring the impact of oil development.

It seems particularly unfortunate that RU 24 has been discontinued in that the bivalves and annelids constitute a relatively stable population that could be easily used as a critical monitor for oil pollution. The bivalves are not subjected to the extreme fluctuations in populations that are a part of the ecology of pelagic and demersal fish. Changes in the population density and diversity of *Siliqua patula* habitat could be directly related to the rare natural ecological catastrophe or to the effects of oil pollution.

Table 8. Identification and total numbers of invertebrates (*polychaetes and nemeridians*) captured July 1 - August 30, 1976 on the Alaska Peninsula and Kodiak Island.

Beach	Volume of sand sieved in thousands of liters	*Scolelepis squamatus*	*Haploscoloplos elongatus*	*Ophelia assimilis*	*Anaites groenlandica*	*Eteone longa*	*Glycinde picta*	*Cistenides brevicoma*	*Nephtys caeca*	*Nephtys californiensis*	*Nemertea*	*Cerebratulus californiensis*
Big River	1.5	157	44	9	0	0	0	0	7	2	0	1
Hallo Bay	1.8	264	14	0	6	0	0	2	57	0	1	4
Kukak	3.0	912	16	0	4	1	1	0	80	1	5	3
Bumble Bay	.2	3	0	4	0	0	0	0	1	0	0	0
Tugidak	1.4	0	9	4	0	2	7	0	0	7	0	0
Dakavak	1.5	24	1	111	2	1	0	0	0	104	3	1
Kashvik	1.7	270	24	9	0	5	2	0	23	21	0	0
Alinchak	1.1	496	0	0	0	0	0	0	13	9	0	0

Appendix

Table 1. Sediment analysis of core samples collected July 1 - August 30, 1976 on beaches on the Alaska Peninsula and Kodiak Island. Percentage composition expressed in phi (ϕ) grain size.

T = Trace amounts

	Big River Tide Level			Hallo Bay Tide Level						
phi (ϕ) size	-3	-2	-1	-3	-2	-1	0	+1	+2	+3
< -2	.15	.17	1.50	3.74	3.35	1.35	.46	.41	.72	2.86
-2 to -1	.07	.34	.00	4.11	2.16	2.94	1.18	.94	.86	10.26
-1 to 0	.26	.95	.23	6.41	8.21	6.09	2.32	2.72	1.51	11.93
0 to 1	1.57	2.38	1.19	8.89	6.16	6.78	4.04	7.86	4.60	6.95
1 to 2	18.65	22.28	29.65	11.46	12.93	22.48	32.33	42.10	19.30	33.01
2 to 3	77.57	71.34	66.31	57.36	58.64	56.60	56.09	38.65	57.01	32.45
3 to 4	1.91	2.28	1.73	5.68	7.32	3.63	3.07	3.47	14.87	2.83
> 4	.45	.41	.58	.41	1.33	.21	.21	.53	.93	.11

	Kukak Tide Level											
ϕ size	-2	-1	0	+1	+2	+2'	+3	+4	+5	+6	+7	+8	+9
< -2	.14	.20	.24	.00	.00	.00	.00	.00	.00	.00	.08	.00	.00
-2 to -1	.19	.56	.20	.04	.00	.04	.00	.22	.09	.00	.29	T	.22
-1 to 0	.14	.32	.24	.38	T	T	.23	.13	.09	.30	.54	.57	.75
0 to 1	7.29	2.43	2.82	2.79	4.42	1.77	9.33	2.23	5.07	4.29	5.80	7.03	5.15
1 to 2	11.65	6.20	7.09	6.42	8.09	5.23	14.09	6.91	10.74	10.08	17.66	39.52	33.67
2 to 3	72.71	82.94	82.65	84.53	80.41	86.59	71.95	83.11	81.44	82.59	73.44	50.57	56.08
3 to 4	7.24	6.76	6.76	5.16	6.28	5.71	3.51	5.77	2.10	2.27	1.46	1.22	1.94

Appendix

Table 1. Sediment analysis of core samples collected July 1 - August 30, 1976 on beaches on the Alaska Peninsula and Kodiak Island. Percentage composition expressed in phi (ϕ) grain size.

T = Trace amounts

	Bumble Bay Tide Level							Tugidak Tide Level				
phi (ϕ) size	-1	0	+1	+2	+3	+4	+5	-1	-.5	0	+.5	+1
< - 2	2.16	.16	1.03	.70	5.91	T	.56	.10	.11	.31	.35	.54
-2 to -1	1.36	1.79	.64	1.21	1.03	1.36	2.00	.59	.39	.45	.84	.87
-1 to 0	10.62	9.42	8.06	11.58	11.06	11.82	18.06	.59	.50	.45	.91	.94
0 to 1	29.75	19.79	27.84	28.79	23.68	35.17	35.82	.31	.82	1.07	.67	1.88
1 to 2	25.61	22.76	28.38	26.88	20.96	30.43	23.59	.70	10.12	8.46	8.94	6.65
2 to 3	29.64	43.28	32.64	29.48	34.71	20.40	19.24	89.97	83.96	85.91	83.60	85.90
3 to 4	1.33	2.59	1.13	1.27	2.16	.58	.62	3.81	3.96	3.78	4.33	3.07
>4	.03	.03	T	T	T	T	T	.03	.04	.10	.11	.14

	Dakavak Tide Level								Alinchak Tide Level				
ϕ size	-2	-1	0	+1	+2	+3	+4	+5	0	+1	+2	+3	+3'
< -2	.00	.00	.00	.00	.00	T	.47	4.47	.33	T	.20	T	.12
-2 to -1	.12	T	T	T	T	T	.47	.73	1.05	.51	.47	.18	1.67
-1 to 0	.56	.19	.29	.17	.11	.17	1.42	2.09	2.28	1.31	1.38	.65	5.33
0 to 1	3.81	5.63	4.37	2.57	4.35	9.91	3.40	10.80	6.65	3.60	4.57	2.48	11.67
1 to 2	12.84	14.02	17.91	15.96	29.64	31.88	20.89	23.98	36.75	38.43	34.83	64.36	54.09
2 to 3	74.49	74.49	72.38	76.01	62.09	55.21	66.30	57.68	49.48	51.46	55.99	28.82	23.46
3 to 4	7.58	5.14	4.62	3.58	3.31	2.55	3.73	1.85	2.50	3.71	1.89	2.55	2.80
>4	.20	.10	.25	.26	.28	.34	.09	.19	.72	.98	.59	.72	.78

Appendix

Table 1. Sediment analysis of core samples collected July 1 - August 30, 1976 on beaches on the Alaska Peninsula and Kodiak Island. Percentage composition expressed in phi (ϕ) grain size.

T = Trace amounts

	Kashvik Tide Level							
ϕ size	-2	-1	0	+1	+2	+3	+4	+5
< -2	.17	.00	.00	6.06	.30	1.09	1.47	.98
-2 to -1	.21	.23	.33	6.64	.37	2.26	2.94	2.53
-1 to 0	.51	.34	.77	5.52	.75	3.24	3.43	1.43
0 to 1	1.51	1.43	6.84	7.01	2.96	7.58	8.19	17.22
1 to 2	15.38	23.53	72.01	36.71	17.77	54.41	45.81	45.59
2 to 3	75.55	71.08	19.06	35.18	66.23	29.26	36.53	30.61
3 to 4	5.41	2.60	.18	21.00	9.41	1.24	1.06	1.22
> 4	.99	.45	.11	.64	2.14	.84	.60	.82

Appendix Table 2. Bivalve molluscs dug in tide level station plots from Alaska Peninsula and Kodiak Island area beaches July 1 - August 30, 1976. (Does not include genus *Siliqua*.)

Beach	Organism (to species)	Tide Level[1] in feet	# Captured	Mean Length (mm)
Big River	*Spisula polynyma*	-2 (-0.61)	2	119
	"	+1 (+0.30)	1	57
	Clinocardium nuttallii	0 (0.00)	1	51
	"	+1 (+0.30)	1	55
Hallo Bay	*Spisula polynyma*	-3 (-0.91)	15	121
	"	-2 (-0.61)	3	120
	"	-1 (-0.30)	3	95
	Clinocardium nuttallii	-3 (-0.91)	1	67
	"	-1 (-0.30)	1	55
	Mya arenaria	-1 (-0.30)	1	112
	"	+1 (+0.30)	1	93
	"	+2 (+0.61)	5	65
	"	+4 (+1.22)	4	60
	"	+5 (+1.83)	9	85
	Tellina lutea alternidentata	+4 (+1.22)	1	60
Kukak	*Spisula polynyma*	-1 (-0.30)	8	130
	"	0 (0.00)	3	117
	"	+1 (+0.30)	2	116
	"	+2 (+0.61)	13	108
	"	+3 (+0.91)	1	126
	Clinocardium nuttallii	-1 (-0.30)	2	101
	"	0 (0.00)	1	106

Appendix Table . continued.

Beach	Organism (to species)	Tide Level[1] in feet	# Captured	Mean Length (mm)
Kukak (cont.)	*Clinocardium nuttallii*	+1 (+0.30)	2	46
	"	+2 (+0.61)	4	81
	"	+3 (+0.91)	3	55
	"	+5 (+1.52)	1	44
	Tellina lutea alternidentata	0 (0.00)	1	40
	"	+2 (+0.61)	1	68
Bumble Bay*				
Tugidak*				
Dakavak*				
Kashvik	*Spisula polynyma*	-1 (-0.30)	3	121
	"	0 (0.00)	2	18
Alinchak*				

[1]meters in parenthesis

*no molluscs other than *Siliqua* found at tide level station plot.

Appendix Table 3. All organisms captured from tide level station sub plots on Alaska Peninsula and Kodiak Island area beaches. July 1 - August 30, 1976.

Beach	Organism (to species)	Tide level in feet (meters)	# Captured	Mean Length (mm)
Big River	*Siliqua patula*	-2 (-0.61)	1	37
	"	-1 (-0.30)	3	54
	"	0 (0.00)	1	73.
	Siliqua alta	+1 (+0.30)	1	18
	Spisula polynyma	-2 (-0.61)	4	12
	"	-1 (-0.30)	4	10
	Macoma lama	-2 (-0.61)	5	13
	"	-1 (-0.30)	4	15
	"	0 (0.00)	1	10
	"	+1 (+0.30)	1	12
	Tellina lutea alternidentata	-1 (-0.30)	3	18
	Scolelepis squamatus	-2 (-0.61)	36	*
	"	-1 (-0.30)	53	*
	"	0 (0.00)	25	*
	"	+1 (+0.30)	32	*
	"	+3 (+0.91)	11	*
	Haploscoloplos elongatus	-2 (-0.61)	8	*
	"	-1 (-0.30)	14	*
	"	0 (0.00)	4	*
	"	+1 +0.30)	8	*
	Nephtys caeca	-2 (-0.61)	4	74
	"	-1 (-0.30)	3	71

* Indicates no measurements available.

Appendix Table 3. continued

Beach	Organism (to species)	Tide level in feet (meters)	# Captured	Mean Length (mm)
Big River continued	*Nephtys californiensis*	0 (0.00)	1	*
	Ophelia assimilis	0 (0.00)	3	54
	"	+1 (+0.30)	3	23
	"	+3 (+0.91)	3	64
	Nemertia (sp)	0 (0.00)	2	*
	Cerebratulus californiensis	0 (0.00)	1	*
	Eohaustoridae (sp)	-2 (-0.61)	present	*
	"	-1 (-0.30)	"	*
	"	0 (0.00)	"	*
	"	+1 (+0.30)	"	*
	"	+3 (+0.61)	"	*
	Ammodytes hexapterus	-2 (-0.61)	6	83
Hallo Bay	*Siliqua patula*	-1 (-0.30)	2	6
	"	0 (0.00)	4	7
	Siliqua alta	-2 (-0.61)	1	12
	"	-1 (-0.30)	2	7
	Clinocardium nuttallii	-3 (-0.91)	1	79
	"	-2 (-0.61)	2	5
	Macoma lama	-3 (-0.91)	40	12
	"	-1 (-0.30)	9	8
	"	0 (0.00)	1	6
	"	+1 (+0.30)	12	10
	"	+4 (+1.22)	2	11

Appendix Table 3. continued

Beach	Organism (to species)	Tide level in feet (meters)	# Captured	Mean Length (mm)
Hallo Bay continued	*Macoma balthica*	-2 (-0.61)	2	9
	"	-1 (-0.30)	2	7
	"	0 (0.00)	2	12
	"	+1 (+0.30)	6	10
	"	+2 (+0.61)	3	12
	"	+4 (+1.22)	1	13
	Macoma calcarea	+1 (+0.30)	1	7
	Macoma loveni	-3 (-0.91)	2	11
	Scolelepis squamatus	-3 (-0.91)	12	*
	"	-2 (-0.61)	15	*
	"	-1 (-0.30)	12	*
	"	0 (0.00)	5	*
	"	+1 (+0.30)	10	*
	"	+3 (+0.91)	3	*
	Haploscoloplos elongatus	-3 (-0.91)	1	*
	"	-2 (-0.61)	6	*
	"	-1 (-0.30)	3	*
	"	+1 (+0.30)	2	*
	"	+3 (+0.91)	3	*
	Nephtys caeca	-3 (-0.91)	12	*
	"	-2 (-0.61)	15	*
	"	-1 (-0.30)	12	*
	"	0 (0.00)	5	*
	"	+1 (+0.30)	10	*
	"	+3 (+0.91)	3	*

Appendix Table 3. continued

Beach	Organism (to species)	Tide level feet (meters)	# Captured	Mean Length (mm)
Hallo Bay continued	*Anaitides groenlandica*	-2 (-0.61)	3	*
	"	-1 (-0.30)	1	30
	"	+1 (+0.30)	1	*
	"	+3 (+0.91)	1	*
	Cistenides brevicoma	-1 (-0.30)	1	*
	"	+1 (+0.30)	1	*
	Nemertea (sp)	+3 (+0.91)	1	*
	Cerebratulus californiensis	-3 (-0.91)	1	*
	"	-2 (-0.61)	1	*
	"	-1 (-0.30)	1	*
	"	+1 (+0.30)	1	*
	Eohaustoridae (sp)	0 (0.00)	present	*
	"	+1 (+0.30)	present	*
	"	+3 (+0.91)	present	*
Kukak	*Siliqua patula*	-1 (-0.30)	2	92
	"	0 (0.00)	2	6
	"	+1 (+0.30)	2	11
	"	+2 (+0.61)	2	22
	Siliqua alta	-1 (-0.30)	2	14
	"	0 (0.00)	2	20
	"	+1 (+0.30)	2	19
	"	+2 (+0.61)	1	18
	"	+6 (+1.83)	1	26

A, pendix Table 3. continued

Beach	Organism (to species)	Tide Level in feet (meters)	# Captured	Mean Length (mm)
Kukak continued	*Spisula polynyma*	-1 (-0.30)	2	9
	"	0 (0.00)	1	*
	"	+1 (+0.30)	4	9
	"	+2 (+0.61)	1	9
	"	+6 (+1.83)	1	21
	Clinocardium nuttallii	-1 (-0.30)	1	42
	"	+1 (+0.30)	1	29
	"	+3 (+0.91)	1	103
	Macoma balthica	0 (0.00)	1	6
	"	+5 (+1.52)	2	15
	Macoma lama	-1 (-0.30)	39	8
	"	0 (0.00)	65	7
	"	+1 (+0.30)	43	9
	"	+6 (+1.83)	1	17
	"	+7 (+2.13)	1	7
	Macoma yoldiformis	-1 (-0.30)	2	9
	"	0 (0.00)	1	11
	Prototheca stamenae	+2 (+0.61)	1	9
	Scolelepis squamatus	-1 (-0.30)	122	*
	"	0 (0.00)	35	*
	"	+1 (+0.30)	120	*
	"	+2 (+0.61)	94	*
	"	+3 (+0.91)	95	*
	"	+4 (+1.22	Present	*

Appendix Table 3. continued

Beach	Organism (to species)	Tide Level feet (meters)	# Captured	Mean Length (mm)
Kukak continued	*Scolelepis squamatus* continued	+5 (+1.52)	167	*
	"	+7 (+2.13)	205	*
	Haploscoloplos elongatus	-1 (-0.30)	7	*
	"	0 (0.00)	1	55
	"	+1 (+0.30)	2	*
	"	+3 (+0.91)	4	*
	Nephtys caeca	-1 (-0.30)	7	108
	"	0 (0.00)	6	*
	"	+1 (+0.30)	4	80
	"	+1 (+0.30)	4	*
	"	+2 (+0.61)	7	74
	"	+2 (+0.61)	2	*
	"	+3 (+0.91)	13	97
	"	+4 (+1.22)	8	126
	"	+5 (+1.52)	14	121
	"	+7 (+2.13)	5	129
	Nephtys californiensis	+2 (+0.61)	1	*
	Anaitides groenlandica	-1 (-0.30)	2	90
	"	+5 (+1.52)	1	*
	Eteone longa	+2 (+0.61)	1	*
	Glycinde picta	-1 (-0.30)	1	*
	Nemertea (sp)	+1 (+0.30)	1	*
	"	+5 (+1.52)	3	*
	"	+7 (+2.13)	1	*

Appendix Table 3. continued

Beach	Organism (to species)	Tide Level in feet (meters)	# Captured	Mean Length (mm)
Kukak continued	*Cerebratulus californiensis*	-1 (-0.30)	1	*
	"	+2 (+0.61)	1	*
	"	+4 (+1.22)	1	*
	Eohaustoridae (sp)	-1 (-0.30)	present	*
	"	0 (0.00)	present	*
	"	+2 (+0.61)	present	*
	"	+3 (+0.61)	present	*
	"	+4 (+1.22)	present	*
	"	+5 (+1.52)	present	*
Bumble Bay[1]	*Scolelepis squamatus*	0 (0.00)	1	*
	"	+3 (+0.91)	1	*
	"	+4 (+1.22)	1	*
	Nephtys caeca	0 (0.00)	1	*
	Ophelia assimilis	0 (0.00)	1	*
	"	+2 (+0.61)	1	*
	"	+3 (+0.91)	1	*
	"	+4 (+1.22)	1	*
Tugidak	*Siliqua patula*	+.5 (+.015)	2	74
	Haploscoloplos elongatus	-1 (-0.30)	1	22
	"	-.5 (-.015	1	36
	"	0 (0.00)	1	11
	"	+1 (+0.30)	6	*
	Eteone longa	+1 (+0.30)	2	*

[1] Only 33.83 liters of substrate examined at each tide level station.

Appendix Table 3. continued

Beach	Organism (to species)	Tide Level in feet (meters)	#Captured	Mean Length (mm)
Tugidak continued	*Glycinde picta*	-.5 (-.015)	1	*
	"	0 (0.00)	4	*
	"	+.5 (+.015)	2	*
	Nephtys californiensis	-1 (-0.30)	2	*
	"	0 (0.00)	1	*
	"	+.5 (+.015)	3	*
	"	+1 (+0.30)	1	*
	Ophelia assimilis	+.5 (+.015)	2	*
	"	+1 (+0.30)	2	*
Dakavak[1]	*Siliqua patula*	+1 (+0.30)	1	138
	Scolelepis squamatus	-1 (-0.30)	1	*
	"	0 (0.00)	6	*
	"	+1 (+0.30)	2	*
	"	+3 (+0.91)	8	*
	"	+4 (+1.22)	7	*
	Haploscoloplos elongatus	-1 (-0.30)	1	*
	Anaitedes groenlandica	+4 (+1.22)	2	*
	Eteone longa	+3 (+0.91)	1	*
	Nephtys californiensis	-1 (-0.30)	17	*
	"	0 (0.00)	24	*
	"	+1 (+0.30)	42	*
	"	+3 (+0.91)	17	*
	"	+4 (+1.22)	3	*

[1]Tide level station (+0.61) subsample lost as a result of improper preservation.

Appendix Table 3. continued

Beach	Organism (to species)	Tide Level in feet (meters)	# Captured	Mean Length (mm)
Dakavak continued	*Ophelia Assimilis*	-1 (-0.30)	40	*
	"	0 (0.00)	27	*
	"	+1 (+0.30)	20	*
	"	+3 (+0.91)	12	*
	"	+4 (+1.22)	12	*
	Nemertea (sp)	0 (0.00)	1	*
	"	+1 (+0.30)	2	*
	Cerebratulus californiensis	0 (0.00)	1	75
	Eohaustoridae (sp)	+1 (+0.30)	present	*
Kashvik	*Siliqua patula*	-1 (-0.30)	8	37
	"	0 (0.00)	1	23
	"	+2 (+0.61)	1	151
	Spisula polynyma	-1 (-0.30)	1	7
	Macoma balthica	+2 (+0.61)	3	16
	"	+3 (+0.91)	2	18
	"	+5 (+1.52)	1	16
	Macoma lama	-1 (-0.30)	8	19
	"	0 (0.00)	6	12
	"	+1 (+0.30)	3	13
	"	+2 (+0.61)	1	13
	"	+3 (+0.91)	1	14
	"	+4 (+1.22)	1	19

Appendix Table 3. continued

Beach	Organism (to species)	Tide Level in feet (meters)	# Captured	Mean Length (mm)
Kashvik continued	*Scolelepis squamatus*	-1 (-0.30)	27	*
	"	0 (0.00)	76	*
	"	+1 (+0.30)	70	*
	"	+2 (+0.61)	40	*
	"	+3 (+0.91)	30	*
	"	+4 (+1.22)	17	*
	Haploscoloplos elongatus	-1 (-0.30)	3	*
	"	0 (0.00)	16	*
	"	+1 (+0.30)	3	*
	Anaitides groenlandica	0 (0.00)	1	*
	"	+1 (+0.30)	3	*
	"	+2 (+0.61)	1	*
	Glycinde picta	-1 (-0.30)	2	*
	Nephtys caeca	-1 (-0.30)	6	*
	"	0 (0.00)	6	*
	"	+1 (+0.30)	3	*
	"	+2 (+0.61)	2	144
	"	+2 (+0.61)	2	*
	"	+3 (+0.91)	4	*
	"	+4 (+1.22)	2	*
	Nephtys californiensis	-1 (-0.30)	14	*
	"	0 (0.00)	2	*
	"	+1 (+0.30)	2	*
	"	+2 (+0.61)	3	*

Appendix Table 3. continued

Beach	Organism (to species)	Tide Level in feet (meters)	# Captured	Mean Length (mm)
Kashvik continued	*Ophelia assimilis*	+3 (+0.91)	9	*
	Eohaustoridae (sp)	-1 (-0.30)	present	*
	"	0 (0.00)	present	*
	"	+2 (+0.61)	present	*
	"	+3 (+0.91)	present	*
	"	+4 (+1.22)	present	*
	Amnodytes hexapterous	-1 (-0.30)	3	72
Alinchak	*Siliqua patula*	+1 (+0.30)	2	16
	"	+2 (+0.61)	2	18
	"	+3 (+0.91)	1	26
	Macoma lama	+2 (+0.61)	1	9
	Scolelepis squamatus	+1 (+0.30)	84	*
	"	+2 (+0.61)	223	*
	"	+3 (+0.91)	33	*
	Nephtys caeca	+1 (+0.30)	3	133
	"	+1 (+0.30)	3	*
	"	+2 (+0.61)	4	111
	"	+2 (+0.61)	2	*
	"	+3 (+0.91)	1	143
	Nephtys californiensis	+1 (+0.30)	3	66
	"	+2 (+0.61)	5	51
	"	+3 (+0.91)	1	55
	Eohaustoridae (sp)	+2 (+0.61)	present	*
	Amnodytes hexapterus	+3 (+0.91)	1	100

OCSEAP FUNDS EXPENDED
(Razor Clam Distribution and Assessment Study)

11-41-3-402 OCS Razor Clam

	Budget	Expenditure[1]	Balance
100 (Personnel Services)	$29,100.00	$22,219.85	$6,880.15
200 (Travel)	3,000.00	1,298.23	1,701.77
300 (Contractual)	14,500.00	10,890.66	3,609.34
400 (Commodities)	3,900.00	5,928.90	-2,028.90
500 (Equipment)	2,000.00	4,020.75	-2,020.75

[1]Estimated through September 30, 1976.

RU# 27

NO REPORT WAS RECEIVED

A final report is expected next quarter

NOAA 03-5-022-67
Research Unit #58
July 1 - October 1, 1976

Quarterly Report

A Description and Numerical Analysis of the Factors Affecting the Processes of Production in the Gulf of Alaska

George C. Anderson

Ronald K. Lam

Beatrice Booth

University of Washington
Seattle, Washington 98195

October 5, 1976

Departmental Concurrence

REF: A76-66

Quarterly Report

I. Subtask a. Objective: To conduct a search and present a compilation of available baseline biological and associated physical and chemical data from the Gulf of Alaska (planktonic realm).

A. Data preparation - Biochemical data

Calculations on existing data as described in Quarterly Report of July 7 were completed, including integration of chlorophyll a from Station P profiles not originally integrated.

New data from the Straits of Georgia and Saanich Inlet were compiled.

All data were converted into OCSEAP format.

B. Tape formation - Biochemical data

A program was written to enter all biochemical data onto magnetic tape and to read, check, and copy the tape. Two copies of the tape were produced and listed. One copy was sent to the Juneau office.

C. Phytoplankton species data

Phytoplankton data were compiled from four sources: Venrick, Horner *et al.*, KH 694, Oshoro Maru 046. These data were keypunched and, together with the Munson data will be entered onto magnetic tape this week.

II. Subtask b. Objective: To use the compiled data for a description of the temporal and geographic variation in phytoplankton standing stock (and species), production, and related physical and chemical factors.

A. ANOVA program

The ANOVA program (as described in our July report) has been written. For each variable, a plot was produced of the mean and variance of each cell. (A cell includes measurements at one depth in one area during one season of one year.) This test of the independence of the variance indicated that eight variables (Chl a, NO_3, O_2, Phaeopigments, NH_3, chlorophyll a-integrated, mixed depth, light level) should be transformed before the Analysis of Variance tests are run. Appropriate transformations have been found for all the variables except chlorophyll a and oxygen. When we have eliminated variance dependence in these two variables, we will proceed with the ANOVA program.

B. Phytoplankton species program

The program was completed and run. Results are now being graphically displayed. Some species display a clearly limited distribution (*Asterionella japonica*); whereas others are frequent and widely distributed (*Acanthoica* sp.). Dominance computed by biomass is often in variance with dominance computed by cell number (Asteromphalus spp.). (See Maps 1-3).

III. Subtask c. Objective: To use the data from Station P in a model of phytoplankton productivity and to test the sensitivity of the model to changes in physiological constants and external parameters.

A. Standard run

A standard run, simulating the evolution of the chlorophyll distribution in the upper 150 m of water over a period of one year, has been completed for Station P. The chlorophyll distribution depends on five constant parameters and six independent variables.

B. Variations

An analysis of the sensitivity of the near-surface chlorophyll distribution to variations in the parameters and independent variables has been completed. This has been verified by simulating some of these same variations with the numerical model. We found that for periods of high zooplankton grazing pressure (parts of the spring and summer) the chlorophyll concentration was held at the grazing threshold. During the winter, the results were sensitive to all of the variations.

V. Problems encountered

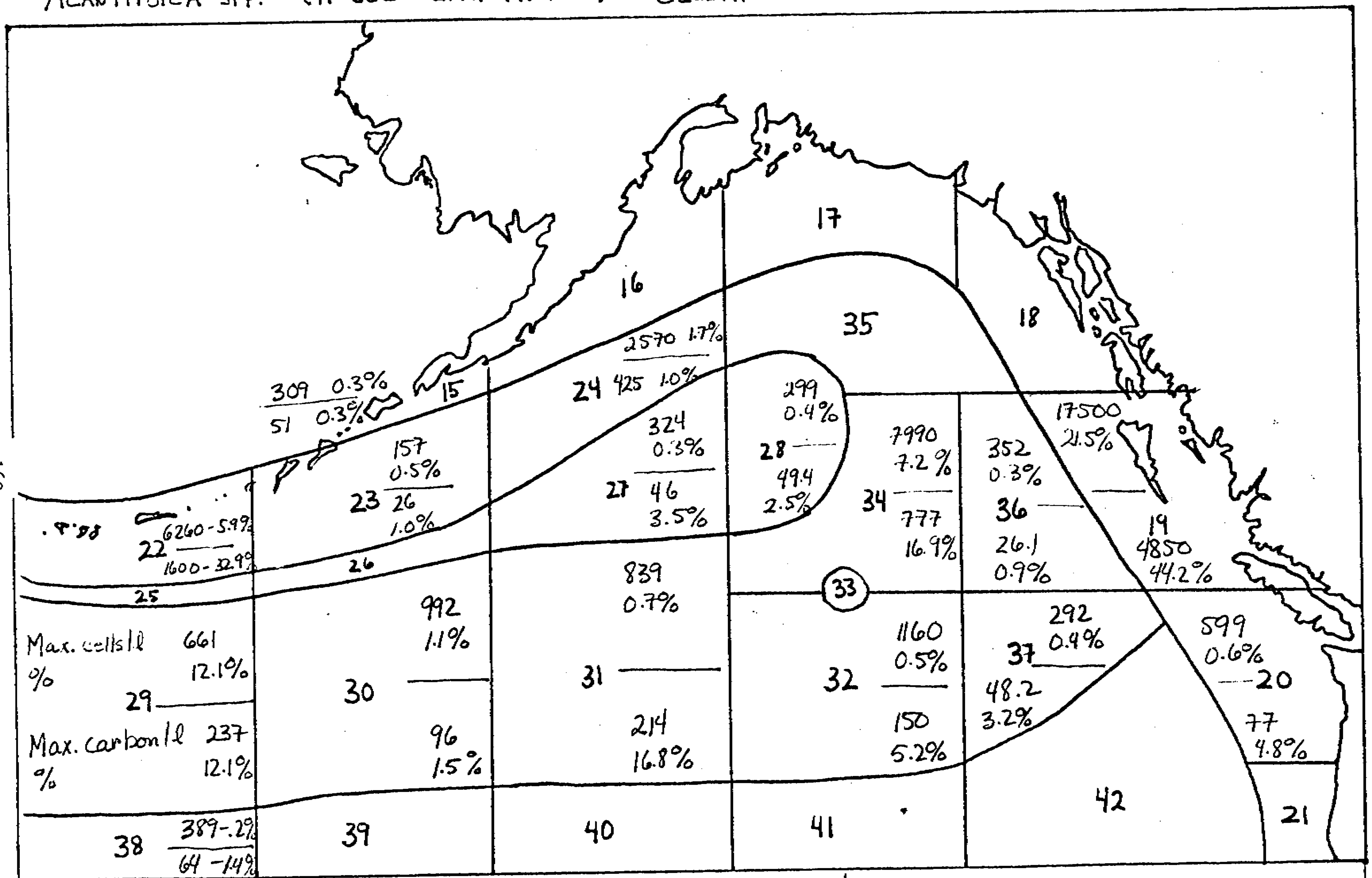
Production of Tape #1 (Biochemical data) cost twice as much as our original estimate. Because of the diverse sources and formats of our data, the program to produce the tape was more complex than expected. During correction of errors discovered on the cards, more errors were introduced which had to be corrected on the tape. In the initial attempt to reproduce the tape, a parity error was discovered. After four days, the source of the problem was located in the computer, rather than in the tape, and was circumvented. All of these factors prevented us from meeting the October 1 deadline for submission of the data. A further result is that the program of Tape #2 is not yet written. This program should be simpler than that for Tape #1 because part of the data are already on a tape and the reaminder are in OCSEAP format.

Tape #2 has also been delayed by the late code assignments for phytoplankton species. Apparently, our first request (August) for new code numbers as lost in the mails. We delayed keypunching until finally receiving the code numbers in September. We hope to be finished with Tape #2 within two weeks. To be sure, we have adjusted the deadline to November 1.

VI. Estimate of funds expended through September 30, 1976

Salaries	$22,926
Employee benefits	2,966
Equipment	963
Materials and services	7,300
Travel and per diem	368
Indirect costs	10,822
Total	$45,345

ACANTHOICA SPP. (A COCCOLITHOPHORID) OCSEAP CODE # 07000005_ _



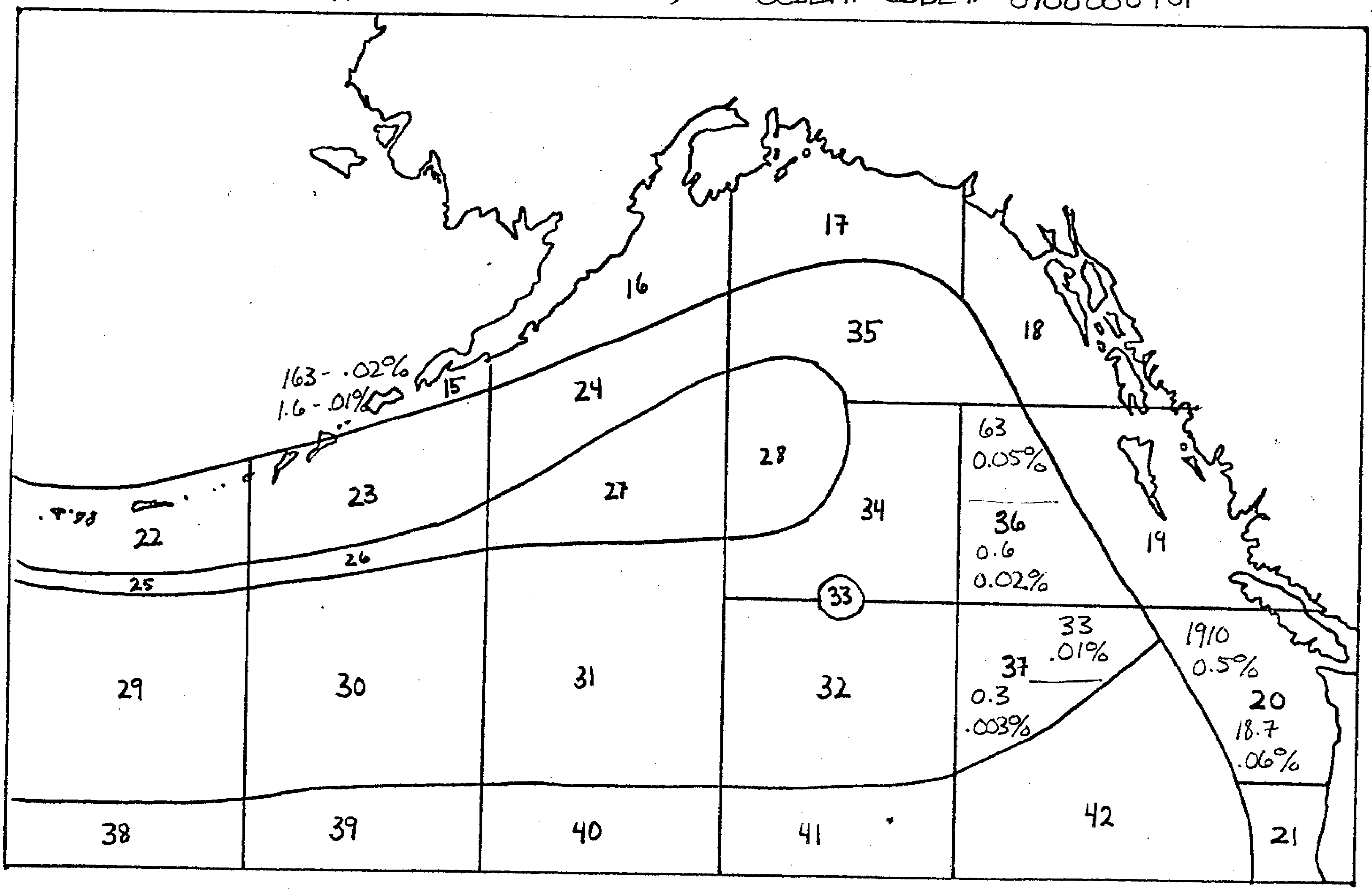
DOMINANCE:
≥ 1% CARBON/L
≥ 10% CARBON/L
≥ 25% CARBON/L

DESCRIPTION OF NUMBERS IN EACH AREA:

MAXIMUM CELLS/L
MAXIMUM PERCENTAGE OF CELLS/L
MAXIMUM CARBON/L : nanograms/L
MAXIMUM PERCENTAGE OF CARBON/L

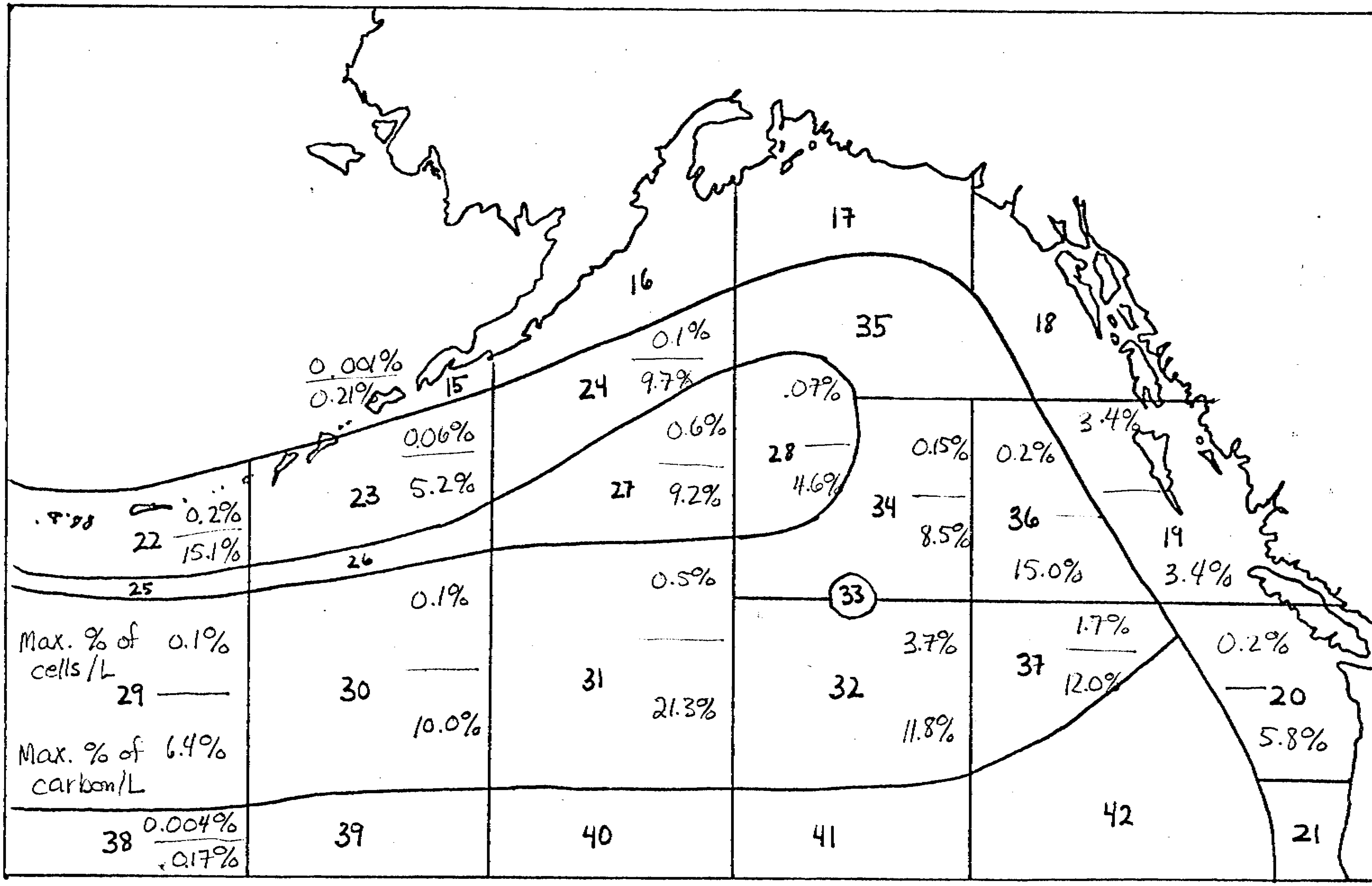
MAP 1

ASTERIONELLA JAPONICA (A DIATOM) OCSEAP CODE # 0900000701



Map 2

ASTEROMPHALUS SPP (A DIATOM) OCSEAP CODE # 09000009__



DOMINANCE: MAXIMUM PERCENTAGE OF CELLS/L

DOMINANCE: MAXIMUM PERCENTAGE OF CARBON/L

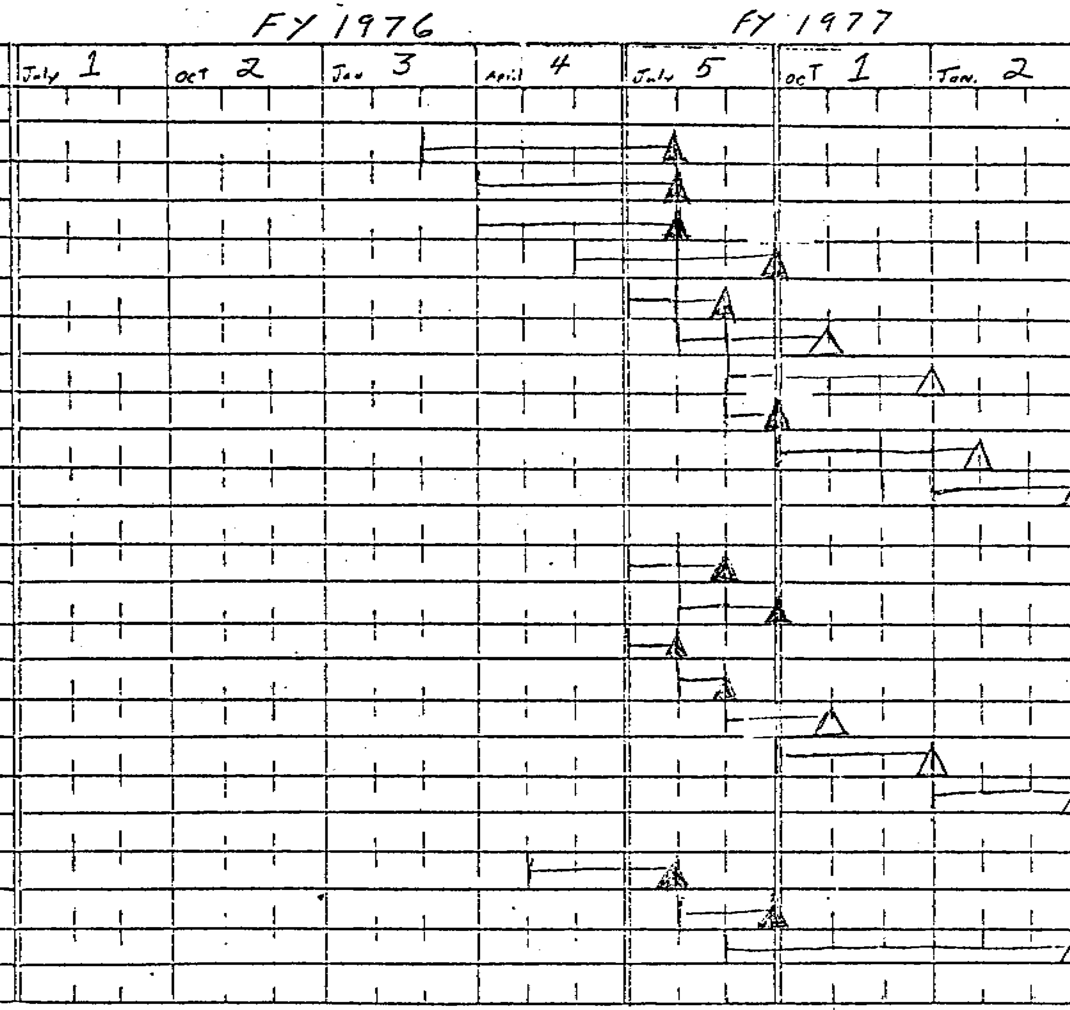
MAP 3

Project Numerical Analysis

Date June 23, 1976

PI(s) G.C. Anderson K.K. Tom

	Major Milestones / Activities
1	Production standing stock, physical & chemical features
2	Data compiled
3	Standardization and computations completed
4	Data on cards
5	Cards corrected
6	ANOVA program written
7	ANOVA program run
8	Preliminary analysis and rerun
9	Data on magnetic tape
10	Preparation of visual presentation of results
11	Final written report
12	Phytoplankton species data
13	Data compiled
14	Data on cards and corrected
15	Sorting program written
16	Sorting program run
17	Data on magnetic tape
18	Preparation of visual presentation of results
19	Final written report
20	SIMULATION
21	STANDARD run
22	VARIATIONS
23	FINAL
24	



Activity -- Start End

Milestone: Planned △
Completed ▲

OCSEAP QUARTERLY REPORT

Task A-7
Contract # R7120811 & R7120812
Research Unit #64/354
Reporting Period July 1, 1976
to September 30, 1976

RESOURCES OF NON-SALMONID PELAGIC FISH OF THE EASTERN BERING SEA AND THE GULF OF ALASKA

Co-Principal Investigators

Walter T. Pereyra
Martin O. Nelson

Northwest Fisheries Center
National Marine Fisheries Service
Seattle, Washington 98112

September 23, 1976

RESOURCES OF NON-SALMONID PELAGIC FISH OF THE EASTERN BERING SEA AND THE GULF OF ALASKA

Task Objectives

A. Review and summarize existing published and unpublished scientific literature on the distribution, abundance, life histories, and population structure of non-salmonid pelagic fishes of the Eastern Bering Sea and the Gulf of Alaska.

B. Examine and summarize unpublished research vessel survey and commercial fishery data on the distribution, relative abundance, and population structure of the subject species in the area.

C. Prepare a data report on records of the distribution and relative abundance of the subject species.

D. Prepare an annotated bibliography and a narrative report which collates results of studies undertaken under the objectives (A) and (B) and describes, within the constraints of the available data, observed temporal and spatial variations in the distribution, abundance, and population structure of the species in the target areas.

Coverage

The geographic and species coverage and the types/scope of information to be included in the review, remain the same as reported in the previous Quarterly Report of June 25, 1976, for R.U. 64/354 (see Fig. 1, 2; Table 1). The study is essentially confined to these areas and species except in cases where the sole extant sources of information on certain species are found in scientific literature pertaining to other areas.

Activities During the 6th Quarter

The original data for completion of reports and submission of all findings and data pertaining to OCSEAP R.U. 64/354 had been October 1, 1976.

Because of several problems that arose during the current quarter, it became apparent that the above deadline would be impossible to meet. A 60-day extension of the deadline to November 30, 1976, was requested to assure the completion of the final narrative report and the analysis of data to be included therein. Approval of the extension was granted by the Project Office on September 23, 1976.

Difficulties encountered during the current quarter were as follows:

a) Preparation of reports based on the scientific literature exceeded the time limits originally estimated because of the sheer volume of material and the limited effort available.

b) Two staff members who have been deeply involved in the preparation of the narrative report and data processing and analysis reached the end of their temporary appointments during the month of September. Further services have been secured through contractual arrangements.

c) Processing of the data records has been hampered by the large number of keypunch errors found in the data cards prepared by the contractor, General Services Administration. As a result, several hundred cards had to be reprocessed. Further, the inability of the Center's computing facilities to handle the data in their present format necessitated the use of Washington, D. C. computing facilities and the creation of special programs which resulted in additional delays. During August, the card files were loaded onto tapes and updating, sorting and further reformatting programs were written, tested and debugged. Further programming for data analysis and generating of graphs, plots, and charts is currently proceeding.

In spite of the above problems, the following are being provided to the Juneau Project Office within the originally specified deadline, in partial fulfillment of the contractual obligations of R.U. 64/354:

1) Nine track magnetic computer tape containing all non-proprietary data pertaining to sampling and catches of non-salmonids under study, as specified in the Annual Progress Report of R.U. 64/354 of March 26, 1976.

2) Data documentation forms; report describing the data record, methods of data acquisition, reliability and accuracy estimates, and evaluation of individual records; and a complete listing of the tape contents.

3) Annotated bibliography of 208 references and abstracts containing information on pelagic fish within the target areas. The abstracts are arranged alphabetically by author and date and are cross indexed according to subject matter and general geographic area.

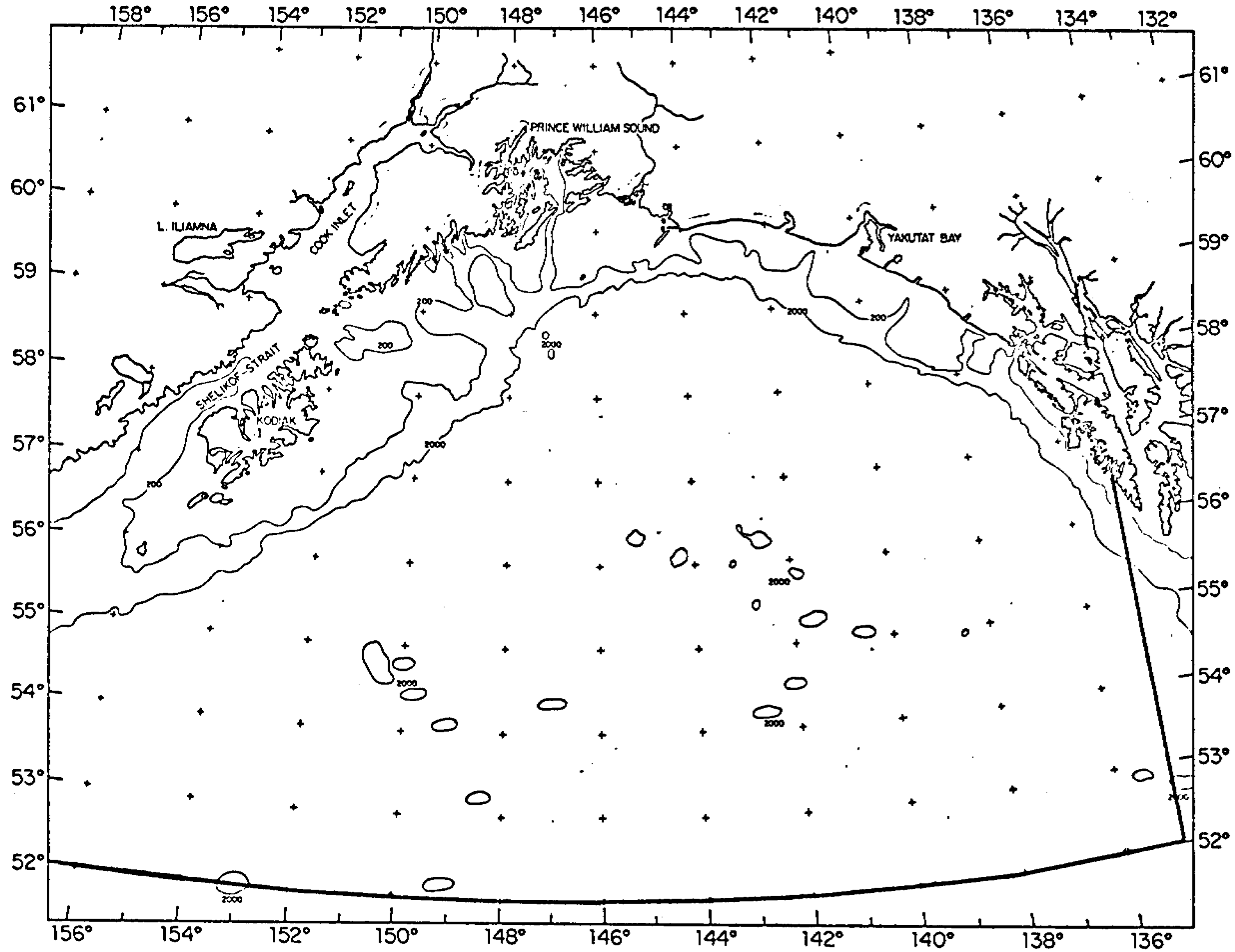


Figure 1. R.U. 64/354 study area

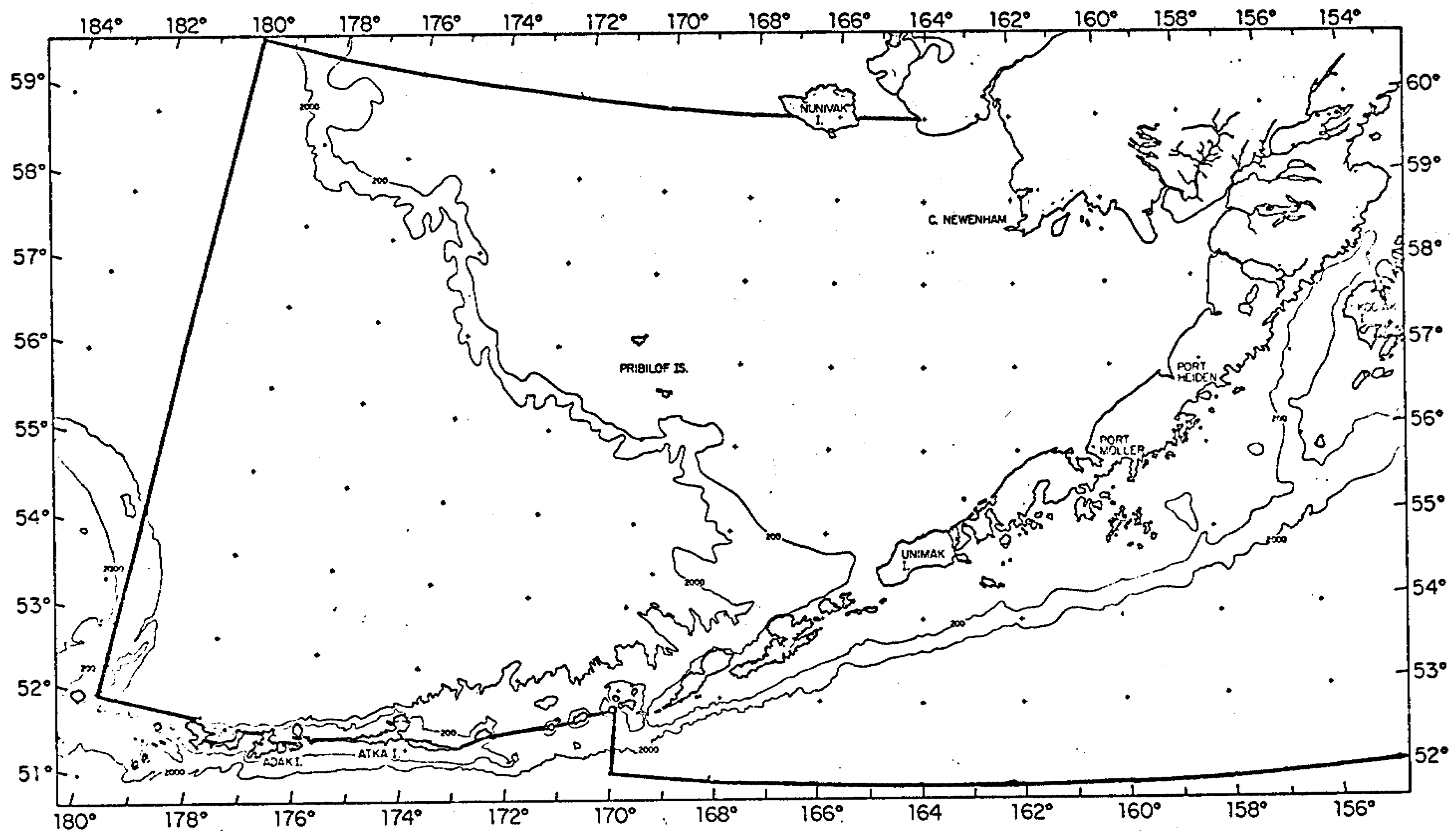


Figure 2. R.U. 64/354 study area.

TABLE 1

Species List of Non-salmonid Pelagic Fishes

Lamnidae
- Basking shark (*Cetorhinus maximus*)
- Salmon shark (*Lamna ditropis*)

Carcharhinidae
- Blue shark (*Prionace glauca*)

Squalidae
- Spiny dogfish (*Squalus acanthias*)

Clupeidae
- Shad (*Alosa sapidissima*)
- Pacific herring (*Clupea harengus pallasi*)

Osmeridae
- Pond smelt (*Hypomesus olidus*)
- Surf smelt (*Hypomesus pretiosus*)
- Capelin (*Mallotus villosus* or *M. catervarius*)
- Boreal smelt (*Osmerus eperlanus*)
- Rainbow smelt (*Osmerus mordax*)
- Longfin smelt (*Spirinchus thaleichthys*)
- Eulachon (*Thaleichthys pacificus*)

Bathylagidae

Myctophidae

Scomberesocidae
- Pacific saury (*Cololabis saira*)

Carangidae
- Jack mackerel (*Trachurus symmetricus*)

Bramidae
- Pacific pomfret (*Brama japonica*)

Trichodontidae
- Pacific sandfish (*Trichodon trichodon*)

Zaproridae
- Prowfish (*Zaprora silenus*)

Ammodytidae
- Pacific sand lance (*Ammodytes hexapterus*)

Scombridae
- Chub mackerel (*Scomber japonicus*)
- Albacore tuna (*Thunnus alalunga*)

Hexagrammidae
- Atka mackerel (*Pleurogrammus monopterygius*)
  (*Pleurogrammus azonus*)

AN ANNOTATED BIBLIOGRAPHY ON NON-SALMONID PELAGIC FISHES OF THE GULF OF ALASKA AND EASTERN BERING SEA

by

Janet M. Wall*

and

Paul T. Macy*

Submitted as part of the Final Report
for Contracts #R7120811 and #R7120812
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*Northwest Fisheries Center, National Marine Fisheries Service,
NOAA, 2725 Montlake Boulevard East, Seattle, WA 98112

CONTENTS

AN ANNOTATED BIBLIOGRAPHY ON NON-SALMONID PELAGIC FISHES OF THE GULF OF ALASKA AND EASTERN BERING SEA

By Janet M. Wall and Paul T. Macy

INTRODUCTION

The Northwest Fisheries Center in September 1975 received contracts from the Outer Continental Shelf Energy Assessment Program (OCSEAP), Bureau of Land Management, Department of the Interior, for a project to review literature and data for resources of non-salmonid pelagic fishes of the eastern Bering Sea and Gulf of Alaska. This bibliography was prepared as part of the final report required for those contracts.

The objective of the project is to review published and unpublished literature on the distribution, abundance, life histories, fisheries, and population dynamics of non-salmonid pelagic fishes of the two areas. The geographic areas of coverage were defined as follows: Eastern Bering Sea--the area from lat 52° to 60°N. and from long 180° to the Alaskan coast; Gulf of Alaska--the area from the central Gulf of Alaska coastline south to lat 52°N, to the Aleutian Islands on the west and to long 135°W, on the east, respectively.

For the purposes of this study, non-salmonid fishes were conceived to be those which spend the majority of their lives, and especially their adult stages, in the near-surface and midwater layers and are primarily sampled with, and exploited by, off-bottom gear. This latter qualification has had the effect of placing semipelagic gadoid (e.g., pollock) and scorpaenid species in the demersal realm, and thus outside the scope of this study.

Individual species were selected for inclusion in the bibliography on the basis of their prominence in the catches of both United States and foreign commercial fishing fleets, their relative abundance in research vessel catches indicating potentially latent resources, and/or their prominence in the provision and maintenance of ecological balance as major predators, competitors, or forage fish. The final list of species considered includes 15 families and more than 22 individual species.

Literature on non-salmonid pelagic fishes is scanty because most of the species are not objects of commercial fisheries. United States literature and statistics cover the commercial species fairly well, but non-commercial fishes usually have been collected on an incidental basis by sampling gear designed to capture other species. Japanese and Russian literature on fish that are targets of fishing fleets or literature detailing biological studies on unexploited species likewise is incomplete or lacking.

All of the citations included in the bibliography have been verified against the original literature, but they have not been evaluated for quality or merit for inclusion. Some references are checklists or distribution lists only; others are detailed scientific studies. A few citations for unpublished references are included because they contain important information not available elsewhere; these are noted by asterisks (*).

The style of the citations follows that used by the National Marine Fisheries Service in its publications. References are arranged alphabetically by author and by year. Those with multiple authors are listed alphabetically by senior author's surname and then by the junior author's surname. When more than one paper is listed for an author or authors, the arrangement is chronological by year. The name of the journal is used as author instead of "Anonymous" when no author is shown on an article. Journals and periodicals are abbreviated using the rules of the Word-Abbreviation List, American National Standards Institute, Standards Committee Z39, published by the National Clearinghouse for Periodical Title Word Abbreviations.

Japanese and Russian journal and periodical sources have been listed in romanized or transliterated form unless the original was printed with an English title. Russian transliteration follows the transliteration table issued by the National Federation of Science Abstracting and Indexing Services. Translations of foreign literature were obtained when available, and translation information is included with the citations.

The index is in two parts--by subject and by geographic area. Fish species are listed by their common names, and scientific names are cross-referenced to appropriate common names. The common names used follow, for the most part, the List of common and scientific names of fishes from the United States and Canada (3rd edition), by Reeve M. Bailey et al., published by the American Fisheries Society, 1970.

In addition to the annotated bibliography, we have included a separate list of bibliographic sources we reviewed in the course of our work. References in these bibliographies pertinent to our research subjects and areas have been annotated and listed in our bibliography.

Finally, although we made every effort to locate and include all pertinent literature, we realize that no bibliographer can rightfully claim to have located every reference on a subject. We can only hope we have not overlooked any important literature and that the bibliography will be of value to scientists and others seeking information on the non-salmonid pelagic fishes of the eastern Bering Sea and Gulf of Alaska.

ANNOTATED BIBLIOGRAPHY

ADMINISTRATION OF ALASKA COMMERCIAL FISHERIES.
1956. Progress report and recommendations for 1957. U.S. Fish Wildl. Serv., Admin. of Alaska Commer. Fish., Juneau, Alaska. 34 p.

Three pages of graphs illustrate total catch of herring in Alaska in 1880-1956 and percentage age composition in southeast Alaskan catches in 1951-1956. Spawning areas in southeast Alaska (Baranof Island area) are shown on a map.

ALASKA DEPARTMENT OF FISH AND GAME.
1965-1974. Alaska catch and production: Commercial fisheries statistics [1965-1974]. Alaska Dep. Fish Game, Juneau, Stat. Leafl. 11, 13, 15, 17, 19, 21, 23, 25-27. Various pagination.

Presents catches, weights, and values to the fishermen. Includes herring catches and value of landings by region and by gear. Production statistics include number of operating plants and wholesale values of production.

ALDERDICE, D. F., and F. P. J. VELSEN.
1971. Some effects of salinity and temperature on early development of Pacific herring (Clupea pallasi). J. Fish. Res. Board Can. 28(10): 1545-1562.

Results obtained from laboratory incubation of herring eggs at 13 different salinity-temperature combinations were compared with field observations in the North Pacific Ocean. These suggested that the physical limitations of a successful herring spawning ground are a salinity range of 8 to 28 ‰. that population abundance is associated with spawning temperatures of 5-9°C., that abundance is limited by temperatures of 9-10°C., and that maximum temperature for spawning is about 10°C. The study showed the lower limit of thermal tolerance of herring eggs was between 4 and 5°C.

ALVERSON, DAYTON L.
1968. Fishery resources in the northeastern Pacific Ocean. In: De Witt Gilbert (editor), The future of the fishing industry of the United States, p. 86-101. Univ. Washington, Seattle, Univ. Wash. Publ. Fish., New Ser. 4.

Summarizes data from a variety of published sources on the demersal and pelagic fish and shellfish resources. The spiny dogfish is considered a demersal species and its vertical distribution, size, and estimations of its standing stocks and sustainable yield are presented. Very little data are available on pelagic resources, but their potential value is considered.

ALVERSON, D. L., A. T. PRUTER, and L. L. RONHOLT.
1964. Sharks, skates, and ratfishes. Chapt. 7, p. 145-149, in their A study of demersal fishes and fisheries of the northeastern Pacific Ocean. H. R. MacMillan Lectures in Fisheries, Univ. B.C., Inst. Fish., Vancouver, B. C.

Includes brief notes on the dogfish fishery on the Pacific coast from Oregon to the Gulf of Alaska. Although relatively abundant on the continental slope south of Cape Spencer, Alaska, dogfish catches declined north of Cape Spencer and at depths greater than 99 fathoms.

ANDERSON, A. W., and C. E. PETERSON.
1952-1954. Fishery statistics of the United States [1949-1951]. U. S. Dep. Int., Fish Wildl. Serv., Stat. Dig. No's. 25, 27, 30. Various pagination.

Catch data of Alaskan fisheries by districts are included as well as the market value and poundage of the fishery products. Has data for herring and sometimes smelt, dogfish, or sharks.

ANDERSON, A. W., and E. A. POWER.
1946-1951, 1955-1967. Fishery statistics of the United States [1942-1948, 1952-1955]. U.S. Dep. Int., Fish Wildl. Serv., Stat. Dig. No's. 11, 14, 16, 18, 19, 21, 22, 34, 36, 39, 41. Various pagination.

For annotation, see Anderson and Peterson (1952-1954).

ANDRIYASHEV, ANATOLY P.
1937. K poznaniyu ikhtiofauny Beringova i Chukotskogo moreĭ (A contribution to the knowledge of the fishes from the Bering and Chukchi Seas). Akad. Nauk SSSR, Zool. Inst., Issled. Moreĭ No. 25 (Issled. Dal'nevost. Moreĭ No. 5): 292-355. In Russian. (Transl. by Lisa Lanz with Norman J. Wilimovsky, 1955, U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 145, 81 p.)

Describes fishes primarily from the collections made by the trawlers Dal'nevostochnik ("Far East") in 1932 and the Krasnoarmeets ("Red Army") in 1933. In addition to the morphological data, some information on distribution and ecological preferences are noted.

ARON, WILLIAM.
1958. Preliminary report of midwater trawling studies in the North Pacific Ocean. Univ. Wash., Seattle, Dep. Oceanogr., Tech. Rep. 58: 1-55. (Processed.)

Preliminary results of midwater trawl sampling conducted by the University of Washington Department of Oceanography on the vessel Brown Bear from July 22 to September 22, 1957 are given. See Aron (1960a) for revision and analysis of cruise data.

ARON, WILLIAM.
1959. Midwater trawling studies in the North Pacific. Limnol. Oceanogr. 4(4): 409-418.

Summarizes the results of 149 exploratory hauls in the northeastern Pacific with a modified Isaacs-Kidd midwater trawl towed at depths ranging from 20 to 250 meters. Contains notes on the depth distribution of some myctophid species.

*1960a. The distribution of animals in the eastern North Pacific and its relationship to oceanographic conditions. PhD Thesis, Univ. Wash., Seattle. 82 p., 155 app. p.

Data from sampling by the University of Washington Department of Oceanography during three cruises of the Brown Bear in the North Pacific Ocean in summer 1957 and summer and fall 1958 are presented. Cruise No. 179 covered stations in the Gulf of Alaska and Bering Sea. Data include chemical and physical conditions as well as information on phytoplankton, zooplankton, fish larvae, and fish captured by the modified Isaacs-Kidd midwater trawl. There is some discussion on the distribution and abundance of myctophid species and their occurrence in relation to oceanic conditions, depth, and time of day.

1960b. The distribution of animals in the eastern North Pacific and its relationship to physical and chemical conditions. Univ. Wash., Seattle, Dep. Oceanogr., Tech. Rep. 63. 65 p., 156 p. appendix. (Processed.)

See Aron (1960a) for annotation.

1962. The distribution of animals in the eastern North Pacific and its relationship to physical and chemical conditions. J. Fish. Res. Board Can. 19(2): 271-314.

Several species of myctophid fishes collected by an Isaacs-Kidd midwater trawl in the northeastern Pacific Ocean were found to be useful indicator organisms to identify oceanic water masses. Numbers of animals declined and species composition changed in going from subarctic water to warmer intermediate water.

*BAXTER, RAE.
1975. Inshore marine resources of Bristol Bay, Alaska. Alaska Dep. Fish Game, Bethel, Alaska. Unpubl. manuscr. 97 p.

Information was obtained with commercial trawl vessels in August 1974 and June 1975, supplemented with personal observations and notes on interviews with local fishermen. Includes maps of herring and capelin spawning grounds and a species list giving the average length and length range of the specimens obtained from Bristol Bay.

BEAN, TARLETON H.

1887. The fishery resources and fishing-grounds of Alaska. In George Brown Goode et al., The fisheries and fishery industries of the United States, p. 81-115. Gov. Print. Off., Washington, D.C.

The important food and bait fishes of various districts of Alaska are described. Of pelagic species, the Atka mackerel were valuable both as food fish for humans and as food for other fish in the Kodiak-Shumagin Islands area and Aleutian Islands. Capelin were mentioned as food for salmon and cod. Other important food fishes were smelts (2 species), eulachon, and herring.

1889. The food fishes of Alaska. In Investigation of the fur-seal and other fisheries of Alaska, Report from the Committee on Merchant Marine and Fisheries of the House of Representatives, p. XL-XLIII. Gov. Print. Office, Washington, D. C.

Consists of brief notes on the major fish species found in Alaskan waters. Comments on the importance of capelin, Atka mackerel, sand lance, eulachon, surf smelt, and herrings as food for other fishes.

BEKKER, V. E.

1963a. Taksonomiya i rasprostranenie tarletonbinii (*Tarletonbeania crenularis*, Myctophidae, Pisces). /Taxonomy and distribution of the blue lanternfish (*Tarletonbeania crenularis*, Myctophidae, Pisces)/. Akad. Nauk SSSR, Tr. Inst. Okeanol. 62: 145-163. In Russian. (Transl., Scripps Inst. Oceanogr., La Jolla, Calif.)

A total of 428 specimens collected by the Soviet vessel *Vityaz* in 1954-1959 and 23 specimens borrowed from Scripps Institution of Oceanography were studied. No specific differences were found between the western *T. crenularis* and the eastern *T. taylori*, which should be considered as subspecies, *T. crenularis crenularis* and *T. crenularis taylori*. The range of the subspecies is divided by the zone where the Aleutian Current diverges to form the Alaskan and Californian currents (approx. long 140°W). The intermediate area where well-defined specimens of both subspecies are found together extends from 136°W to 146°W. *T. crenularis* is closely associated with the current systems of the North Pacific (Kuroshio, Aleutian, Alaskan, and Californian). It is absent in waters of the Kuril-Kamchatka region and south of subarctic waters. (--Excerpted from author's summary.)

BEKKER, V. E.

1963b. Severotikhookeanskie vidy roda Protomyctophum (Myctophidae, Pisces). [North Pacific species of the genus Protomyctophum (Myctophidae, Pisces)]. Akad. Nauk. SSSR, Tr. Inst. Okeanol. 62: 164-191. In Russian, Engl. summary. (Transl., 1968, Systematic Lab., Natl. Mar. Fish. Serv., Washington, D.C., Transl. 60.)

Three species of primitive Myctophidae are found in the North Pacific: Electrona rissoi (?), Protomyctophum crockeri, and P. thompsoni. P. crockeri is closely associated with waters of mixed origin and P. thompsoni with subarctic waters. The latter inhabits mainly waters of the Kuril-Kamchatka coastal region and the Western Gyral (within limits of Pacific Ocean proper), in Aleutian waters, in the Alaskan Gyral, and in the American coastal region south to lat 40°N; it is considered rare within the subarctic region. P. crockeri is represented by western and eastern forms with an interruption of its range between long 165°E and 150°W. The western range of P. crockeri is in the zone of penetration of Kuroshio and Oyashio waters and its eastern range is in the eastern part of the subarctic region, in the intermediate region as well as in the Californian and American coastal regions south of 45°. (From author's summary).

BETHUNE, WINONA.

1949. Report on the investigation of albacore (Thunnus alalunga): Albacore log records. Fish. Res. Board Can., Pac. Biol. Stn., Nanaimo, B.C., Circ. 17: 10-13. (Processed.)

Log books of fishermen in summer 1948 showed areas off Queen Charlotte Islands from lat 52°30' and 53°N and long 132° and 133°W were most productive of albacore for the season (but also had greatest fishing intensity). More than 33% of the catch was in temperatures between 58° and 60°F., 22% at 60°F., and 17% at 59°F.

BOWER, WARD T.

1919-1941. Alaska fishery and fur-seal industries in [1918-1939]. (Title varies.) U.S. Dep. Commer., Bur. Fish., App. to Rep. U.S. Comm. Fish. [1918-1919, 1921-1940], (Reports in 1918-19, 1921-29 also issued as Doc. No's. 872, 891, 909, 933, 951, 973, 992, 1008, 1023, 1040, 1064, 1086; 1930-1939 also as Admin. Rep. No's. 2, 7, 11, 16, 19, 23, 28, 31, 36, 40). Various pagination.

The major fisheries of Alaska--salmon, cod, halibut, and herring, as well as aquatic furs--are described and reviewed each year. Data include annual statistics of the herring industry--the numbers of people employed, the investment in gear, and the poundages and value of the products. Occasionally, potential fisheries resources such as capelin and eulachon are discussed.

1942-1944, 1946-1948. Alaska fishery and fur-seal industries: [1940-1946]. U.S. Dep. Int., Fish Wildl. Serv., Stat. Dig. No's. 2, 5, 10, 13, 15, 17. Various pagination.

For annotation, See Bower (1919-1941).

BOWER, WARD T., and HENRY D. ALLER.
1915, 1917-1918. Alaska fisheries and fur industries in [1914-1917]. U.S. Dep. Commer., Bur. Fish., App. to Rep. U.S. Comm. Fish. [1914-1917], (Doc. No's. 819, 834, 838, 847). Various pagination.

For annotation, see Bower (1919-1941).

BRIGHT, DONALD B.
1959. The occurrence and food of the sleeper shark, Somniosus pacificus, in a central Alaska bay. Copeia 1959(1): 76-77.

A female sleeper shark was found June 3, 1958 trapped in a tide pool in Kachemak Bay, Cook Inlet, Alaska. Although this species has been reported in Alaska in the Bering Sea and southeastern Alaska, this is thought to be the first record in this area.

1960. A record of the porbeagle, Lamna nasus, from Cook Inlet, Alaska. Copeia 1960(2): 145-146.

Notes on a salmon shark caught in a gill net in Kachemak Bay, Alaska, July 18, 1959, include external description, measurements, stomach contents, and parasites.

BROWNING, ROBERT J.
1974. Fisheries of the North Pacific: history, species, gear & processes. Alaska Northwest Publ. Co., Anchorage. 408 p.

Describes, in popular style, the biology of 70 species of commercially important fish and shellfish of the North Pacific and the various types of vessels, methods and gear used in catching, handling, and preserving them.

BUCK, EUGENE H.
1973. Herring, p. 16-19. In his Alaska and the law of the sea: national patterns and trends of fishery development in the North Pacific. Arctic Environ. Inf. and Data Center, Univ. of Alaska, Anchorage (Alaska Sea Grant Rep. 73-4).

Contains two graphs presenting the herring catch statistics of the North Pacific. One illustrates the catch by country for 1905 to 1970 and the other shows the contribution to the catch of the various districts for 1930 to 1969.

*CHAPMAN, WILBERT McLEOD.
1937. Oceanic fishes from the northeastern Pacific Ocean collected by the International Fisheries Commission. PhD Thesis, University of Washington, Seattle, Wash. 158 p.

Biological data were analyzed from macroplankton collections at 1,161 stations by the International Fisheries Commission in the northeast Pacific from Cape Flattery, Wash., to the Sanak Islands, Alaska during 1926-1934. Pelagic and bathypelagic fishes studied include Bathylagus alascanus and B. pacificus, Myctophum oculeum and M. crenulare, Lampanyctus leucopsarus and L. micropunctatus, and Diaphus rafinesquei. Morphological data on fish from various stations are given, as well as latitudes and longitudes of stations where samples were taken.

CHITWOOD, PHILIP E.
1969. Japanese, Soviet, and South Korean fisheries off Alaska: Development and history through 1966. U.S. Fish Wildl. Serv., Circ. 310. 34 p.

Includes a brief summary of the U.S.S.R. herring fishery in the Bering Sea. Some catch statistics and numbers of vessels are given.

CLEMENS, W. A., and G. V. WILBY.
1961. Fishes of the Pacific coast of Canada. Fish. Res. Board Can., Bull. 68 (2nd ed., rev.). 443 p. (Orig. ed., rev., 1949, 368 p.)

Essentially an identification manual with brief notes giving the description, life history, and distribution of each species. Includes literature references.

COBB, JOHN N.
1906. The commercial fisheries of Alaska in 1905. [U.S.] Bur. Fish., Rep. Comm. Fish. 1905 (1907), (Doc. 603, Oct. 16, 1906). 46 p.

Describes the major fisheries of Alaska in 1905: cod, halibut, herring, and salmon. In addition, provides short notes on potential fisheries, such as Atka mackerel.

1907. The fisheries of Alaska in 1906. [U.S.] Bur. Fish., Rep. Comm. Fish., 1906 (1908), (Doc. 618, issued May 16, 1907). 70 p.

Describes the major fisheries of Alaska in 1906: salmon, cod, halibut, and herring, as well as aquatic furs and potential fishery resources such as eulachon and Atka mackerel.

DAHLGREN, EDWIN H.
1936. Further developments in the tagging of the Pacific herring, Clupea pallasii. J. Cons. Int. Explor. Mer 11(2): 229-247.

Tagging studies of the Pacific herring in southeast Alaska in 1932-1935, using magnetic belly tags, clarified the separateness of certain stocks and indicated that commercial fishing took a much greater portion of the stocks than was previously supposed by the industry.

DAHLGREN, E. H., and L. N. KOLLOEN.
1943a. Outlook for the Alaska herring fishery in 1943. U.S. Fish Wildl. Serv., Fish. Leafl. 16. 16 p.

Discusses the fluctuations of herring stocks from 1927 to 1942 in the Kodiak, Prince William Sound, and Southeastern Alaska districts. The degree of success of a given year class was found to be comparable in each of the three areas.

DAHLGREN, EDWIN H., and L. N. KOLLOEN.
1943b. Fluctuations in the abundance of the Alaska herring. Sci. Monthly 56: 538-543.

Throughout history, herring has been important as a source of food, meal, and oil and as forage for larger fish. Possible reasons for the great fluctuations which occur in the fishery are considered: changes in availability; decreased abundance due to man's intervention; changes in recruitment; and basic changes in migratory patterns. Differing success of year classes is thought to be the main reason for the large fluctuations, but the pressure of man's fishery is thought to be the main factor in the overall decline in abundance of many herring stocks.

1944. Outlook for the Alaska herring fishery in 1944. U.S. Fish Wildl. Serv., Spec. Sci. Rep. 25. 18 p.

Catch data (with year class composition) of Kodiak, Prince William Sound, and southeastern Alaska fisheries are presented. Estimates are given for 1944 catches based on analyses of the data.

DALL, WM.
1871. The food fishes of Alaska. Rep. U.S. Comm. Agric. 1870: 375-392.

Describes, briefly, the predominant food fishes of Alaska in 1870, with notes on the native fisheries and potential for commercial fisheries.

DICKINSON, WILLIAM R.
1973. Japanese fishing vessels off Alaska. Mar. Fish. Rev. 35(1-2): 6-18.

Describes the three types of trawlers, salmon and herring gillnetters, longliners, crab boats and whale catchers comprising the approximately 700 Japanese ships that fish annually off Alaska. The Japanese herring trawling industry, which fishes in the Bering Sea between the Pribilofs and St. Matthews Island, increased its catch from 3,000 metric tons in 1966-67 to 35,000 metric tons in 1971. In addition, a small herring gillnet fishery operates off the western coast of Alaska.

DUDNIK, YU. I., and E. A. USOL'TSEV.
1964. O sel'di vostochnoĭ chasti Beringova morya (The herrings of the eastern part of the Bering Sea). Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 49 (Izv. Tikhookean. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 51): 225-229. In Russian. (Transl. by Israel Prog. Sci. Transl., 1968, p. 236-240 in P. A. Moiseev (ed.), Soviet fisheries investigations in the northeast Pacific, Pt. 2, avail. Natl. Tech. Inf. Serv., Springfield, Va. as TT 67-51204.)

The distribution, behavior, age and size composition of herring in winter fishing grounds in the eastern Bering Sea during 1959-62 are discussed. Some notes on feeding and migration are included. Contains a figure showing the distribution of herring at different times of the year.

EVERMANN, BARTON WARREN.
1912-1914. Alaska fisheries and fur industries in /1911-1913/. U.S. Dep. Commer., Bur. Fish., App. to Rep. U.S. Comm. Fish. /1911-1913/, (Doc. No.'s 766, 780, 797). Various pagination.

For annotation, see Bower (1919-1941).

FACULTY OF FISHERIES, HOKKAIDO UNIVERSITY.
1957a. 1955 cruise of the "Oshoro Maru" to the Bering Sea and northern North Pacific (NORPAC Project). 15. Data on fish larvae collected with fish larva net. Data Rec. Oceanogr. Obs. Explor. Fish. 1: 112-115.

Table 26 lists fish larvae collected by station position, date, time, species, and number of specimens.

1957b. 1956 cruise of the "Oshoro Maru" to the Bering Sea. 14. Data on fish larvae collected with fish larva net. Data Rec. Oceanogr. Obs. Explor. Fish. 1: 204-207.

Table 10 lists fish larvae collected by station position, date and time, species, and number of specimens at a number of stations.

1958. 1957 cruise of the "Oshoro Maru" to Aleutian waters. 15. Data on fish larvae collected with fish larva net. Data Rec. Oceanogr. Obs. Explor. Fish. 2: 70-74.

Table 10 lists fish larvae collected by station position, date and time, species, and number of specimens for a number of stations in the central and western Bering Sea.

1959. The "Oshoro Maru" Cruise 42 to the Bering Sea in May-July 1958 (IGY Programme). 12. Data on fish larvae collected with fish larva net. Data Rec. Oceanogr. Obs. Explor. Fish. 3: 122-127.

Table lists fish larvae collected by station position, date and time, species, number of individuals, and range of total length for a number of stations in the central and western Bering Sea.

1960. The "Oshoro Maru" Cruise 44 to the Bering Sea in June-July, 1959. 12. Data on fish larvae collected with a fish larva net. Data Rec. Oceanogr. Obs. Explor. Fish. 4: 80-86.

Table lists fish larvae collected by station position, date and time, species, number of specimens, and range of total length at a number of stations.

1961a. The "Oshoro Maru" Cruise 46 to the Bering Sea and North Pacific in June-August 1960. 17. Data on fish larvae collected with a larva net. Data Rec. Oceanogr. Obs. Explor. Fish. 5: 202-207.

Table shows specimens of fish larvae from mixed plankton samples collected by larva net hauls. Data include date, geographic position, time, number of larvae, and range of total length.

FACULTY OF FISHERIES, HOKKAIDO UNIVERSITY.

1961b. The "Oshoro Maru" Cruise 46 to the Bering Sea and North Pacific in June-August 1960. 18. Data on fish larvae collected with an underway plankton catcher V. Data Rec. Oceanogr. Obs. Explor. Fish. 5: 208-213.

Table gives scientific names of fish larvae found in mixed plankton samples collected during high speed tows with an underway plankton catcher V. For those tows yielding larvae, data include genus or species, date, geographic position; tows with no fish larvae also are noted.

1964. The "Oshoro Maru" Cruise 4 to the Bering Sea and northwestern North Pacific in May-July 1963. 6. Data on fish larvae collected with a larva net and a small planned Isaacs-Kidd midwater trawl net in the Bering Sea. Data Rec. Oceanogr. Obs. Explor. Fish. 8: 257-260.

Tables 21-22 list fish larvae collected at a number of stations in the Bering Sea by station position, date, species or family, number of specimens and range of total length.

1967a. The "Oshoro Maru" Cruise 19 to the northern North Pacific and Bering Sea in June-August 1966. 8. Data on fish larvae collected with a larva net. Data Rec. Oceanogr. Obs. Explor. Fish. 11: 219-226.

Table 7 lists fish larvae collected by station position, date, species, number of specimens per net, and ranges of total length.

1967b. The "Oshoro Maru" Cruise 19 to the northern North Pacific and Bering Sea in June-August 1966. 9. Data on salmon gillnet set. Data Rec. Oceanogr. Obs. Explor. Fish. 11: 226-233.

Tables list mesh sizes used and incidental catches, including salmon shark in the eastern Bering Sea.

1968. The "Oshoro Maru" Cruise 24 to the northern North Pacific and Bering Sea in June-August 1967. 10. Data on fish larvae collected by surface tow and midwater tow with the larva net. Data Rec. Oceanogr. Obs. Explor. Fish. 12: 375-382.

Tables 6-8 and 6-9 list fish larvae collected by station position, date, species, number of individuals, and range of length at a number of stations in the Bering Sea.

1969. The "Oshoro Maru" Cruise 28 to the northern North Pacific, Bering Sea and the Gulf of Alaska in June-August 1968. 15. Data of fish larvae collected with a larva net. Data Rec. Oceanogr. Obs. Explor. Fish. 13: 70-75.

Table 13 lists fish larvae collected by station position, date, species, number of specimens, range of total length, and mean length at a number of stations in the Bering Sea in June-August and five stations in the Gulf of Alaska in August.

1970a. The "Oshoro Maru" Cruise 28 to the northern North Pacific, Bering Sea and the Gulf of Alaska in June-August 1968. 16. Data on salmon gillnet set. Data Rec. Oceanogr. Obs. Explor. Fish. 13: 76-85.

Tables list net meshes used and include data on catches of herring and salmon shark in various meshes in the eastern Bering Sea.

FACULTY OF FISHERIES, HOKKAIDO UNIVERSITY.
1970b. The "Oshoro Maru" Cruise 28 to the northern North Pacific, Bering Sea and the Gulf of Alaska in June-August 1968. 18. Data on trawl fishing. Data Rec. Oceanogr. Obs. Explor. Fish. 13: 119-121.

Tables include catches of Pleurogrammus monopterygius and Mallotus catervarius in the Gulf of Alaska in July 1968.

1970c. The "Oshoro Maru" Cruise 32 to the North Pacific, Bering Sea and Bristol Bay in June-August 1969. 12. Data on fish larvae collected with a larva net. Data Rec. Oceanogr. Obs. Explor. Fish. 14: 68-73.

Table lists fish larvae collected by station position, date, species, number of specimens, range of total length, and average length for 48 stations.

1970d. The "Oshoro Maru" Cruise 32 to the North Pacific, Bering Sea and Bristol Bay in June-August 1969. 13. Data on salmon gillnet set. Data Rec. Oceanogr. Obs. Explor. Fish. 14: 74-81.

Table lists mesh sizes used and incidental catches, including Atka mackerel, sandfish, shark, and herring in the eastern Bering Sea.

1970e. The "Oshoro Maru" Cruise 32 to the northern North Pacific, Bering Sea and Bristol Bay in June-August 1969. 15. Data on trawl fishing. Data Rec. Oceanogr. Obs. Explor. Fish. 14: 116-119.

Includes, in Table 13, catch of herring in kg per trawl haul for 9 hauls in August 1969 at locations shown in Fig. 5.

1972. The "Oshoro Maru" Cruise 37 to the northern North Pacific, Bering Sea and the Gulf of Alaska in June-August 1970. 15. Data on trawl fishing. Data Rec. Oceanogr. Obs. Explor. Fish. 15: 85-89.

Table 13 includes catches of dogfish (Squalus acanthias) and capelin (Mallotus catervarius) in kg. per haul and Atka mackerel (Pleurogrammus monopterygius) in numbers of individuals captured in 15 trawl hauls in the Gulf of Alaska in June-August 1970.

*FAVORITE, FELIX, W. JAMES INGRAHAM, JR., and DONALD M. FISK.
1975. Environmental conditions near Portlock and Albatross Banks (Gulf of Alaska) May 1972. U.S. Dep. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., Northwest Fish. Center, Proc. Rep. 45 p.

Data presented are from a multidisciplinary cruise on the RV George B. Kelez in spring 1972 to the northern Gulf of Alaska. The locations of the catches of sand lance larvae, the second most dominant larval form in the catches (11.4%), are shown on a map.

FEDOROV, V. V.
1973a. Ikhtiofauna materikovogo sklona Beringova morya i nekotorye aspekty ee proiskhozhdeniya i formirovaniya (Ichthyofauna of the continental slope of the Bering Sea and some aspects of its origin and formation). Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 87: 3-41. In Russian. (Transl., 1975, 70 p., Dep. Environ, Fish. and Mar. Serv., Pac. Biol. Stn., Nanaimo, B.C., Transl. Ser. 3345.)

Catalogues 234 species of Bering Sea fishes into groups (ichthyocoenoses and biotopes) according to their predominant habitat (horizontal or vertical distribution). Discusses the zoogeographic origin of secondary deep water fishes, considering the morphology of the Bering Sea basin in the past.

1973b. Spisok ryb Beringova morya (A list of the Bering Sea fishes). Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 87: 42-71. In Russian.

Consists of a list, in taxonomic order, of 393 species of fishes of the Bering Sea and includes the Russian, English, and Japanese common names. No biological data are given.

FIEDLER, R. H.
1931-1932, 1934-1936, 1938-1941. Fishery industries of the United States [1929-1932, 1934-1939]. U.S. Dep. Commer., Bur. Fish., App. to Rep. U.S. Comm. Fish. [1930-1933, 1935-1940]. Various appendix numbers (Reports for 1934-1939 also issued as Admin. Rep. No's. 20, 24, 27, 32, 37, 41). Various pagination.

Each year various fisheries are reviewed, including catch data of Alaskan fisheries by districts as well as market values and poundage of fishery products. Data for herring, and occasionally smelt and dogfish, are included.

1942-1943, 1945. Fishery statistics of the United States [1939-1941]. U.S. Dep. Int., Fish Wildl. Serv., Stat. Dig. No's. 1, 4, 7. Various pagination.

See annotation above.

FIEDLER, R. H., JOHN RUEL MANNING, and F. F. JOHNSON.
1934. Fishery industries of the United States, 1933. App. 1, Rep. U.S. Comm. Fish. 1934 (1936): 1-237.

For annotation, see Anderson and Peterson (1952-1954).

FISCUS, CLIFFORD H., GARY A. BAINES, and FORD WILKE.
1964. Pelagic fur seal investigations, Alaska waters, 1962. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 475. 59 p.

Capelin was found to be the single most important food item in the stomach contents of the Alaskan fur seal in Unimak Pass and vicinity, comprising over 56% of the total food by volume in the three sub-areas studied. Squid and pollock ranked second and third in the diet. Herring, eulachon, Atka mackerel, and sand lance contributed to a lesser degree.

FISHERIES AGENCY OF JAPAN.
1974. Resources of yellowfin sole, rock sole, flathead sole, Pacific halibut, shrimps, Pacific herring, Pacific cod and turbot in the Bering Sea. Fisheries Agency of Japan. 21 p. In Japanese. (Transl. by Yoshiya Takahashi, 10 p., Int. North Pac. Fish. Comm. Doc. 1679.)

Includes the history of the Bering Sea herring fishery as well as graphs of herring catches by Japan, catches by Japan and the U.S.S.R. combined, and the catch per unit effort for 1960 to 1972.

FISHERY AGENCY OF JAPAN [sic.]
1975. Resources of rock sole, flathead sole, Pacific cod, turbot and Pacific herring in the Bering Sea. Fishery Agency of Japan. 8 p. In Japanese. (Transl. by Yoshiya Takahashi, 3 p., Int. North Pac. Fish. Comm. Doc. 1775.)

Includes the history of the Bering Sea herring fishery as well as a graph and table giving the catch, average stock density indices, and effective fishing effort for gill net and stern trawls in the years 1964 to 1974.

FRASER, C. McLEAN.
1922. The Pacific herring. Biol. Board Can., Contrib. Can. Biol. 1921(6): 103-111.

Contains observations on the uniformity of size among Pacific herring in schools, their movements in relation to food supply, gonad maturation, their behavior during spawning, and factors causing the mortality of eggs, larvae, and young.

GERSHANOVICH, DAVID E., NIKOLAI C. FADEEV, TATIYANA G. LIUBIMOVA, PETER A. MOISEEV, and VALERY V. NATAROV.
1974. Principal results of Soviet oceanographic investigations in the Bering Sea, Chapt. 11, p. 363-370. In: D. W. Hood and E. J. Kelley (eds.), Oceanography of the Bering Sea. Univ. Alaska, Inst. Mar. Sci., Occas. Publ. 2.

The geologic and hydrologic structure, circulation dynamics, and biomass distribution of marine fauna of the Bering Sea are summarized. A description of the currently exploited herring stocks--their seasonal distribution and concentrations--is included.

GILBERT, CHARLES H.
1895. The ichthyological collections of the steamer Albatross during the years 1890 and 1891. U.S. Comm. Fish and Fish., Part 19, Rep. Comm. 1893: 393-476.

Fish collected in the Bering Sea and the North Pacific during the summers of 1890 and 1891 are listed. Among species noted are herring, capelin, eulachon, rainbow smelt, sand lance, Atka mackerel, and sandfish.

GORBUNOVA, N. N.
1962. Razmnozhenie i razvitie ryb semeǐstva terpugovykh (Hexagrammidae). /Spawning and development of greenlings (Family Hexagrammidae)/. Akad. Nauk SSSR, Tr. Inst. Okeanol. 59: 118-182. In Russian. (Transl. p. 121-185 in 208 p. transl. of T.S. Rass (editor), "Greenlings: taxonomy, biology, interoceanic transplantation", translated by Israel Program Sci. Transl., for U.S. Dep. Int. and Natl. Sci. Found., 1970, avail. Natl. Tech. Inf. Serv., Springfield, Va. as TT 69-55097.)

Natural spawning of greenlings was studied in the Maritime Territory and Kamchatka, U.S.S.R. during 1949-1959. In addition, eggs of several species were incubated and their development observed in the laboratory. This paper describes the reproductive biology of each greenling species. It includes information on spawning biology, egg incubation, embryonic development, larval growth, and distribution.

GULLAND, J. A. (ed.).
1971. The fish resources of the oceans. Food Agric. Organ. U.N., FAO Fish. Tech. Pap. 97. 425 p.

Contains a very brief review of herring fisheries and state of the stocks in Alaska and British Columbia.

HANAMURA, NOBUHIKO.
1961. On the present status of the herring stocks of Canada and southeastern Alaska. Int. North Pac. Fish. Comm., Bull. 4: 63-85.

Reevaluation of the status of the herring stocks of British Columbia and southeastern Alaska by Hanamura of the Hokkaido Regional Fish Research Laboratory, Japan. On the basis of his calculations, the rate of exploitation of both Canadian and U.S. herring could be increased without adversely affecting recruitment.

HART, J. L.
1949. Report on the investigation of albacore (Thunnus alalunga): The lengths of albacore in the commercial catch. Fish. Res. Board Can., Biol. Stn., Nanaimo, B.C., Circ. 17: 19-20. (Processed.)

Length measurements of 4,210 albacore from commercial catches off British Columbia in 1948 showed two groups of lengths were most common. One group had lengths centering around 63 cm. and the second less abundant group was around 75 cm. Northern fishing grounds north of Cape St. James had the most abundant size group averaging larger than in the south.

HART, J. L.
1973. Pacific fishes of Canada. Fish. Res. Board Can., Bull. 180. 740 p.

This is essentially an identification manual with brief notes giving the description, life history, and distribution of each species. Literature references are included.

HITZ, CHARLES R., and ROBERT R. FRENCH.
1965. Occurrence of pomfret (Brama japonica) in the northeastern Pacific Ocean. U.S. Fish Wildl. Serv., Fish. Ind. Res. 3(1): 1-7.

Data compiled in gill net surveys from 1950 to 1962 and purse seine sets from 1956 to 1962 were analyzed. Results show that pomfret in the Gulf of Alaska were caught mainly during August and September at surface water temperatures from 11° to 14°C. The catches suggest that in certain areas pomfret may be present in commercially harvestable quantities. No pomfret were taken in the Bering Sea. Sampling areas and relative numbers of fish caught per gear set are drawn on maps.

HOLLAND, GILBERT A.
1957. Migration and growth of the dogfish shark, Squalus acanthias (Linnaeus), of the eastern North Pacific. Wash. Dep. Fish., Fish. Res. Papers 2(1): 43-59.

Commercial fishery recoveries of dogfish tagged off the coasts of Washington and Vancouver Island indicated a southward migration in fall and winter and a northward migration in spring and summer. Recoveries were made as far south as Baja California and as far north as Hecate Strait, B.C. One specimen was recovered off Honshu Island, Japan, a distance of about 4,700 nautical miles, more than 7 years after tagging. The author believes the data show evidence of an indigenous population of dogfish in Puget Sound and the Strait of Georgia and a migratory population off the Pacific Coast ranging at least from Baja California north and west to Japan. A table shows annual landings in pounds of dogfish livers in California, Oregon, Washington, British Columbia, and Alaska for 1937-1954.

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION.
1957-1975. Statistical Yearbook [1952-1972]. Vancouver, B.C. Pagination and authorship varies.

Presents annual tables of commercial fishery catches by Canada, Japan, United States and U.S.S.R. in North American waters by region and species in numbers and pounds. Includes statistics on the Alaskan herring industry and occasionally provides data on the Japanese herring catch in the Bering Sea. Table format and information provided vary somewhat through the years.

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION.

1961a. The exploitation, scientific investigation and management of herring (Clupea pallasi) on the Pacific coast of North America in relation to the abstention provisions of the North Pacific Fisheries Convention. Int. North Pac. Fish. Comm., Bull. 4. 100 p.

Consists of a collection of articles, (many of which had been previously issued as INPFC Documents) regarding the status of British Columbian and Alaskan herring stocks and whether they are eligible for abstention status under the North Pacific Fisheries Convention provisions. Articles are presented as a dialogue between the concerned parties; those applying to the Bering Sea or Gulf of Alaska are listed in this bibliography as International North Pacific Fisheries Commission 1961b-1961j.

1961b. Report of the United States of America concerning the management of certain North Pacific herring stocks with reference to Article III(1) (a) of the International Convention for the High Seas Fisheries of the North Pacific Ocean of 1952. Int. North Pac. Fish. Comm., Bull. 4: 14-20.

Information is presented for use in considering whether the North Pacific herring stocks qualify for continuing abstention under the three conditions specified in Article IV of the Convention. The first condition specifies that more intensive exploitation must not be likely to provide a substantial and sustained increase in yield. Population data and comparisons of yields at two levels of fishing intensity are presented to help satisfy this condition. The other two conditions: that the stock in question is already regulated by each exploiting party, and that the stock is undergoing continuing and extensive scientific study were also substantiated.

1961c. Variation of fishing effort in recent years, Alaska herring. Int. North Pac. Fish Comm., Bull. 4: 25-26.

A table shows the annual fishing effort statistics from 1929 to 1956 in response to a request by the INPFC for more information.

1961d. The relation between number of spawning herring and resulting recruitment. Int. North Pac. Fish. Comm., Bull. 4: 27-28.

The herring catch per ton-day in southeast Alaska from 1929 to 1953 is given as a crude estimate of abundance of the standing stocks.

1961e. Clarification of the difference in estimates of natural mortality rates used in the United States and Canadian reports on herring. Int. North Pac. Fish. Comm., Bull. 4: 31.

The natural mortality rate estimates used in the U.S. and Canadian reports on herring were stated to differ because 1) they pertain to different age groups, and 2) the natural mortality rate appears to be lower in southeastern Alaska, at least among the younger age groups.

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION.

1961f. Additional information regarding the United States reports on herring stocks. Int. North Pac. Fish. Comm., Bull. 4: 32-33. (Note: Tables in this paper replace those given in 1961b.)

The additional information consists of three tables: 1) Alaska herring catches for the years 1929-1957; 2) Alaska herring catch quotas for the years 1940-1958; and 3) the total catch from southeastern Alaska herring year classes. These tables were based on corrected catch figures and were intended to replace the appropriate tables in the original U.S. abstention report (Int. North Pac. Fish. Comm., 1961b).

1961g. Year class fluctuations in United States herring stocks. Int. North Pac. Fish. Comm., Bull. 4: 34-37.

A table of year class fluctuations from 1919 to 1957 shows the yearly contribution of herring in numbers of fish x 1000 in the catch in southeastern Alaska plus the total contribution of each year class.

1961h. Summary of the views of the Japanese national section on the qualifications for abstention of North American herring. Int. North Pac. Fish. Comm., Bull. 4: 45-48.

Views of the Japanese National Section on the Canadian and U.S. reports on qualification of the herring stocks for abstention (Int. North Pac. Fish. Comm., Bull. 4: 1-13; 1961b) are given. The Japanese contend that the herring stocks do not qualify for abstention since 1) an increased fishing effort would result in an increase in yield; and 2) an increase in catches would not result in a decrease in recruitment.

1961i. The status of exploitation of North American herring stocks. Int. North Pac. Fish. Comm., Bull. 4: 86-92.

Based on data previously submitted by the United States and Canada (Int. North Pac. Fish. Comm. Bull. 4: 1-13; and 1961b), the article expresses the views of Japan that the North American herring stocks do not meet the abstention requirements of the Convention.

1961j. Additional information on herring stocks of the United States. Int. North Pac. Fish. Comm., Bull. 4: 93-100.

Contains a reevaluation of the natural mortality rate of Alaskan herring stocks using an analysis of data from a series of tagging experiments conducted in southeastern Alaska in the 1930's.

INTERNATIONAL PACIFIC HALIBUT COMMISSION.

1964. Catch records of a trawl survey conducted by the International Pacific Halibut Commission between Unimak Pass and Cape Spencer, Alaska from May 1961 to April 1963. Rep. Int. Pac. Halibut Comm. 36. 524 p.

Demersal trawl catch records obtained at 1,560 stations between Unimak Island and Cape Spencer, Alaska, from May 1961 to April 1963 are summarized. Atka mackerel, capelin, sandfish, sand lance, and surf smelt are grouped with a large variety of other fish species as "miscellaneous roundfish". Dogfish are grouped with skates as "elasmobranchs", but the catch data for Pacific saury, herring, and eulachon are given individually.

JORDAN, DAVID STARR, and CHARLES HENRY GILBERT.
1899. The fishes of the Bering Sea. In David Starr Jordan (editor), The fur seals and fur-seal islands of the North Pacific Ocean, Part 3, p. 433-492. Gov. Print. Off., Washington, D.C.

Fish collections were made about Unalaska, Bogoslof Island, and off St. George and St. Paul Islands as part of the 1896 cruise of the Albatross. Notes include remarks about specimens obtained by various investigators from the vicinity of Kamchatka and the Kurile Islands and also from the Shelikof Straits.

KASAHARA, HIROSHI.
1964. Recent developments in the exploitation of bottomfishes in the Bering Sea and Gulf of Alaska. Chapt. 14 in his Fisheries resources of the North Pacific Ocean, Pt. 2, p. 137-149. H.R. MacMillan Lectures in Fisheries, Univ. B.C., Inst. Fish., Vancouver, B.C.

Includes brief notes on the Japanese herring fishery in the Bering Sea in 1961 and 1962.

KASHKINA, A. A.
1970. Letniĭ ikhtioplankton Beringova morya (Summer ichthyoplankton of the Bering Sea). Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 70 (Izv. Tikhookean. Nauchno-issled. Rybn. Khoz. Okeanogr. 72): 225-245. In Russian. (Transl. by Israel Program Sci. Transl., 1972, p. 225-247 in P. A. Moiseev (ed.), Soviet fisheries investigations in the northeastern Pacific, Pt. 5, avail. Natl. Tech. Inf. Serv., Springfield, Va., as TT 71-50127.)

The Soviet vessel Ogon collected material during a cruise in June and July 1962. The ichthyoplankton was found to contain eggs and larvae from 23 families. Larvae and fry of the sand lance, Ammodytes hexapterus, were caught at 13 stations. Data on these collections are included, as well as a map showing the locations sand lance larvae have been found by three different expeditions.

KENYON, KARL W.
1956. Food of fur seals taken on St. Paul Island, Alaska, 1954. J. Wildl. Manage. 20(2): 214-215.

Of the 50,239 immature male fur seals killed on St. Paul Island between June 26 and July 26, 1954, only 32 (or about 0.06%) contained food items in the stomachs. Sandfish, which had not previously been reported as a fur seal food item, comprised 94.2% by volume of the 27 stomach contents that were examined. Sea poacher, cod, and squid formed the remainder of the food items.

*KESSLER, DOYNE W., and GERALD M. REID.
1962. Studies of the summer herring fishery in southeastern Alaska, 1962. U.S. Fish Wildl. Serv., Biol. Lab., Auke Bay, Alaska, Manuscr. Rep. 1962, MR 62-12. 6 p. (Processed.)

No fishing for reduction purposes was done in Prince William Sound or Kodiak waters in 1962, but data were taken from catch samples in southeastern Alaska. Data include geographic distribution of catch, age composition, and total catch by weekly periods.

KETCHEN, K. S.
1972. Size at maturity, fecundity, and embryonic growth of the spiny dogfish (*Squalus acanthias*) in British Columbia waters. J. Fish. Res. Board Canada. 29(12): 1717-1723.

Information on the maturity and reproduction of the spiny dogfish from the Pacific coast of Canada is compared with findings in other areas. Observations include maximum size, size at maturity, fecundity, and intrauterine growth rate.

KOBAYASHI, KIYU.
1961. Larvae and young of the sand-lance, *Ammodytes hexapterus* Pallas from the North Pacific. (In Japanese, English abstract.) Bull. Fac. Fish. Hokkaido Univ. 12(2): 111-120.

Larvae and young from 1,671 sand lance specimens collected from the northwestern Pacific Ocean, including the Okhotsk and Bering Seas are described. Data were compiled on fin rays, pigment distribution, myotome and vertebral number, body length composition, and number of larvae and young collected in the various locations in 1955-60.

KOLLOEN, LAWRENCE N.
1947. The decline and rehabilitation of the southeastern Alaska herring fishery. U. S. Fish Wildl. Serv., Fish. Leafl. 252. 13 p.

Overfishing and poor year class recruitment were felt responsible for the decline of the fishery in the late 1930's. A limitation of fishing and a series of successful year classes restored the stocks, but continued management was recommended to help prevent future declines.

KOLLOEN, L. N., and C. H. ELLING.
1948. Outlook for the Alaska herring fishery in 1948. U. S. Fish Wildl. Serv., Spec. Sci. Rep. 52. 23 p. + 2 figs.

Catch data (with year class composition) for Kodiak, southeastern Alaska, and Prince William Sound fisheries are presented. The 1948 catches were estimated on the basis of analyses of the data.

KOLLOEN, LAWRENCE N., and KEITH A. SMITH.
1953. Southeastern Alaska exploratory herring fishing operations, winter 1952/53. Commer. Fish. Rev. 15(11): 1-24.

The exploratory fishing vessel John N. Cobb found that, except at a few locations, herring were not abundant during the operational period of Nov. 4 to Dec. 19, 1952. In winter, the herring appeared to stay at much greater depths than in the summer, as indicated by echolocation surveys. Data include scope of explorations of Cobb and commercial vessels, notes on herring occurrence, length and weight, age, oil content, and winter and summer behavior.

LARKINS, HERBERT A.
1964. Some epipelagic fishes of the North Pacific Ocean, Bering Sea, and Gulf of Alaska. Trans. Am. Fish. Soc. 93(3): 286-290.

Incidental species caught by the salmon gill-netting explorations of the U. S. Bureau of Commercial Fisheries in the North Pacific Ocean, Bering Sea, and Gulf of Alaska from 1955 to 1961 are discussed. The numbers of each species taken in the total area and the frequency with which they were caught in each of the six sub-areas are presented in tables.

LeBRASSEUR, R. J.
1964a. Stomach contents of blue shark (Prionace glauca L.) taken in the Gulf of Alaska. J. Fish. Res. Board Can. 21(4): 861-862.

Observations of stomach contents of 29 blue sharks caught in 2 gillnet sets made in July 1959 in the southeastern part of the Gulf of Alaska suggest that, when salmon are available, the blue shark may temporarily abandon its opportunistic habits and selectively feed on them. Food items are listed.

1964b. Data record, collections of fish taken in Isaacs-Kidd midwater trawl from northeastern Pacific Ocean 1958-59. Fish. Res. Board Can., Manuscr. Rep. Ser. (Oceanogr.-Limnol.) 175. 25 p.

Contains data from a series of Isaacs-Kidd midwater trawls that were undertaken by Canadian research vessels in 1958-59 to accompany the high seas exploratory salmon fishing investigation in an attempt to sample the larger forage organisms available to salmon. Fish species caught are listed by latitude and longitude, date, gear, depth caught, and length.

1970. Larval fish species collected in zooplankton samples from the northeastern Pacific Ocean, 1956-1959. Fish. Res. Board Can., Tech. Rep. 175. 47 p.

Species and geographic locations of ichthyoplankton samples taken off the British Columbia coast and in the Gulf of Alaska are listed. The incidence of fish larvae in samples within 100 miles of the coast was much greater than in the open ocean.

LEGGETT, WILLIAM C., and RICHARD R. WHITNEY.
1972. Water temperature and the migrations of American shad. U.S. Dep. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., Fish. Bull. 70(3): 659-670.

The peak of spawning runs of the American shad is correlated with water temperatures near 18.5°C. Migration patterns in the Atlantic and Pacific Oceans also appear to be temperature related. Although shad are not known to spawn north of the Fraser River, B.C., they do migrate into the Gulf of Alaska during summer months.

LIPANOV, V. G., and P. I. SHESTOPALOV.
1961. Beringovomorskaya sel'd' i perspektivy ee promysla (Bering Sea herring and its fishery prospects). Rybn. Khoz. 37(11): 45-47. In Russian. (Partial transl. by Milan A. Kravanja, 1962, Natl. Mar. Fish. Serv., Transl. Program, Washington, D. C.)

Exploratory herring fishery operations by the U.S.S.R. in the Bering Sea from January 1960 to April 1961 are described. Echosounding and test trawling were used to locate schools of wintering herring in the central and eastern regions. Trawling was found to be more advantageous than drift-net fishing, and large trawlers were proven to be more efficient than small ones.

LYLES, CHARLES H.
1965-1969. Fishery statistics of the United States [1963-1967]. U. S. Dep. Int., Fish Wildl. Serv., Stat. Dig. No's. 57, 58, 59, 60, 61. Various pagination.

For annotation, see Anderson and Peterson (1952-1954).

MACHIDORI, SEIJI, and SATORU NAKAMURA.
1971. Distribution and some biological informations of pomfret (Brama raii) in the northwestern North Pacific Ocean. Bull. Far Seas Fish. Res. Lab. 5: 131-145. In Japanese with English abstract.

Japanese salmon research vessels collected data on horizontal and vertical distributions, length, age, and stomach contents of pomfret in the northwestern North Pacific and Okhotsk and Bering Seas during 1968-1970. No pomfret were caught in the Okhotsk and Bering Seas.

MANZER, J. I.
1972. Length-weight relationship for pomfret. J. Fish. Res. Board Can. 29(7): 1079-1081.

Examines the length-weight relationship of 298 pomfret of 30-49 cm fork length (lower third of length range) caught in the Gulf of Alaska during 1956 and 1957.

MARINE FISHERIES REVIEW.
1976. USSR reports catch off U.S. Pacific coast. Mar. Fish. Rev. 38(3): 35.

The Soviet preliminary total for catch of Pacific herring in the eastern Bering Sea, January—August 1975, was 18,351 metric tons.

MARINE MAMMAL BIOLOGICAL LABORATORY.
1970. Fur seal investigations, 1968. U.S. Dep. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., Spec. Sci. Rep. Fish. 617. 125 p.

Approximately 85% of the stomach contents of pelagic fur seals captured off Alaska consisted of walleye pollock, squids, and Atka mackerel. Saury, sandfish, and sand lance were among the organisms making up the remainder of the diet. Maps show the capture locations of fur seals whose stomachs contained Atka mackerel and capelin.

MARSH, MILLARD C., and JOHN N. COBB.
1908-1911. The fisheries of Alaska in /1907-1910/. U.S. Bur. Fish., Rep. Comm. Fish. /1907-1910/, (also issued as Doc. No's. 632, 645, 730, 746). Various pagination.

For annotation, see Bower (1919-1941).

MEAD, GILES W., and RICHARD L. HAEDRICH.
1965. The distribution of the oceanic fish, Brama brama. Bull. Mus. Comp. Zool. Harvard Univ. 134(2): 29-67.

Although primarily an analysis of the distribution and seasonal migration of the Atlantic species, Brama brama, the paper discusses (p. 38-40) the seasonal distribution of Brama japonica found in the Gulf of Alaska for comparison. These observations are based on the incidental pomfret catches in the high seas salmon gill-net surveys that were summarized by Neave and Hanavan (1960) and Hitz and French (1965).

MOBERLY, STANLEY A.
1973. Age, sex and size composition of Pacific herring, Clupea pallasii, from southeastern Alaska during winter and spring, 1970-1971. Alaska Dep. Fish Game, Tech. Data Rep. 11. 20 p. (Processed.)

Describes the present fishery and gives a brief note on ongoing biological studies. Contains tables of age, size and sex composition of herring collected from various areas in southeastern Alaska and Yakutat during winter and spring, 1970-1971.

1974a. Age, sex and size composition of Pacific herring, (Clupea pallasii), from southeastern Alaska and Yakutat during winter and spring, 1971-1972. Alaska Dep. Fish Game, Tech. Data Rep. 15. 20 p. (Processed.)

The present fishery is described and brief notes are given on ongoing biological studies. Tables of age, size and sex composition of herring collected from various areas in southeastern Alaska (but not including Yakutat) during winter and spring 1971-1972 are included.

MOBERLY, STANLEY A.

1974b. Age, sex and size composition of Pacific herring, (Clupea pallasii), from southeastern Alaska during fall, winter and spring, 1972-1973. Alaska Dep. Fish Game, Tech. Data Rep. 16. 24 p. (Processed.)

The present fishery is described and brief notes about ongoing biological studies are given. Tables list age, size, and sex composition of herring collected from various areas in southeastern Alaska and Yakutat during fall, winter, and spring, 1972-1973.

1974c. Age, sex and size composition of Pacific herring, (Clupea pallasii), from southeastern Alaska during fall, winter and spring, 1973-1974. Alaska Dep. Fish Game, Tech. Data Rep. 18. 23 p. (Processed.)

The fishery is described and ongoing biological studies are briefly discussed. Tables list age, size, and sex composition of herring collected in various areas in southeastern Alaska during fall, winter, and spring, 1973-1974.

MOBERLY, STANLEY A., and R. E. THORNE.

1974. Assessment of southeastern Alaska herring stocks using hydroacoustical techniques 1970-71. Alaska Dep. Fish Game, Juneau, Inf. Leafl. 165. 24 p.

Hydroacoustical data on herring stocks were collected, including volumes and densities of herring schools encountered, population sizes were estimated in areas surveyed, and diel distribution was noted.

MOISEEV. P. A.

1965. Chto pokazali issledovaniya Beringova morya (What research in the Bering Sea has demonstrated). Dalryba, Tsentral'noe Byuro Tekhnicheskoĭ Informatsii, Vladivostok. 27 p. In Russian. (Prelim. transl. by U.S. Joint Publ. Res. Serv., 1966, avail. Natl. Mar. Fish. Serv., Office Int. Fish., Washington, D.C.)

This general review discusses bottom topography, oceanographic features, benthos distribution, fish species (demersal only, but includes grenadiers), and potential fisheries based on recent Soviet exploratory fishing expeditions.

1970. Nekotorye voprosy otsenki biologicheskikh resursov Mirovogo okeana v svete rezul'tatov rabot Beringovomorskoĭ ėkspeditsii (Some problems of estimating biological resources of the oceans in the light of the results of the Bering Sea Expedition). Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 70 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 72): 8-14. In Russian. (Transl. by Israel Program Sci. Transl., 1972, p. 1-6 in P. A. Moiseev (ed.), Soviet fisheries investigations in the northeastern Pacific, Part 5, avail. Natl. Tech. Inf. Serv., Springfield, Va., as TT 71-50127.)

The Bering Sea expedition of the Soviets during 1958-1961 examined the fishery resources, their distribution, biology, ecology, and behavior. Knowledge of the resources was considerably expanded, and commercial fisheries of the area were developed. Productivity of narrow shelf areas was found to be 5-6 times higher than that of broad shelves. This article makes general conclusions about productivity but does not discuss specific fisheries.

*MORSKI INSTYTUT RYBACKI W GDYNI.
1976. Activities of the Polish fishing fleet in the North East Pacific/INPFC statistical area for January-December 1975. Morski Instytut w Gdyni /Gdynia, Poland/. 156 tables.

Tables and figures show catches of various fish species by Polish stern trawlers from California to Alaska waters in 1975. Species include horse mackerel, herring, and Atka mackerel. Catches are arranged by area, trawler class, species, and month.

MUSIENKO, L. N.
1963. Ikhtioplankton Beringova morya (po materialam Beringovomorskom ėkspeditsii TINRO i VNIRO 1958-1959 gg.) /Ichthyoplankton of the Bering Sea (data of the Bering Sea Expedition of 1958-1959)/. Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 48 (Izv. Tikhookean. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 50): 239-269. In Russian. (Transl. by Israel Prog. Sci. Transl., 1968, p. 251-286 in P. A. Moiseev (ed.), Soviet fisheries investigations in the northeast Pacific, Pt. 1, avail. Natl. Tech. Inf. Serv., Springfield, Va. as TT 67-51203.)

The Soviet vessels Zhemchug and Alazeya collected samples during 1958 and 1959 with fish plankton nets mainly between lat 53° and 60°N and long 175-161°W. Data include information on egg and larval distribution, time and location of collection, biology, and description of development of species collected.

1970. Razmnozhenie i razvitie ryb Beringova morya (Reproduction and development of Bering Sea fishes). Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 70(Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 72): 166-224. In Russian. (Transl. by Israel Program Sci. Transl., 1972, p. 161-224 in P. A. Moiseev (ed.), Soviet fisheries investigations in the northeastern Pacific, Pt. 5, avail. Natl. Tech. Inf. Serv., Springfield, Va., as TT 71-50127.)

Information is given on the reproduction and development of fishes collected by the Soviet Bering Sea expedition and exploratory vessels. Notes on spawning and larvae of herring, rainbow smelt, capelin, eulachon, sandfish, sand lance, and Atka mackerel are included. Appendix tables give the spawning times by seasons, the conditions for spawning and development of eggs, and the characteristics of the eggs, larvae, and fry of some of the Bering Sea species.

NAGASAKI, F.
1961. The status of exploitation of North American herring stocks. Int. North Pac. Fish. Comm., Bull. 4: 38-44.

Data given in the herring abstention proposals submitted by Canada and the United States (Int. N. Pac. Fish. Comm., Bull. 4: 1-13; and 1961b) are reevaluated, expressing the Japanese views. The author feels that neither the British Columbia nor Alaskan herring stocks qualify for abstention.

NAKAYA, KAZUHIRO.
1971. Descriptive notes on a porbeagle, Lamna nasus, from Argentine waters, compared with the North Pacific salmon shark, Lamna ditropis. Bull. Fac. Fish. Hokkaido Univ. 21(4): 269-279.

Morphological descriptions are given for three North Pacific salmon sharks from the Okhotsk Sea and off Hokkaido, Japan, and four salmon shark jaws from the Bering Sea. A comparison is made with corresponding information on one Argentine porbeagle specimen. No information is shown for the Bering Sea specimens except total length, locality (lat. and long.) of catch, and type of gear.

NATIONAL MARINE FISHERIES SERVICE.
1971-1975a. Fishery statistics of the United States /1968-1972/. U.S. Dep. Commer., Natl. Mar. Fish. Serv., Stat. Dig. No's. 62, 63, 64, 65, 66. Various pagination.

For annotation, see Anderson and Peterson (1952-1954).

*1973-1975b. Alaska Region monthly narrative report, /Oct. 1973 to Sept.-Oct. 1975/. U.S. Dep. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., /Juneau, Alaska/. Various pagination.

Reports include a section on foreign fishing activities off Alaska, in which the numbers and kinds of vessels of each nationality are given, as well as the target species they are thought to be fishing.

NEAVE, FERRIS, and M. G. HANAVAN.
1960. Seasonal distribution of some epipelagic fishes in the Gulf of Alaska region. J. Fish. Res. Board Can. 17(2): 221-233.

Presents the summer distribution in the Gulf of Alaska of the salmon shark, Pacific salmon, steelhead, pomfret, blue shark, jack mackerel, and albacore as determined by the catch in surface gillnets in early, middle, and late summer of 1956 and 1957. Seasonal changes in range were found to correspond with surface water temperature changes.

NELSON, EDWARD W., with additional notes by TARLETON H. BEAN.
1887. Field notes on Alaskan fishes. In: Edward W. Nelson, Report upon natural history collections made in Alaska between the years 1877 and 1881. No. III, Arctic series of publications issued in connection with the Signal Service, U.S. Army, Pt. 3, p. 295-322. Gov. Print. Off., Washington, D.C.

Among species described is Osmerus dentex which was noted as abundant from Kotzebue Sound to the mouth of the Kuskoqwim in tide creeks and inner bays all along shore from about the 10th of September until November.

NORTH PACIFIC FUR SEAL COMMISSION.
1962. Report on investigations from 1958 to 1961. Presented to the North Pacific Fur Seal Commission by Standing Scientific Committee on 26 November 1962. 183 p.

Tables give the volume and percent frequency of food items in the stomachs of fur seals captured off California, Oregon, and various regions of Alaska. In Alaskan waters herring, capelin, pollock, and sand lance made up 93 and 92% of the stomach contents of pelagic fur seals in 1958 and 1960, respectively. Table 50 lists stomach contents in southeastern Alaska, Gulf of Alaska, and western Alaska during February-July 1958. Table 52 details contents in southeastern Alaska, Gulf of Alaska, western Alaska, and Bering Sea and Unimak Pass, March-August 1960.

1969. Report on investigations from 1964 to 1966. Washington, D.C. 161 p.

In July and August 1964, squids, herring, pollock, capelin, and deepsea smelt composed the majority of the food items in the stomachs of fur seals collected in the Bering Sea. Tables include one listing food items found in stomachs in the Bering Sea in summer and fall, 1964.

1971. Report on investigations in 1962-63. Washington, D.C. 96 p.

In 1962 and 1963 capelin, squid, pollock, Atka mackerel, and deepsea smelt made up the major food items found in the stomachs of fur seals captured off western Alaska and in the Bering Sea. Table 54 lists stomach contents in the Bering Sea, June-October 1962, and Table 55 details contents during July-September 1963.

1975. Report on investigations from 1967 through 1972. Washington, D.C. 212 p.

In Alaska in May to August 1968, the major food items of pelagic fur seals were walleye pollock (32%), squids (26%), Atka mackerel (14%), and Pacific sand lance (11%). Tables list food species taken in various areas including the Gulf of Alaska (spring and summer), western Alaska (summer), and Bering Sea (summer).

OKADA, SHUN, and KIYU KOBAYASHI.
1968. Hokuyo-gyorui-zusetsu (Colored illustrations of pelagic and bottomfishes in the Bering Sea). Hokuyo Sakemasu Shigen Chosa Kenkyukai and Nihon Suisan Shigen Hogo Kyokai, Tokyo. 179 p.

Basically a check list, it is limited to 81 pelagic and bottom fishes caught in drift nets and trawls on voyages of the Japanese research vessel <u>Oshoro Maru</u> in 1952-55 and 1963-65. Data are supplemented by information from Japanese and foreign literature. Lists scientific and common names (in Japanese, English and Russian), brief descriptions, some morphological and biological data, and distribution. Each species is shown in a color photograph.

OTSU, TAMIO, and RICHARD N. UCHIDA.
1963. Model of the migration of albacore in the North Pacific Ocean. U.S. Fish Wildl. Serv., Fish. Bull. 63(1): 33-44.

This study hypothesizes that there is a single albacore population in the North Pacific. Data are given on their movements; commercial sizes move predominantly from eastern Pacific toward Japan, but movements from spawning grounds up into the Gulf of Alaska are not shown.

PACIFIC FISHERMAN.
1948. Alaska's tuna surprise wanes. Pac. Fisherman 46(11): 34.

Brief news article describes the unusual occurrence of albacore in the vicinity of the Queen Charlotte Islands and their subsequent disappearance. While the tuna were in the area, however, nearly 400,000 lbs. of albacore were landed in Ketchikan where prices paid ranged from $520 to $550 per ton.

1958. Gulf of Alaska albacore taken by halibut schooners. Pac. Fisherman 56(10): 11.

The halibut schooners Sunset and Trinity brought several hundred pounds of long-fin tuna picked up on trolling lines in the Gulf of Alaska (location not given). The article notes that tuna taken earlier in Shelikof Strait were tentatively identified as bluefin.

PARIN, N. V.
1960. Areal saĭry (Cololabis saira Brev.--Scombresocidae, Pisces) i znachenie okeanograficheskikh faktorov dlya ee rasprostraneniya [Range of the saury (Cololabis saira Brev.--Scombresocidae, Pisces) and effects of oceanographic features on its distribution]. Dokl. Akad. Nauk. SSSR 130(3): 649-652. In Russian. (Transl. by Laurence Penny, 1962, avail. Natl. Mar. Fish. Serv., Lang. Serv. Div., Washington, D. C.)

The Pacific saury is a true pelagic species with an amphi-Pacific distribution. The author discusses the major feeding, spawning, and nursery grounds of the saury in the Pacific Ocean and characteristics of each. Spawning times, distribution of eggs and larvae in winter and summer, and water temperatures are included.

1968. Ikhtiofauna okeanskoĭ epipelagiali (Ichthiofauna of the epipelagic zone). Izdatel'stvo "Nauka", Moscow. 186 p. In Russian. (Transl. by Israel Prog. Sci. Transl., 1970, 206 p., avail. Natl. Tech. Inf. Serv., Springfield, Va. as TT 69-59020.)

The author considers this an attempt to condense existing information on the systematics, geographical distribution, ecology, and yield of the fishes that permanently or temporarily inhabit the upper horizons of the pelagic. Chapt. 6, (p. 71-110 of transl.), is a survey, according to families, of the geographical distribution of epipelagic fishes of the world ocean.

POWELL, DONALD E., DAYTON L. ALVERSON, and ROBERT LIVINGSTONE, JR.
1952. North Pacific albacore tuna exploration--1950. U.S. Fish Wildl. Serv., Fish. Leafl. 402. 56 p.

Exploratory fishing on the research vessel John N. Cobb continued a project begun in midsummer 1949 to study the range and commercial fishery prospects for tuna in the northeast Pacific. Two weeks were spent in Alaskan waters but no commercial quantities of albacore were found. Biological observations include length frequencies of tuna caught in 1950, food, and distribution as related to water temperature.

POWELL, DONALD E., and HENRY A. HILDEBRAND.
1950. Albacore tuna exploration in Alaskan and adjacent waters--1949. U.S. Fish Wildl. Serv., Fish. Leafl. 376. 33 p.

The R/V Oregon made an exploratory cruise to investigate the commercial range, abundance, and movements of albacore off the western coast of British Columbia and southeastern Alaska. Surface water temperatures were correlated with occurrence of albacore. Stomach analyses showed that the tuna fed almost solely on plankton and small fish.

POWELL, DONALD E., and ALVIN E. PETERSON.
1957. Experimental fishing to determine distribution of salmon in the North Pacific Ocean, 1955. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 205. 30 p.

Includes catch locations of pelagic species other than salmon caught incidentally on the exploratory salmon gillnetting operations of three research vessels in the Gulf of Alaska during the summer and early fall of 1955.

POWER, E. A.
1958-1963. Fishery statistics of the United States [1956-1961]. U.S. Dep. Int., Fish Wildl. Serv., Stat. Dig. No's. 43, 44, 49, 51, 53, 54. Various pagination.

For annotation, see Anderson and Peterson (1952-1954).

POWER, E. A., and C. H. LYLES.
1964. Fishery statistics of the United States 1962. U.S. Dep. Int., Fish Wildl. Serv., Stat. Dig. 56. 466 p.

Catch data of Alaskan fisheries by region and by gear are included as well as the market value and poundage of the fishery products. Data are given for herring.

PROKHOROV, V. G.
1968. O zimnem periode zhizni beringovomorskoĭ sel'di (Winter period of life of herring in the Bering Sea). Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 64: 329-337. In Russian. (Transl., 1970, 21 p., Fish. Res. Board Can., Transl. Ser. 1433.)

Investigations by Soviet scientists in the western Bering Sea in 1958-1965 and in the southeastern part in 1960-1963 resulted in the determination of areas of winter residence of herring. Dispersal and behavior of herring were measured hydroacoustically. Samples of fish from trawl catches were analyzed to determine age, fat content, and hemoglobin content of blood. Karaginskii and Pribilof Island populations were similar in yearly cycle and general biology but differed in their age at maturity, age composition, and temperature of their wintering grounds.

QUAST, JAY C.
1964. Occurrence of the Pacific bonito in coastal Alaskan waters. Copeia 1964(2): 448.

Pacific bonito specimens caught in Alaska in Clarence Strait and the Copper River delta during June 1963 extend the known range of this species 400 and 950 miles northward. At the time of capture, oceanic temperatures in the Gulf of Alaska were probably higher than usual.

RADOVICH, JOHN.
1961. Relationships of some marine organisms of the northeast Pacific to water temperatures particularly during 1957 through 1959. Calif. Dep. Fish Game, Fish Bull. 112. 62 p.

During a period of abnormally warm oceanic temperatures off the Pacific coast from 1957 to 1959, many marine species wandered north of their usual range. This article notes the unusual occurrences of fish, including the capture of a bluefin tuna near Kodiak Island, Alaska, in July 1958, and mentions a record of barracuda off Kodiak Island in 1937.

REEVES, J. E.
1972. Section 19. Groundfish of the Gulf of Alaska, p. 411-455. In Donald H. Rosenberg (ed.), A review of the oceanography and renewable resources of the northern Gulf of Alaska. Univ. Alaska, Fairbanks, Inst. Mar. Sci., IMS Rep. R72-23, Sea Grant Rep. 73-3.

The appendix (p. 448-451) contains a short review of the herring fishery in the Gulf of Alaska. It includes a table of the total herring catches in southeastern, central, and western Alaska for selected years from 1916 to 1941 and all years from 1960 to 1969.

REID, GERALD M.
*1962. Studies of the summer herring fishery in southeastern Alaska, 1961. U.S. Fish Wildl. Serv., Biol. Lab., Auke Bay, Alaska, Manuscr. Rep. MR 62-2. 9 p. (Processed.)

No fishing for reduction purposes was carried out in Prince William Sound or Kodiak in 1961, but data were taken from southeastern Alaska. These include catch by area and by 10-day period and age composition.

1971. Age composition, weight, length, and sex of herring, Clupea pallasii, used for reduction in Alaska, 1929-66. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 634. 25 p.

Sampling data from the reduction fisheries for herring, Clupea pallasii, in southeastern Alaska (1929-66), Prince William Sound (1937-58), and Kodiak (1936-59) are summarized. The data include the weight of the catches, the weight allowed by quota, and age composition, average weight, average length, and sex ratios. (Author's abstract).

REID, GERALD M.
1972. Alaska's fishery resources--the Pacific herring. U.S. Dep. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., Fish. Facts-2. 20 p.

Summarizes (in popular form) the history of the Alaskan herring fishery, the biology and life history of herring, and the nature of its population dynamics.

ROUNSEFELL, GEORGE A.
1930a. Contribution to the biology of the Pacific herring, Clupea pallasii, and the condition of the fishery in Alaska. Bull. U. S. Bur. Fish. 45: 227-320.

Discusses the history and condition of the fishery; contains information on racial studies and catch data analysis as well as descriptions of the size distribution, spawning habits, age, growth, and condition (fatness) of the herring of southeastern and central Alaska.

1930b. The existence and causes of dominant year classes in the Alaska herring. Contrib. Mar. Biol., p. 260-270. Stanford Univ. Press, Calif.

The existence of dominant year classes in Prince William Sound, Alaska, is demonstrated for the years 1924 to 1929. Year class strength is the reflection of the spawning success which was found to have a high correlation with the averages of the mean monthly temperatures in March to June. This correlation was suggested to be associated with food supply or predation.

1931. Fluctuations in the supply of herring (Clupea pallasii) in southeastern Alaska. Bull. U.S. Bur. Fish. 47(Bull. 2 issued July 15, 1931): 15-56.

Contains an analysis of catch records from 1926 to 1929, with a discussion of the reasons for fluctuations in supply and a list of recommendations for fishery regulation.

*1934. Report on scientific activities of the U.S. Bureau of Fisheries in Alaska and the Pacific Northwest. Unpubl. manuscript, report to Daniel C. Roper, Sec. Commerce, avail. Natl. Mar. Fish. Serv., Northwest Fish. Center Library, Seattle, Wash. 52 p. (Typescript.)

Report includes the status of the herring investigations in Alaska in 1934. Describes the utilization of herring, the localization of the fishing grounds, the life history of herring, the difference between races, the variation in abundance from year to year, and the studies being conducted to determine the mortality rate. Much of the information may have been included in Rounsefell and Dahlgren (1935).

ROUNSEFELL, GEORGE A., and EDWIN H. DAHLGREN.
1932. Fluctuations in the supply of herring, Clupea pallasii, in Prince William Sound, Alaska. Bull. U.S. Bur. Fish. 47(Bull. 9, issued May 12, 1932): 263-291.

The early history of the fishery, local populations, analysis of catch records from 1924 to 1930, seasonal changes in availability, weight composition, size and age composition, and recommendations for fishery regulation are presented.

1934. Occurrence of mackerel in Alaska. Copeia 1934(1): 42.

Record of a chub mackerel, Pneumatophorus diego, being taken in herring catches in Prince William Sound in July 1932 extended the known northern limit of its range a thousand miles. In August of the same year many mackerel were caught in the Dall Head salmon trap in southeast Alaska.

1935. Races of herring, Clupea pallasii, in southeastern Alaska. Bull. U.S. Bur. Fish. 48: 119-141.

Studies were conducted to differentiate herring races in southeast Alaska by means of spawning and feeding grounds, analysis of vertebral counts, growth rates, and tagging.

ROYCE, WILLIAM F.
1963. First record of white shark (Carcharodon carcharias) from southeastern Alaska. Copeia 1963(1): 179.

A great white shark was found on a beach on the east coast of the Queen Charlotte Islands in October 1961, About this time another was found on the beach at Craig, Alaska (55°28'N, 133°08'W), and fishermen reported numerous sightings off Prince of Wales Island.

RUDOMILOV, O. I.
1972. Plodovitost' sel'di vostochnoĭ chasti Beringova morya (Fecundity of herring of the eastern part of the Bering Sea). Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 82: 321-332. In Russian, Engl. abstract.

Investigations on Russian research vessels in the Pribilof Island area in 1970 showed the absolute individual fecundity of female herring was 10.4 to 112.6 thousand eggs and averaged 46.2 thousand. Comparative fecundity was 130 to 385 eggs per gram of body weight (gutted). Egg diameters also are given. Absolute and comparative fecundities of Pribilof herring are compared to those of the Korfo-Karaginsk herring in the western Bering Sea.

RUMYANTSEV, A. I., and M. A. DARDA.
1970. Letnyaya sel'd' vostochnoĭ chasti Beringova morya (Summer herring in the eastern Bering Sea). Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 70 (Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 72): 402-432. In Russian. (Transl. by Israel Program Sci. Transl., 1972, p. 409-441 in P. A. Moiseev (ed.), Soviet fisheries investigations in the northeastern Pacific, Pt. 5, avail. Natl. Tech. Inf. Serv., Springfield, Va., as TT 71-50127.)

Investigations carried out by six USSR vessels in the summer of 1964 revealed the presence of herring throughout the eastern Bering Sea, but not in commercial quantities. The lack of high concentrations at this time was thought to be due to a scarcity of forage organisms. Studies on the age and size composition and growth rates suggest there is a mixture of herring populations in this area.

RUTENBERG, E. P.
1962. Obzor ryb semeĭstva terpugovykh (Hexagrammidae). (Survey of the fishes of family Hexagrammidae). Akad. Nauk SSSR, Tr. Inst. Okeanol. 59: 3-100. (Transl. p. 1-103 in 208 p. transl. of T. S. Rass (editor), "Greenlings: taxonomy, biology, inter-oceanic transplantation", translated by Israel Program Sci. Transl. for U.S. Dep. Int. and Natl. Sci. Found., 1970, avail. Natl. Tech. Inf. Serv., Springfield, Va. as TT 69-55097.)

Treats the systematics and morphological descriptions of the family Hexagrammidae as a whole and the individual genera and species. In addition, gives the distribution, biology, and economic importance of each species and discusses the geographical distribution of the greenlings throughout the world's oceans.

SANO, OSAMU.
1959a. Notes on the salmon shark as a predator of salmon (Oncorhynchus spp.) in the North Pacific Ocean. Hoku Sui Shi Geppo (Hokkaido Prefectural Fish. Res. Lab., Mon. Rep.) 16(2): 65-75. In Japanese. (Transl. by M.P. Miyake, 14 p., avail. Univ. Washington, Seattle, Fish. Res. Inst.)

Discusses the relationship between salmon shark and salmon, especially in the area around the Aleutian Islands. Feeding habits of the salmon shark are noted. Salmon were found in 70% of the stomach contents of the North Pacific sharks which were examined. Study of the migration patterns of the Aleutian salmon sharks and those of the central Kuril Islands seems to indicate that there are at least two separate populations and that the migrations of at least the Aleutian Island sharks appear to be related to food availability.

SANO, OSAMU.

1959b. The possible cause of diagonal slashes of the North Pacific salmon. Hoku Sui Shi Geppo (Hokkaido Prefectural Fish. Res. Lab., Mon. Rep.) 16(9): 348-350. In Japanese. (Transl. by Hack Chin Kim, 6 p., processed, 1959, avail. Northwest Fish. Center, NMFS, Seattle, Wash. as Transl. Ser. 27.)

Approximately 2 percent of Japanese salmon catches have diagonal body slashes. Examination of the mackerel sharks' stomach contents, mouth structure, and shape of slashes showed the marks may very possibly be caused by predatory attacks of the sharks. Localities not known.

1960. The investigation of salmon shark as a predator on salmon in the North Pacific, 1959. Bull. Hokkaido Reg. Fish. Res. Lab., No. 22: 68-82, pl. 1-2. In Japanese, Engl. abst. (Transl. by M. P. Miyake, 1961, 28 p., available Univ. Washington, Fish. Res. Inst., Seattle, Wash.)

Salmon sharks caught in gill nets during the 1959 salmon fishing season by 16 Japanese mothership fleets operating in the western Bering Sea and northwestern Pacific Ocean were studied. Information is given on location and abundance of shark catch, total lengths and body weights, stomach content analyses, and the proportion of injured salmon (from shark predation) found in offshore fisheries catches and river escapement.

1966. Predation of shark on salmon. (Abstract). Proc. 11th Pac. Sci. Congr., Tokyo, 7: 30.

Results of Japanese research during 1958-64 on predation of the salmon shark, Lamna ditropis, on salmon are summarized. Distribution of the shark is listed, and major food species in addition to salmon are mentioned.

SCAGEL, R. F.

1949a. Report on the investigation of albacore (Thunnus alalunga): General description of scouting operations and fishing experiments. Fish. Res. Board Can., Pac. Biol. Stn., Nanaimo, B.C., Circ. 17: 2-4 . (Processed.)

Exploratory fishing by Canadian scientists in 1948 resulted in the discovery of albacore in the Queen Charlotte Islands area. The occurrence was believed to possibly indicate that mass movements occur in the population or may be a response to changes in the Japan Current. Warm water of the Japan Current was encountered close to the edge of the continental shelf off Vancouver Island and the Washington coast.

1949b. Report on the investigation of albacore (Thunnus alalunga): Temperature conditions in relation to albacore occurrence and catches. Fish. Res. Board Can., Pac. Biol. Stn., Nanaimo, B.C., Circ. 17: 5-9. (Processed.)

Investigations in summer 1948 off the Queen Charlotte Islands showed the lowest water temperature at which albacore were caught was 56.8°F. and the highest was 63.0°F. Best fishing was at temperatures between 58°F. and 60°F. Total albacore catch was 513 fish. No water temperature over 60°F. was recorded close to Queen Charlotte Islands but such temperatures were found to the south.

SCATTERGOOD, LESLIE W., CARL J. SINDERMANN, and B. E. SKUD.
1959. Spawning of North American herring. Trans. Am. Fish. Soc. 88(3): 164-168.

Compares the spawning of the North American herring on the Atlantic vs. Pacific coasts with respect to season, time of spawning and water temperatures at spawning. Pacific coast data are grouped according to state, with Alaska divided into two regions: 1) southeastern Alaska and 2) central and western Alaska.

SCHEFFER, VICTOR B.
1940. Two recent records of *Zaprora silenus* Jordan from the Aleutian Islands. Copeia 1940(3): 203.

In 1938, only 13 specimens of the prowfish *Zaprora silenus* were known to science. Two additional specimens, caught in the Aleutian Islands in 1937 were subsequently identified, one of which was an immature fish found in close association with a large orange jellyfish.

1959. Invertebrates and fishes collected in the Aleutians, 1936-38. *In* Olas J. Murie, Fauna of the Aleutian Islands and Alaska Peninsula. U.S. Fish Wildl. Serv., North Am. Fauna 61: 365-406.

Marine algae, fish, and marine, freshwater and land invertebrates that live on the shores and slopes of the Aleutian Islands and in the surrounding seas are discussed from observations made in 1936-38.

SCHULTZ, LEONARD P.
1934. *Zaprora silenus* Jordan from Alaska. Copeia 1934(2): 98.

The date, method, and location of capture of each of eight prowfish (*Zaprora silenus*) specimens are given. All were collected in 1931; one at Akutan Island in the Aleutian Islands, and seven in the vicinity of Kodiak Island (previously known western limit of the fishes' range).

SHABONEEV, I. E.
1965. O biologii i promysle sel'di vostochnoĭ chasti Beringova morya (Biology and fishing of herring in the eastern part of the Bering Sea). Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 58(Izv. Tikhookean. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 53): 139-154. In Russian. (Transl. by Israel Prog. Sci. Transl., 1968, p. 130-146 *in* P. A. Moiseev (ed.), Soviet fisheries investigations in the northeast Pacific, Pt. 4, avail. Natl. Tech. Inf. Serv., Springfield, Va. as TT 67-51206.)

Russian exploratory fishing vessels found commercial quantities of herring in the eastern Bering Sea during 1957-1963. This paper analyzes results of research, primarily during winter, by the vessels *Alatyr* and *Alazeya* in 1961-1963. Data include those on distribution and behavior of herring on wintering grounds, maturation, size and age composition, growth rate, evaluation of resources by echo-sounding surveys, and catches.

SHIMAZU, TAKESHI.
1975. A description of the adult of Nybelinia surmenicola with discussions on its life history (Cestoda: Trypanorhyncha: Tentaculariidae). Bull. Jap. Soc. Sci. Fish. 41(8): 823-830. In Japanese, with Engl. abstract.

The final stage of the cestode, Nybelinia surmenicola, has been found in the stomach of the salmon shark, Lamna ditropis, taken from the Bering Sea. Intermediate forms of the cestode have been found in euphausiids, squid, walleye pollock, and sockeye salmon.

SHUNTOV, V. P.
1963. Osobennosti raspredeleniya ikhtiofauny v yugovostochnoĭ chasti Beringova morya (Peculiarities of ichthyofauna distribution in the southeastern Bering Sea). Zool. Zh. 42(5): 704-715. In Russian. (Transl. by Joint Publ. Res. Serv., 1963, avail. Natl. Tech. Inf. Serv., Springfield, Va., as JPRS 20623, OTS 63-31519.)

Fish distribution in the southeastern Bering Sea is described from observations made during the Far Eastern Long-Range Survey of the Pacific Research Institute of Marine Fisheries and Oceanography (TINRO) during Sept.-Oct. 1959 and April-Oct. 1960. Distribution of various species is noted with respect to depth, temperature, and the influence of currents. Salinity, oxygen content, bottom type, and food abundance are also discussed.

SKUD, BERNARD EINAR.
1959. Herring spawning surveys in southeastern Alaska. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 321. 16 p.

Aerial surveys were used as a means of assessing the extent of herring spawning. Maps of spawning areas were prepared from surveys, and information is given on the time of spawning and physical characteristics of the beaches.

1963. Herring tagging experiments in southeastern Alaska. U.S. Fish Wildl. Serv., Fish. Bull. 63(1): 19-32.

Results of 1934-37 experiments indicated extensive movement and intermingling between Sitka and Craig stocks. Both migration extent and total mortality appeared to increase with the age of the fish.

SKUD, BERNARD E., HENRY M. SAKUDA, and GERALD M. REID.
1960. Statistics of the Alaska herring fishery, 1878-1956. U.S. Fish Wildl. Serv., Stat. Dig. 48. 21 p.

Contains maps of the statistical areas for each of the three major fishing districts in Alaska (Southeastern, Prince William Sound, and Kodiak). Tables give the tonnage of herring catch by statistical area for each district (1929 to 1956 for Southeast Alaska; 1937 to 1956 for Prince William Sound and Kodiak). Production statistics for 1878 to 1956, and operating units and persons engaged in fishery 1906-1956 are also shown.

SMITH, HUGH M.
1896. A review of the history and results of the attempts to acclimatize fish and other water animals in the Pacific States. Bull. U.S. Fish Comm. 15: 379-472, pls. 73-83.

Contains (p. 404-427) a historical account of the introduction of the shad in the Sacramento and Columbia Rivers and of its subsequent dissemination along the Pacific Coast from Los Angeles County, California to Wrangell Island, Alaska. Includes remarks on the modification of the behavior of shad by the new environmental conditions, as well as notes on its migrations and movements, spawning, abundance, length and weight, feeding habits, and information on the west coast shad fisheries.

SOKOLOVSKII, A. S.
1969. K voprosu o stadakh saĭry v Tikhom okeane (Stocks of saury in the Pacific Ocean). Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 69: 203-208. In Russian. (Transl., 1971, 12 p., Fish. Res. Board Can., Mar. Ecol. Lab., Dartmouth, N.S., Transl. Ser. 1614.)

Pacific saury are classified into three populations--Asian, Aleutian, and American--on the basis of differences in morphometry, parasites, and biological characteristics (fecundity, spawning temperature) found in data collected by Soviet vessels in 1965-67.

*STRATY, RICHARD R., and HERBERT W. JAENICKE.
1971. Studies of the estuarine and early marine life of sockeye salmon in Bristol Bay, 1965-67. U.S. Dep. Commer., Natl. Mar. Fish. Serv., Biol. Lab., Auke Bay, Alaska, Manuscr. Rep.--File, MR-F 83. 137 p. (Typescript.)

Lists numbers of sand lance, rainbow smelt, and herring caught in Bristol Bay by seine and tow net from June 6 to Sept. 5, 1966, and numbers of sand lance and rainbow smelt caught by lampara net from June 14 to Aug. 14, 1967. Also has data on sand lance found in the stomach contents of juvenile sockeye and silver salmon.

SVETOVIDOV, A. N.
1949. O nekotorykh biologicheskikh osobennostyakh Tikhookeanskoĭ sel'di i o prichinakh, ikh obuslovivshikh (Biological features of the Pacific herrings and the factors causing them). Izv. Tikhookean. Nauchno-issled. Inst. Rybn. Khoz. Okeanogr. 31: 59-64. In Russian. (Transl. by Kr. Fred. Wiborg avail. Natl. Mar. Fish. Serv., Lang. Serv. Div., Washington, D.C.)

Compares behavior and biological features of Atlantic and Pacific herring, principally those concerning reproduction, including time of spawning, relation of water temperature and salinity to spawning, spawning depths and substrates, morphological characteristics. Reasons for observed differences are given.

SVETOVIDOV, A. N.
1952. Sel'devye (Clupeidae) /The herrings (Clupeidae)/. Akad. Nauk SSSR, Zool. Inst., Fauna SSSR, Ryby, 2(1), N.S. 48. 331 p. In Russian. (Transl. by Israel Program Sci. Transl. for U.S. Natl. Sci. Found. and Smithsonian Inst., 1963, 428 p., avail. Natl. Tech. Inf. Serv., Springfield, Va. as OTS 61-11435.)

The herring family, treated as a whole, is discussed in the first section in relation to the history of its classification, taxonomy and principles of classification, geographic distribution, biology, and economic importance. In the second section, a review of each species is given, arranged according to the preceding topics. Pacific herring stocks and their biological features in Asian and American waters are compared.

TAKAHASHI, TOYOMI, and MITUO KONDA.
1974. On the age composition and the hourly changes of the catch of the herring by the trawl net in the northwestern sea area of the Pribilof Islands in the 1971/1972 winter. Bull. Fac. Fish. Hokkaido Univ. 25(1): 47-54. In Japanese, Engl. abst.

During the herring trawling operations in winter 1971/1972 in an area northwest of the Pribilofs, 6,650 herring were obtained for analysis. Hourly changes in the catch rate indicated a peak in fishing efficiency around noon, after which, the herring were thought to leave the bottom to feed. The age five and nine fish, which were spawned in warm years, dominated the catches, and 4-year-olds (spawned in a cold year) were few in number.

TANNER, Z. L.
1890. Explorations of the fishing grounds of Alaska, Washington Territory, and Oregon, during 1888, by the U.S. Fish Commission steamer Albatross, Lieut. Comdr. Z. L. Tanner, U.S. Navy, Commanding. Bull. U.S. Fish Comm. 8: 1-95.

Includes an account of the first systematic assessment of the fishing grounds from Unalaska Island to Prince William Sound, July 19 to Aug. 27, 1888. The state of the existing fisheries is reviewed, in addition to notes on exploratory fishing, hydrography and navigation.

TAYLOR, F. H. C.
1967. Midwater trawl catches from Queen Charlotte Sound and the open ocean adjacent to the Queen Charlotte Islands. Fish. Res. Board Can., Tech. Rep. 11. 44 p.

The Canadian research vessel G. B. Reed conducted three cruises in Queen Charlotte Sound and off the west coast of the Queen Charlotte Islands (including the Bowie Seamount in the Gulf of Alaska) during 1964 and 1965. The report lists data on fish collected by midwater trawls by species, geographic area, date, bottom type, depth and other information.

TAYLOR, F. H. C., M. FUJINAGA, and FORD WILKE.
1955. Distribution and food habits of the fur seals of the North Pacific Ocean: Report of cooperative investigations by the Governments of Canada, Japan, and the United States of America, February-July 1952. U.S. Dep. Int., Fish Wildl. Serv., Washington, D.C. 86 p.

Stomach contents of 116 fur seals collected in the Gulf of Alaska from February 14 to July 3, 1952 were analyzed. Capelin made up more than 90% of the food; hake, squid, sand lance, and unidentified fish composed the remainder.

TESTER, ALBERT L.
1944. Echo sounding for summer herring. Fish. Res. Board Can., Prog. Rep. Pac. Coast Stn. 61: 17-20.

Echosounding surveys for herring were conducted from the Canadian vessel A. P. Knight in southeastern Alaska and along the British Columbia coast during June and July, 1944. No extensive concentrations of herring schools were recorded in southeastern Alaskan waters, only indications of small individual schools and faint echo markings which were interpreted as representing dispersed herring.

1946. Comparison of the Atlantic and Pacific herring and herring fisheries. Fish. Res. Board Can., Prog. Rep. Pac. Coast Stn. 66: 4-8.

The similarities and differences between the two species (*Clupea harengus* and *Clupea pallasii*), including lengths of fish, racial characters, spawning, egg size, availability and fishing methods, handling and processing, and size of catch, are reviewed.

THOMPSON, SETON H.
1950-1957. Alaska fishery and fur-seal industries: [1947-1955]. U.S. Dep. Int., Fish Wildl. Serv., Stat. Dig. No's. 20, 23, 26, 31, 33, 35, 37, 40. Various pagination.

For annotation, see Bower (1919-1941).

THOMPSON, SETON H., and DONALD W. ERICKSON.
1960. Alaska fishery and fur-seal industries: 1956. U.S. Fish Wildl. Serv., Stat. Dig. 45. 88 p.

For annotation, see Bower (1919-1941).

*TRUMBLE, ROBERT JASPER.
1973. Distribution, relative abundance, and general biology of selected underutilized fishery resources of the eastern North Pacific Ocean. M. S. Thesis, Univ. Washington, Seattle, Wash. 178 p.

Reviews the available literature on a number of underexploited resources of the northeast Pacific, including capelin, jack mackerel, mesopelagic species, pomfret, sand lance, and saury. Also discusses the procedure and problems of assessing stock size from fishing surveys, echo sounding, egg and larvae studies, and predator stomach content analyses.

TURNER, L. M.
1886. Researches in Alaska, pt. IV. Fishes. In his: Contributions to the natural history of Alaska: Results of investigations made chiefly in the Yukon district and the Aleutian Islands; conducted under the auspices of the Signal Service, U.S. Army, extending from May, 1874, to August, 1881, p. 87-113. No. II, Arctic Series of Publs. issued in connection with the Signal Service, U.S. Army. Gov. Print. Off., Washington, D.C.

Contains annotated notes on a collection of 47 species of fish made by Turner during his service in Alaska in 1874-1881, as well as information on fish biology, behavior, and native fishing methods that he observed.

VAN CLEVE, RICHARD, and W. F. THOMPSON.
1938. A record of the pomfret and barracuda from Alaska. Copeia 1938(1): 45-46.

During September 1937, one specimen each of barracuda (Sphyraena argentea) and pomfret (Brama raii) were taken in a salmon trap at Cape Uyak (57°38'N, 145°21'W) off Kodiak Island. This represented a northern extension of the known range of both species. In addition, 70 pomfret were reported taken by a cod-fishing schooner 100-600 miles east of Unimak Pass in 1937.

VANYAEV, N. A.
1963. Predislovie (Forword). Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 48 (Izv. Tikhookean. Nauchno-issled. Inst. Morsk. Rybn. Khoz. Okeanogr. 50): 5-6. In Russian. (Transl. by Israel Program Sci. Transl., 1968, p. v-vi in P. A. Moiseev (ed.), Soviet fisheries investigations in the northeast Pacific, Pt. 1, avail. Natl. Tech. Inf. Serv., Springfield, Va. as TT 67-51203.)

Various fish and shellfish resources, including Pacific herring, currently being exploited in the Bering Sea by the Soviets, and their relative commercial importance, are mentioned briefly.

WARNER, IRVING M.
1976. Annual report, Outer Continental Shelf Assessment Project: Herring spawning survey - southern Bering Sea. In: Environmental assessment of the Alaskan continental shelf, Vol. 6, Fish, plankton, benthos, littoral: Principal Investigator's reports for the year ending March 1976, p. 1-15. Natl. Oceanic Atmos. Admin., Environ. Res. Lab., Boulder, Colo.

Unpublished sources of observations about herring, smelt, and capelin local fisheries or spawning along the north side of the Alaska Peninsula, Unalaska Island, Bristol Bay, Norton Sound and Arctic areas are cited.

WELANDER, ARTHUR D.
1940. Notes on the dissemination of shad, Alosa sapidissima (Wilson), along the Pacific coast of North America. Copeia 1940(4): 221-223.

The dissemination of the shad along the Pacific coast from its introduction into the Sacramento River, California in 1871 southward to off San Diego, California, by 1916 and northward and westward to Kodiak Island by 1926 (another sample was taken at the latter in 1937) is reviewed briefly.

WILIMOVSKY, NORMAN J.

1954. List of the fishes of Alaska. Stanford Ichthyol. Bull. 4(5): 279-294.

Consists of a list, in taxonomic order, of 379 species known to occur in Alaskan waters. Brief statements about ranges of distribution are included.

1964. Inshore fish fauna of the Aleutian archipelago. Science in Alaska, 1963, Proc. 14th Alaska Sci. Conf.: 172-190. Alaska Div., Am. Assoc. Advance Sci.

The distribution of fish found in the intertidal area of the Aleutian Islands is listed by species and by island group. The Aleutian inshore environment is described briefly and the relationships and origins of the fauna found there are discussed.

1974. Fishes of the Bering Sea: the state of existing knowledge and requirements for future effective effort, Chapt. 11, p. 243-256. In: D. W. Hood and E. J. Kelley (eds.), Oceanography of the Bering Sea. Univ. Alaska, Inst. Mar. Sci., Occas. Publ. 2.

Most of the knowledge of the approximately 300 species of fishes of the Bering Sea is limited to forms exploited commercially. This paper has a brief historical review of sources of knowledge of fishes of this area, the origins of the fish fauna, and numerical distribution by family. No specific data are given on species. The author concludes there is an overriding need for gathering together available information into a synthesized form.

WILKE, FORD, and KARL W. KENYON.

1954. Migration and food of the northern fur seal. Trans. 19th North Am. Wildl. Conf.: 430-440.

Summarizes the data on pelagic fur seal migration and stomach contents from 1896 to 1954. Cod and squid appeared to comprise the greater part of the diet in the Bering Sea; squid, rockfish, eulachon, capelin, whiting, hake, and salmon were found in Gulf of Alaska seals; and herring predominated in the diet of southeastern Alaska seals.

1957. The food of fur seals in the eastern Bering Sea. J. Wildl. Manage. 21(2): 237-238.

Capelin made up 52% by volume of the stomach contents of 117 fur seals collected pelagically in the Bering Sea in June-July 1955. Pollock and squid formed most of the remainder of the food items. Salmon, pollock, and sandfish comprised the food items found in three stomachs of fur seals killed on St. Paul Island.

WISNER, ROBERT L.

1959. Distribution and differentiation of the North Pacific myctophid fish *Tarletonbeania taylori*. Copeia 1959(1): 1-7.

Collections of *Tarletonbeania taylori* and *T. crenularis* from the northeastern Pacific were examined and meristic counts of each were compared. The studies indicate that the two species are geographically separated, the population in the Gulf of Alaska being predominantly *T. taylori*. Previous records of *T. crenularis* from the Gulf of Alaska may have actually been of *T. taylori*.

SUBJECT INDEX

sand lance, Pacific (continued)
- Clemens and Wilby, 1961
- Faculty of Fisheries, Hokkaido University, 1957a, 1957b, 1958, 1960, 1961a, 1961b, 1964, 1967a, 1968, 1969, 1970c
- Favorite, Ingraham, and Fisk, 1975
- Fedorov, 1973a, 1973b
- Gilbert, 1895
- Hart, 1973
- International Pacific Halibut Commission, 1964
- Jordan and Gilbert, 1899
- Kashkina, 1970
- Kobayashi, 1961
- LeBrasseur, 1964b, 1970
- Musienko, 1963, 1970
- Okada and Kobayashi, 1968
- Scheffer, 1959
- Shuntov, 1963
- Straty and Jaenicke, 1971
- Trumble, 1973
- Wilimovsky, 1954, 1964

as forage
- Bean, 1889
- Fiscus, Baines, and Wilke, 1964
- Marine Mammal Biological Laboratory, 1970
- North Pacific Fur Seal Commission, 1962, 1975
- Straty and Jaenicke, 1971
- Taylor, Fujinaga, and Wilke, 1955

sandfish, Pacific
- Baxter, 1975
- Clemens and Wilby, 1961
- Faculty of Fisheries, Hokkaido University, 1970d
- Fedorov, 1973a, 1973b
- Gilbert, 1895
- Hart, 1973
- International Pacific Halibut Commission, 1964
- Jordan and Gilbert, 1899
- Larkins, 1964
- Musienko, 1970
- Scheffer, 1959
- Shuntov, 1963
- Wilimovsky, 1954, 1964

as forage
- Kenyon, 1956
- Marine Mammal Biological Laboratory, 1970
- North Pacific Fur Seal Commission, 1962, 1975
- Wilke and Kenyon, 1957

Sarda chiliensis (see bonito, Pacific)

GEOGRAPHIC INDEX

Bering Sea (continued)
herring, Pacific
Andriyashev, 1937
Baxter, 1975
Chitwood, 1969
Dickinson, 1973
Dudnik and Usol'tsev, 1964
Faculty of Fisheries, Hokkaido University, 1970a, 1970d, 1970e
Fedorov, 1973a, 1973b
Fisheries Agency of Japan, 1974
Fishery Agency of Japan, 1975
Gershanovich et al., 1974
International North Pacific Fisheries Commission, 1957-1975, 1961a
Kasahara, 1964
Lipanov and Shestopalov, 1961
Marine Fisheries Review, 1976
Musienko, 1970
National Marine Fisheries Service, 1973-1975b
North Pacific Fur Seal Commission, 1962, 1969
Prokhorov, 1968
Rudomilov, 1972
Rumyantsev and Darda, 1970
Shaboneev, 1965
Shuntov, 1963
Straty and Jaenicke, 1971
Svetovidov, 1952
Takahashi and Konda, 1974
Vanyaev, 1963
Warner, 1976
lanternfish
Aron, 1958, 1959, 1960a, 1960b
Bekker, 1963b
Fedorov, 1973a, 1973b
North Pacific Fur Seal Commission, 1962
Shuntov, 1963
mackerel, Atka
Andriyashev, 1937
Faculty of Fisheries, Hokkaido University, 1957a, 1959, 1964, 1967a, 1968, 1969, 1970c, 1970d
Fedorov, 1973a, 1973b
Gorbunova, 1962
Marine Mammal Biological Laboratory, 1970
Musienko, 1963, 1970
North Pacific Fur Seal Commission, 1962, 1971, 1975
Rutenberg, 1962
Shuntov, 1963
pelagic resources (general)
Baxter, 1975
Fedorov, 1973a, 1973b
Gershanovich et al., 1974
Moiseev, 1965, 1970
Wilimovsky, 1974

Bering Sea (continued)

- smelt, longfin
  - Fedorov, 1973b
- smelt, pond
  - Fedorov, 1973b
- smelt, rainbow
  - Andriyashev, 1937
  - Baxter, 1975
  - Fedorov, 1973a, 1973b
  - Musienko, 1970
  - Nelson and Bean, 1887
  - North Pacific Fur Seal Commission, 1962, 1975
  - Straty and Jaenicke, 1971
- smelt, surf
  - Fedorov, 1973b
  - Shuntov, 1963
- smelts, deep sea
  - Aron, 1958, 1960b
  - Fedorov, 1973b
  - Marine Mammal Biological Laboratory, 1970
  - North Pacific Fur Seal Commission, 1969, 1971, 1975

Bristol Bay

- Baxter, 1975
- Straty and Jaenicke, 1971
- Warner, 1976

Cook Inlet

- Bright, 1959, 1960

Gulf of Alaska

- albacore
  - Bethune, 1949
  - Hart, 1949
  - Neave and Hanavan, 1960
  - Otsu and Uchida, 1963
  - Pacific Fisherman, 1948, 1958
  - Partlo, 1955a, 1955b
  - Powell, 1950
  - Powell, Alverson, and Livingstone, 1952
  - Powell and Hildebrand, 1950
  - Scagel, 1949a, 1949b
- barracuda, Pacific
  - Radovich, 1961
  - Van Cleve and Thompson, 1938
- bonito, Pacific
  - Quast, 1964
- capelin
  - Aron, 1958, 1959, 1960b
  - Faculty of Fisheries, Hokkaido University, 1970b, 1972
  - North Pacific Fur Seal Commission, 1962, 1975
  - Taylor, Fujinaga, and Wilke, 1955
  - Wilke and Kenyon, 1954

Gulf of Alaska (continued)

mackerel, Atka
- Faculty of Fisheries, Hokkaido University, 1957a, 1970b, 1972
- Marine Mammal Biological Laboratory, 1970
- Morski Instytut Rybacki w Gdyni, 1976
- National Marine Fisheries Service, 1973-1975b
- North Pacific Fur Seal Commission, 1975

mackerel, chub
- Rounsefell and Dahlgren, 1934

mackerel, jack
- Morski Instytut Rybacki w Gdyni, 1976
- Neave and Hanavan, 1960
- Powell and Peterson, 1957

pomfret, Pacific
- Hitz and French, 1965
- Manzer, 1972
- Mead and Haedrich, 1965
- Neave and Hanavan, 1960
- Parin, 1968
- Pinckard, 1957
- Powell and Peterson, 1957
- Van Cleve and Thompson, 1938

prowfish
- Aron, 1958, 1960b
- LeBrasseur, 1964b, 1970
- Schultz, 1934

ragfish
- Powell and Peterson, 1957

sand lance, Pacific
- Aron, 1958, 1960b
- Faculty of Fisheries, Hokkaido University, 1957a, 1961a, 1961b, 1969
- LeBrasseur, 1964b, 1970
- North Pacific Fur Seal Commission, 1962, 1975
- Taylor, Fujinaga, and Wilke, 1955

sandfish, Pacific
- North Pacific Fur Seal Commission, 1962, 1975

saury, Pacific
- International Pacific Halibut Commission, 1964
- LeBrasseur, 1964b, 1970
- North Pacific Fur Seal Commission, 1975
- Parin, 1968

shad, American
- Leggett and Whitney, 1972
- Welander, 1940

shark, basking
- Parin, 1968

shark, blue
- LeBrasseur, 1964a
- Neave and Hanavan, 1960
- Parin, 1968

shark, Pacific sleeper
- Bright, 1959

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BISHOP, YVONNE, NEAL M. CARTER, DOROTHY GAILUS, W. E. RICKER, and J. MURRAY SPEIRS.
1957. Index and list of titles, Publications of the Fisheries Research Board of Canada, 1901-1954. Fish. Res. Board Can., Bull. 110. 209 p.

CARTER, NEAL M.
1968. Index and list of titles, Fisheries Research Board of Canada and associated publications, 1900-1964. Fish. Res. Board Can., Bull. 164. 649 p.

1973. Index and list of titles, Fisheries Research Board of Canada and associated publications, 1965-1972. Fish. Res. Board Can., Misc. Spec. Publ. 18. 588 p.

DAY, DWANE, and C. R. FORRESTER.
1971. A preliminary bibliography on the trawl fishery and groundfish of the Pacific coast of North America. Fish. Res. Board Can., Tech. Rep. 246. 91 p.

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1969. Fishery publication index, 1955-64; Publications of the Fish and Wildlife Service by series, authors and subjects. U.S. Fish Wildl. Serv., Circ. 296. 240 p.

GRIER, MARY C.
1941. Oceanography of the North Pacific Ocean, Bering Sea and Bering Strait: a contribution toward a bibliography. Univ. Washington, Seattle, Univ. Publ., Lib. Ser. 2. 290 p.

GRUCHY, I. M., and DON E. McALLISTER.
1972. A bibliography of the smelt family, Osmeridae. Fish. Res. Board Can., Tech. Rep. 368. 104 p.

HUGHES, STEVEN E.
1970. Annotated references on the Pacific saury, Cololabis saira. U.S. Dep. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., NOAA Tech. Rep. NMFS SSRF-606. 12 p.

MacDONALD, ROSE E.
1921. An analytical subject bibliography of the publications of the Bureau of Fisheries 1871-1920. Rep. U.S. Comm. Fish. 1920, App. 5. 306 p.

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1959. Ukazatel' literatury po rybnomu khozyaĭstvu Dal'nego Vostoka za 1923-1956 gg. (Annotated bibliography on Far Eastern aquatic fauna, flora and fisheries). Izd. Akademii Nauk SSSR, Moscow. 290 p. In Russian. (Transl. by Israel Program Sci. Transl., 1966, 391 p., avail. Natl. Tech. Inf. Serv., Springfield, Va., as TT 64-11101.)

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QUARTERLY REPORT

Contract #
Research Units 78/79
Reporting Period July 1-September 30, 1976
Number of Pages 15

BASELINE/RECONNAISSANCE CHARACTERIZATION, LITTORAL BIOTA, GULF OF ALASKA AND BERING SEA

Steven T. Zimmerman

Theodore R. Merrell, Jr.

Northwest Fisheries Center Auke Bay Fisheries Laboratory
National Marine Fisheries Service, NOAA
P. O. Box 155
Auke Bay, Alaska 99821

October 1, 1976

I. Task Objectives

There are two objectives in this study: to determine the distribution of the major habitat types (sandy, muddy, rocky, etc.) along the coastline; and to determine the densities and distribution of biotic populations within these habitat types.

There are several phases to each objective. The distribution of habitat types has been determined by visual reconnaissance methods from fixed wing aircraft. Additional information utilizing aerial photography and multispectral scanning methods is being produced in cooperation with NASA and the Environmental Research Institute of Michigan.

The distribution of organisms within habitat types is being determined by field parties from the Auke Bay Fisheries Laboratory (ABFL), with logistical assistance from the Pacific Marine Center. Additional projects include a study of the accumulation of biotic debris in the "drift zone," the estimation of variability between sampling areas, and more intensive studies at a few sites which may receive major impact from oil exploration in the eastern Gulf of Alaska.

II. Field or Laboratory Activities

A. Coordination of field schedules with other OCSEAP projects.

NMFS Auke Bay Laboratory personnel have participated extensively in coordination with other OCSEAP projects, greatly extending the scope of our activities. During the period July 1-September 30 NMFS biologists collaborated in the field with the following investigations:

1. With RU24-ADF&G razor clam studies near Kodiak (Kaiser).
2. With RU208-USGS geomorphology studies on the Yukon River Delta (Dupre).
3. With RU431-USGS geomorphology studies on the northern Alaska Peninsula (Sallenger).

In addition we have closely corrdinated our field methodology and computer programing with the following investigations:

1. With RU24-ADF&G razor clam studies near Kodiak (Kaiser).
2. With RU27-ADF&G littoral studies near Kenai (Flagg).
3. With RU417-Dames and Moore littoral studies in Cook Inlet (Lees).
4. With RU356-Western Washington State College littoral studies in the Arctic (Broad).

While in the field we have made collections for the following investigations:

1. RU162/163-IMS trace metal studies (Burrell).
2. RU275/276-IMS hydrocarbon studies (Shaw).

At the request of the BLM Anchorage OCS office, we have provided data on Kodiak intertidal habitats for the Kodiak DEIS, and arranged for a BLM specialist to accompany our team on a helicopter reconnaissance of the Kodiak coast.

B. Field Activities

JULY

Activity 1:

A. Field party schedule: July 2-16 (approximately) Charter airplane (Kodiak Western-Grumman Goose).

B. Scientific party: Konigsberg-ADF&G; Phillips-NMFS.

C. Methods: At several different tidal heights large quantitative volumes of sand were sieved to determine the abundance and age composition of razor clam populations. Smaller areas were subsampled to determine the densities of associated polychaetes and molluscs.

D. Sample localities: Tuguidak, Kashivak.

E. Data collected: Approximately five tidal heights were surveyed at each site. Observations were made on the types of invertebrates occurring at the different tidal heights.

Activity 2:

A. Field party schedule: July 8-15. Charter helicopter (Kenai Air Service Company, Bell 206-B).

B. Scientific party: Zimmerman, Fujioka-NMFS; Freel-BLM; Michou-Kenai Air Service.

C. Methods: Reconnaissance level study sites were chosen after consulting our aerial survey charts. Large areas were studied to determine the type and extent of zonation.

D. Sample localities: Eighteen sites extending from southern Kodiak (Geese Islands) to northern Shuyak Islands were investigated.

E. Data collected: Extensive observations were made on the differences between exposed and protected habitats and their associated biota.

Activity 3:

A. Field trip schedule: July 13-29. Charter airplane (St. Mary's Air Service).

B. Scientific party: Dupre, Ager-USGS; MacKinnon-NMFS.

C. Methods: This was a coordinated effort between geological and biological research teams. The geological party used beach profiling methods to determine slope and grain size at all sites. The biologists then collected biota associated with beach features and noted the general communities present.

D. Sample localities: Nine general sites in the "Delta Area" were sampled. This area extended from Stebbins to Nelson Island and included most of the Yukon River Delta to Kuikokwim River Delta area.

E. Data collected: The biologist made extensive observations on the types and densities of organisms on unconsolidated beaches. He also collected the remains of organims which had accumulated in the drift zone as an indication of the species composition of shallow subtidal communities offshore.

Activity 4:

A. Field party schedule: July 27-August 4 (approximately). Charter airplane (Kodiak Western-Grumman Goose).

B. Scientific party: Konigsberg-ADF&G; Phillips-NMFS.

C. Methods: At several different tidal heights large quantitative volumes of sand were sieved to determine the presence of razor clams. Smaller areas were subsampled to determine the densities of associated polychaetes and molluscs.

D. Sample localities: Dakavak, Alinchak.

E. Data collected: Approximately five tidal heights were surveyed at each site. Observations were made on the species of invertebrates occurring at the different tidal heights.

August

Activity 1:

A. Field party schedule: August 8-14. NOAA vessel Surveyor.

B. Scientific party: Zimmerman, Romm, Gnagy, Mattson, Munk, Horseman, Barr, Budke-NMFS; Drury, Drury-College of the Atlantic; Guzman-Calgary University; Hoelzl-ERL.

C. Methods: On rocky substrates transect lines and frames were used to quantitatively sample attached biota. On sandy or muddy substrates several cores or buckets of sediment were sieved to collect biota. At each site large areas were studied to determine biological homogeneity. Shallow subtidal sites were studied adjacent to intertidal areas. Large areas were investigated and quantitative samples were collected by air lift or manual removal of specimens.

D. Sample localities: Fourteen sites in Norton Sound were investigated. These extended from Stuart Island in the south to Cape Wooley in the north. King Island was also visited

E. Data collected: One hundred and twenty three quantitative intertidal collections and several quantitative subtidal collections were made. In addition, large areas of beach were flown by helicopter and walked on foot to note biological homogeneity.

Activity 2:

A. Field party schedule: August 28-September 5. Charter helicopter (ERA Helicopters Inc., Sikorsky S55T).

B. Scientific party: Zimmerman, MacKinnon-NMFS; Swope-OCSEAP; Ori, Gunderson-ERA.

C. Methods: Sites were chosen after consulting our aerial survey charts. Large areas were studied to determine spatial homogeneity. Densities of individual species were determined by sieving quantitative samples.

D. Sample localities: Fourteen sites in Bristol Bay were sampled. These extended from Port Heiden to Western Nushagak Peninsula.

E. Data collected: Several quantitative and qualitative collections were made on bars, beaches, and lagoons. A general understanding of the biological communities, their distribution, and densities was gained.

September

Activity 1:

A. Field party schedule: September 6-12. Charter helicopter (ERA Helicopters Inc., Sikorsky S55T).

B. Scientific party: Sallenger, Hunter, Dingler-USGS, MacKinnon-NMFS; Ori, Gunderson-ERA.

C. Methods: This was a coordinated effort between geological and biological research teams. The geological party used beach profiling methods to determine beach slope and grain size. The biologist then collected biota associated with beach features and noted the general communities present.

D. Sample localities: Forty two sites between Kvichak Bay and Cape Mordvinof were studied. This area includes most of the northern Alaska Peninsula.

E. Data collected: The biologist made extensive observations on the types and densities of organisms on unconsolidated beaches. He also collected the remains of organisms which accumulate in the drift zone to indicate the type of shallow subtidal communities present offshore.

C. LABORATORY ACTIVITIES

1. University of Alaska Marine Sorting Center.

In an unprecedented burst of activity the Sorting Center processed approximately 400 quantitative samples during the JulySeptember quarter.

Much of there data have been keypunched and are being computer processed into tables and figures with accompanying statistical interpretation.

2. Auke Bay Sorting Center.

In an attempt to speed up the rate of sample sorting we staffed our own small scale sorting center at Auke Bay during the summer. Utilizing the facilities of the Auke Lake campus of the University of Alaska, we were able to sort and identify all of the quantitative samples collected during the May 1976 Surveyor cruise to the Kodiak area.

3. Kodiak Sorting Facilities.

During the summer of 1976 we coordinated activities with ADF&G (RU24) in order to sample razor clam beaches in the Kodiak area. The ADF&G group was primarily interested in bivalve molluscs. We extended their program to include collections of all associated fauna. These additional samples were brought back to Kodiak and were sorted and identified at the NMFS Laboratory there.

4. Laboratory Work-Up of Aerial Survey Data.

The data from the aerial surveys are being transferred to master charts using graphic and cartographic methods. Cartographic technicians have been working throughout the summer to produce the plates for a coastal Atlas. Again, the University of Alaska, Auke Lake Campus, was very generous in providing space for this activity.

III and IV Results and Preliminary Interpretation

During the summer quarter most of our activities were directed toward the production of a major report on the littoral and shallow subtidal biota of the Kodiak Basin. This report is nearing completion and should be finished by early November, in time for inclusion in the final OCS EIS for the Kodiak Basin.

A. Aerial Survey

The aerial survey flights were completed in June. During subsequent sampling trips, we had several opportunities to check the accuracy of the data while working on the ground. In almost all cases the aerial interpretations were found to be accurate.

A large amount of time was needed to set up the final format for the atlas plates and to arrange the order of the plates. In July a second cartographic technician was added to the staff to speed-up the process. Emphasis has been on the Kodiak plates. To date approximately 48 of the 54 Kodiak plates are complete and ready for printing. We anticipate completion by the first week of October.

B. Intertidal Reconnaissance Studies

1. Kodiak Basin--July-August.

Sampling of sandy beaches in conjunction with ADF&G continued throughout the summer. A total of twelve beaches were sampled. Although very large volumes of sand were sieved and extensive areas were investigated only a few species were found to inhabit open sandy beaches. Biomass usually amounted to a few grams per square meter. Polychaetes and pelecypods made up most of the organisms encountered.

2. Kodiak Basin--July

Most of the eighteen littoral sites studied on these trips were composed of bedrock or boulder. These types of beaches predominate on Kodiak Island and there is great variability between sites.

Preliminary interpretations indicate that large differences are found between protected and unprotected areas. Littoral sites located in bays or behind protective islands or bars had a greater diversity. This was apparently caused by large populations of mussels and barnacles and associated carnivores such as starfish and the oyster drill Thais lamellosa. Unprotected areas usually had very small populations of mussels, if any, and very few carnivores were present. Turbulence may have been a factor limiting the development of invertebrate populations.

The differences in invertebrate populations seemed to be reflected in the algal populations we observed. In unprotected areas the algal community appeared to consist of lush, well developed "climax" plants. In protected areas the algae seemed to be competing for space with invertebrates. Often the algae were forced to use mussels and barnacles as a substrate because the rock surfaces were already covered. In this situation the carnivorous starfish and drills had a strong effect on the algae because they tended to eat and erode away the invertebrate substrate. Thus the algae were constantly being lost from the system through competition and substrate erosion. This appeared to keep the algal community in a transitional rather than a climax ecological state.

3. Yukon Delta Area--July

During July we combined our biological observations with the geological research being carried out by Bill Dupre in the Yukon-Kuskokwim delta areas. Biological observations are summarized as follows:

a. The delta coastline from Pikmiktalik south to Black River is almost entirely a low peat bluff which grades abruptly into a fine sand and peat hummock substrate. This intertidal zone appears to be void of any sessile benthic macro-invertebrates.

b. The presence and absence of drift remains over the northern part of the delta is probably more a result of the hydrodynamics of the coast and lack of suitable beach types for accumulation than an indicator of the presence or absence of sublittoral biotic communities. Drift remains do indicate the presence offshore of a Macoma balthica-Mya arenaria community.

c. Exposed coastline in the Hooper Bay area consists of wide flat sandy beaches. Amphipods were the only intertidal animals found. Drift remains indicate the presence offshore of a number of different biotic assemblages which are probably related to substrate types.

d. Rocky intertidal areas near Tununak, Nelson Island exhibited sparce populations of fairly typical rocky intertidal animals. Aerial reconnaissance of rocky woodlands at Cape Romanzof showed evidence of similiar communities.

e. A protected lagoon at Hooper Bay is a habitat for shellfish resources utilized by people of the nearby village.

4. Norton Sound Basin--August

Fourteen sites were studied in the Norton Sound area. In addition to the sampling sites several hundred miles of coastline were flown in order to gain a general understanding of the area.

The southern portion of the bay is characterized by volcanic bedrock. The northern part of the bay is generally characterized by gravel or sand beaches with occasional high rock bluffs.

When the few rocky sites in the northern part of the bay (King Island, Cape Wooley, Sledge Island, Rocky Point) were compared with those in the southern part (Stuart Island, Egg Island, Wood Point) strong differences were seen. Although none of the sites had diverse or extensive biological cover the southern stations were dramatically richer than the northern ones. Other than diatom colonies, northern sites were almost devoid of cover. Southern stations had quite heavy growths of Fucus sp, Cthamalus and some unidentified foliose red algae. If ice cover can be considered constant over the bay, the differences may have been caused by the greater tidal range in the southern part of the sound.

In all cases, the only organisms found were those which normally inhabit the higher intertidal levels. Mid-range organism such as mussels appear to only grow subtidally in this area.

On exposed sand and gravel beaches no living macro-organisms were found. Investigation of the drift biota usually produced very few remains of living organisms except at Cape Denbigh where large accumulations of drilled bivalve shells and moon snails were found.

Muddy areas were found in protected locations. The sediments often contained large amounts of peat. Small populations of two species of polychaete worms were found. (More material will probably be discovered following microscopic sorting.)

Water temperatures were found to be quite high within Norton Sound. (Average 60° F). (Salinities were quite low (average 20°/oo).

5. Bristol Bay Basin--August

Several of the sand and sand-mud bars and beaches in the Bristol Bay area were investigated. Although it is probably too early to draw conclusions, several trends were discovered.

a. The most ubiquitous animal appeared to be the small clam Macoma balthica which was found at almost all sampling sites. A species of lugworm Arenicola sp was also very common.

b. Areas of highest biological density appeared to occur in semi-protected areas (in lagoons or behind offshore bars). In these areas dense and diverse populations were often found. Some small polychaetes reached numbers in excess of $32,000/m^2$. Large (4") clams such as Mya arenaria reached numbers of $25/m^2$.

c. The coarse sand beaches on exposed coastlines or on bars in the middle of large bays (e.g. Nushagak Bay) had very little biota associated with them.

d. Areas composed of soft mud (e.g. Big Flat, Nichols Lagoon) contained very little. Substrate at most of these sites appeared to be anoxic.

In general the Bristol Bay area can be characterized as being composed of sandy or muddy beaches with extensive bar systems. The inshore areas and lagoons typically contain patchy populations of Arenicola and Macoma. Occasional populations of other polychaetes, amphipods, and Mya arenaria may be found.

6. Northern Alaska Peninsula--September

Thirty nine coastal sites from Kvichak Bay to Unimak Island were visited. As the reconnaissance progressed southwesterly along the peninsula, several trends were observed:

a. There was a general increase in beach sediment grain size and a corresponding increase in beach slope. A change in beach mineralogy occurred in the Cape Kutuzof area northeast of Port Moller.

b. The salinity increased gradually from 26 °/oo near Egegik Bay to 32 °/oo at Unimak Island.

c. The exposed coastal Mya-Macoma-Arenicola benthic community dropped off sharply at Ugashik Bay and appeared to be completely gone by Port Heiden. These communities were present in protected areas along the peninsula as far as Izembeck Lagoon.

d. Drift evidence indicates the beginning of a nearshore molluscan community of Razor clams (Siliqua patula and S. alta) beginning at Port Moller and continuing through Unimak Island.

Sample Sorting, Data Submission and Data Workup

To date, approximately 950 of 1300 quantitative samples collected in 1975 have been analyzed under contract with the University of Alaska Sorting Center.

During 1976 an additional 750 samples were collected. By undertaking our own sorting at Auke Bay, we were able to process over 200 of these samples. Christopher Phillips, working in Kodiak with ADF&G, was able to process approximately 75 more of the samples. Considering that over half the remaining samples are from sandy beaches and probably contain very little biota, the sorting of remaining samples should proceed rapidly.

Most of the data resulting from the sorted samples have been keypunched. A good portion of the data have been outputted to tables similiar to those shown in our July 1, 1976 report.

We anticipate several large data submissions to NODC in the near future. Unfortunately, the problems resulting from the redefinition by OCSEAP of geographic boundaries, continues to plague our data submission schedule. Our format requires submission of data by cruises, which were designed to produce data for the geographic areas that were defined for us in early 1975. When all of the boundaries were changed in 1976, our computer format no longer fit the OCSEAP basin requirements. We had planned to get around this difficulty by submitting data quarterly instead of by cruise. This has been a very inefficient procedure resulting in meaningless files which bear little resemblance to the program design. Meetings were held with the OCSEAP Data Manager in Juneau to discuss this problem. At present we are planning to submit our data in fractions of cruises and will update the files when enough data to complete a cruise is available.

V. Problems Encountered

It was a good summer with no unsolved problems. We met all of our objectives and are grateful to all of the agencies which provided us with logistics or allowed us to participate in their program.

VI. Estimate of Funds Expended During Quarter*

Salaries	$83.5
Travel	21.4
Contracts	17.5
Equipment and Supplies	20.2
Other Direct Costs	9.8
Support	31.0
TOTAL	$183.4

*Does not include ship and aircraft logistics provided by OCSEAP.

Table 1. Number of littoral sites visited and quantitative samples collected during the 1976 field season.

AREA	DATES	Sites Sampled ROCKY	SANDY	MUDDY	Quantitative Samples[1/]
EGOA	April 11-19	2	4	1	124
Kodiak Basin	May 11-21	8	2	1	209[4/]
Kodiak Basin[2/]	May-August	-	12	-	74[4/]
St.George Basin	June 5-20	7	2	4	219
EGOA[3/]	June 8-14	3			-
Kodiak Basin	July 8-15	17	-	1	-
Yukon Delta	July 13-19	1	4	4	-
Norton Sound	August 8-14	6	8	3	123
Bristol Bay	August 8-Sept.5	-	9	8	30
N.Alaska Peninsula	Sept. 6-12	-	36	3	-

1/ This lists only quantitative samples. Species collections, percent cover enumerations, and qualitative samples are not listed as exact numbers are difficult to determine.
2/ Summary of sampling by NMFS Biologist Phillips working with ADF&G Razor Clam study.
3/ Purpose of trip was to provide ground truth for ERIM overflight.
4/ Samples were sorted during summer, 1976.

QUARTERLY REPORT

Contract #: 03-5-022-67-TA8 #4
Research Unit #: 156/164a
Reporting Period: 1 Jul - 30 Sep 1976
Number of Pages: 34

Plankton of the Gulf of Alaska - Ichthyoplankton

T. Saunders English
Department of Oceanography
University of Washington
Seattle, Washington 98195

1 October 1976

Departmental Concurrence: [signature]
Francis A. Richards
Associate Chairman for Research

REF: A76-64

I. Task Objectives

Our main objective is to conduct a quantitative survey to determine the seasonal distribution of commercially or ecosystem important species of ichthyoplankton and shrimp and crab larvae in Lower Cook Inlet, Alaska.

II. Field Activities

A. Ship schedules and Personnel

1. *Acona* - RP-4-AC-231, Leg II, Lower Cook Inlet, 8-15 July 1976

Personnel:

Kendra Daly, Assistant Oceanographer
Leanne Legacie, Assistant Oceanographer

Department of Oceanography
University of Washington
Seattle, Washington 98195

2. *Surveyor* - RP-4-SU-76B, Leg II, Lower Cook Inlet, 24-31 August 1976

Personnel:

Kendra Daly, Assistant Oceanographer
Phyllis Thoreson, Helper

Department of Oceanography
University of Washington
Seattle, Washington 98195

The first cruise was aboard the University of Alaska research vessel *Acona*. The *Acona* has an overall length of 85 feet, a beam of 21.5 feet and a draft of 12 feet. Propulsion is provided by a D-353 Caterpillar 300 hp electric motor which drives 2 rotating fixed pitch propellers. Each shaft has a practical range of 600-1200 RPM. The ship's speed ranged from 4½ to 9½ knots. A 125 hp fixed pitch bow thruster was used for maintaining constant heading at low speed. Two 60 kw diesel generators supply AC 3 phase power for the ship's propulsion. All the nets were deployed from the main deck forward from the deck house. The main trawl winch is located below deck. The hydrowinch or STD winch is located on the main deck.

The second cruise was aboard the NOAA ship *Surveyor* (OSS 32). The vessel has an over-all length of 292 feet, a beam of 46 feet and a draft of 16 feet (displacement is 3,150 L.T.). A steam turbine (3,520 SHP) powers the single screw with a practical RPM range of 10 to 120. There is a 200 hp harbor master at the stern capable of 360° rotation (this was not used during scientific work). The nets were deployed over the stern from a deck situated 16 feet above water. A Jered Oceanographic winch mounted on the deck was used exclusively for net work. The drum presently holds approximately 3000 m of 5/16" 3-conductor wire with a resistance of 200 Ω. This wire was run through a block hanging from a boom that was obliquely mounted from the deck, extending over the water. The slow response of this vessel to the helm created the greatest difficulty encountered in biological work.

B. Methods

All stations were located in Lower Cook Inlet, the open Gulf of Alaska, or Prince William Sound (Figs. 1 and 2, Tables 1 and 2). During the *Acona* cruise the station in Prince William Sound was not sampled due to the shortage of cruise time available. All the stations were not sampled in order, due to adverse sea conditions at the beginning of the cruise. Station 6 in Kachemak Bay was occupied for 24 hours, and station 11 in the open Gulf for 22 hours. All the remaining stations were occupied for an average of 1 to 2 hours each. The weather was mostly overcast and cool.

During the *Surveyor* cruise station 6 in Kachemak Bay was occupied for 20 hours, station 11 in the Gulf of Alaska for 10 hours, and station 13 in Prince William Sound for 16 hours. An average of 1 or 2 hours was spent at each of the remaining stations. Station 3 was occupied twice. However, the second occupation was only for the purpose of collecting primary productivity samples. The weather was mostly overcast and cool.

The continuous acoustic surveys were conducted using a Ross 200A Fine Line Echosounder system operating with a frequency of 105 kHz. The *Acona*'s hull-mounted transducer was used for sonic recording on that cruise. During the *Surveyor* cruise, the ship's hull-mounted transducer was only used while underway. The UW's 10° transducer was lowered approximately one meter below the surface while on station. On both cruises the paper chart was marked with station number, date, time (local and GMT), and other pertinent information. Acoustic scattering layers were of particular interest. Depth ranges of 0-50, 50-100, 100-150 and 150-200 fm were recorded, with the 0-50 fm depth range being particularly emphasized. The incoming signal was also recorded on magnetic tape for at least 5 minutes at every station for later digitizing and analysis at the University of Washington.

Zooplankton and ichthyoplankton were sampled with a bongo net in a double oblique tow. The bongo net consisted of a double-mouthed frame (each mouth with an inside diameter of 60 cm and a mouth area of 0.2827 m^2) made of fiber glass and weighing 95 lbs (a 100 lb weight was also attached to this net). A 505 μm mesh net with an open area ratio (OAR) of

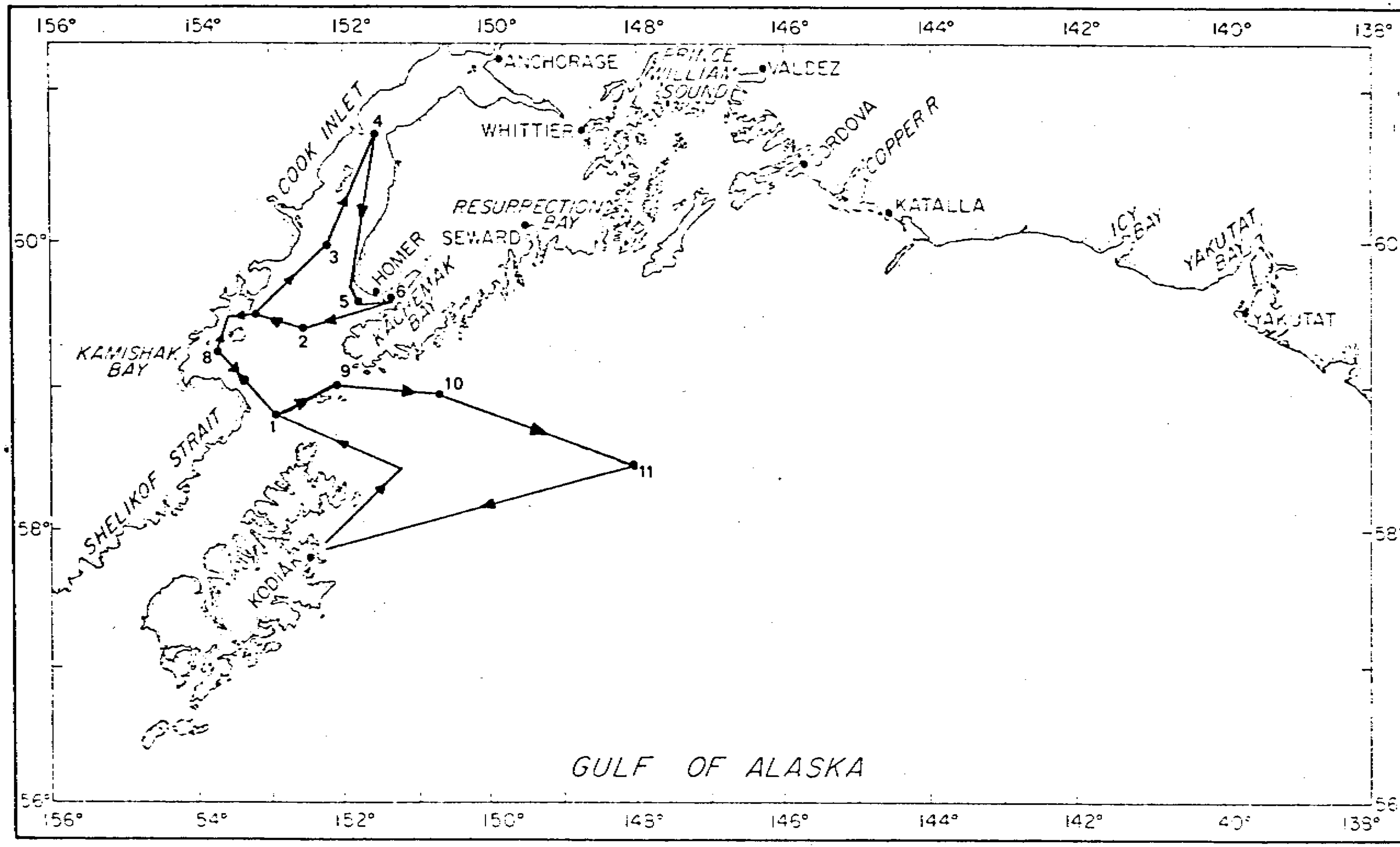

Fig. 1. Station locations, *Acona*, 8-15 July 1976

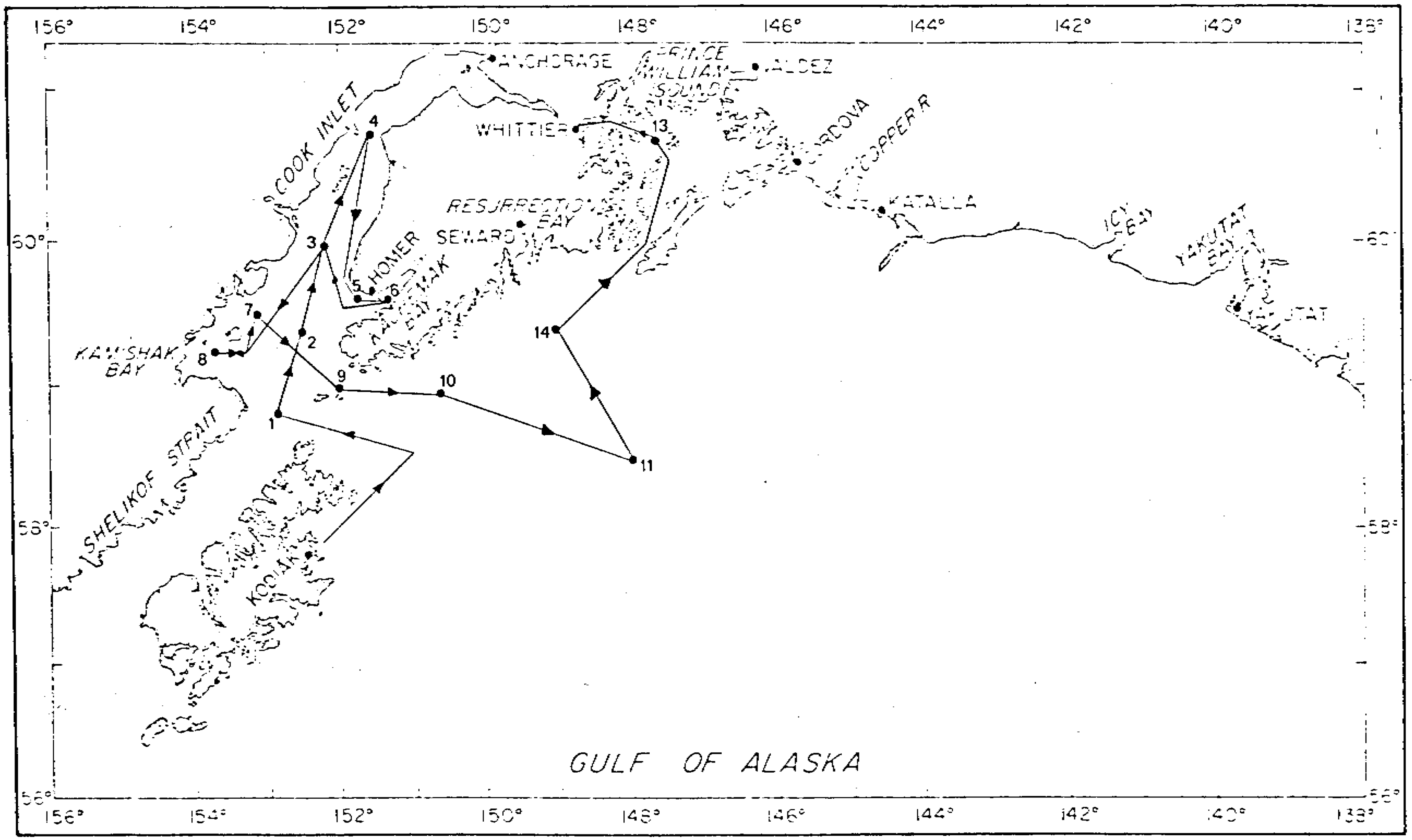

Fig. 2. Station locations, *Surveyor*, 24-31 August 1976

Table 1. Station locations, *Acona*, Leg II

Station	Latitude (N)	Longitude (W)	Chart Depth (m)	Location
1	58° 53.0'	152° 48.0'	171	Shelikof Strait
2	59° 23.0'	152° 40.0'	60	Lower Cook Inlet
3	60° 00.0'	152° 10.0'	68	Lower Cook Inlet
4	60° 38.1'	151° 38.5'	52	Cook Inlet
5	59° 35.0'	151° 48.0'	38	Outer Kachemak Bay
6	59° 37.0'	151° 19.0'	72	Inner Kachemak Bay
7	59° 30.0'	153° 10.0'	34	Kamishak Bay
8	59° 14.0'	153° 40.0'	30	Kamishak Bay
9	59° 02.0'	151° 58.0'	205	Lower Cook Inlet
10	58° 52.1'	150° 48.7'	151	Gulf of Alaska
11	58° 24.0'	148° 02.0'	1408	Gulf of Alaska

Table 2. Station Locations, *Surveyor*, Leg II

Station	Latitude (N)	Longitude (W)	Chart Depth (m)	Location
1	58° 53.2'	152° 46.2'	167	Shelikof Strait
2	59° 22.1'	152° 40.0'	70	Lower Cook Inlet
3	59° 59.5'	152° 11.0'	64	Lower Cook Inlet
4	60° 42.1'	151° 36.5'	90	Cook Inlet
5	59° 34.9'	151° 50.6'	34	Outer Kachemak Bay
6	59° 36.5'	151° 17.7'	97	Inner Kachemak Bay
7	59° 30.1'	153° 07.7'	53	Kamishak Bay
8	59° 14.3'	153° 40.5'	34	Kamishak Bay
9	59° 02.2'	151° 58.6'	192	Lower Cook Inlet
10	58° 51.5'	150° 40.2'	143	Gulf of Alaska
11	58° 24.5'	148° 06.2'	1530	Gulf of Alaska
13	60° 41.2'	147° 40.7'	550	Prince William Sound
14	59° 24.9'	149° 05.0'	198	Gulf of Alaska

8:1 and a 333 μm mesh net, 8:1 OAR, were attached to the frame. A TSK flowmeter was mounted in the mouth of each net to determine the volume of water filtered. A bathykymograph (BKG) was attached to the frame to determine the depth of tow. Double oblique tows required deployment at 50 m/min, a 30 sec soaking time, and retrieval at 20 m/min. A towing speed of 3-4½ knots was typical. The sampling depth for double oblique tows was usually 200 m following standard MARMAP procedures. In shallower water, the net was placed as close to the bottom as possible without endangering the net. Several subtractive hauls were made at stations that showed a strong acoustic scattering layer to help determine the composition of that layer.

Samples were either placed in 500 or 1000 ml bottles which were filled 3/4 full with seawater; the 500 ml sample was preserved with 25 ml of 100% formalin and 10 ml of saturated sodium borate solution (these quantities were doubled for 1000 ml bottles). A label was filled out and inserted in the jar, the jar was filled close to the brim with seawater, and the jar was capped and sealed with plastic electrical tape for storage.

C. Sample localities and tracklines

For sample localities and ship tracklines see Figs. 1 and 2.

D. Data collected or analyzed

1. The number and kinds of net hauls and the acoustic survey are given in Tables 3 and 4 for the *Acona* cruise and Table 5 for the *Surveyor* cruise.

2. The number and kinds of net hauls analyzed from the *Discoverer*, Leg V, 05-09 May 1976 are reported in Tables 6-9; the *Discoverer*, Leg VII, 22-30 May 1976 are reported in Tables 10-12; and the *Acona*, Leg II, 8-15 July 1976 are reported in Table 13.

3. Miles of trackline

Cruise	Kilometers
Acona	1223
Surveyor	1500

III. Results

A. *Acona*, Leg II

The *Acona*'s hull-mounted transducer in conjunction with our Ross recording system, was in operation continuously while the vessel was underway. This gave a sonic chart record of a transect up Cook Inlet, a cross-sectional sonic view of Cook Inlet, and a transect out to the

Table 3. UW Haul Summary Sheet, *Acona*, Leg II

Bongo Tows

Date (1976) (GMT)	Time (GMT)	Station	Haul	Latitude (N)	Longitude (W)	Depth (m)	Volume Filtered† (m^3)	Jars from mesh size (µm) 505	333
12 July	1619	1	1	58° 53.0'	152° 48.0'	150	616	4	3
12 July	1133	2	1	59° 23.0'	152° 40.0'	30	245	1	3
10 July	0901	3	1	60° 00.0'	152° 10.0'	83	207	1	1
10 July	1556	4	1	60° 38.1'	151° 38.5'	60	297	1	1
11 July	0018	5	1	59° 35.0'	151° 48.0'	28	168	1	1
		6	1	59° 37.0'	151° 19.0'		ABORT		
11 July	1009	6	2	59° 37.0'	151° 19.0'	27	108	1	1
11 July	1031	6	3	59° 37.0'	151° 19.0'	73	283	1	1
11 July	2051	6	4	59° 37.0'	151° 19.0'	17	272	1	1
11 July	2113	6	5	59° 37.0'	151° 19.0'	45	373	1	1
10 July	0405	7	1	59° 30.0'	153° 10.0'	20	209	1	1
10 July	0010	8	1	59° 14.0'	151° 40.0'	23	221	1	1
13 July	0548	9	1	59° 02.0'	151° 58.0'	200	732	3	4
13 July	1230	10	1	58° 52.1'	150° 48.7'	104	958	4	4
13 July	2243	11	1	58° 24.0'	148° 02.0'	207	880	2	2
14 July	0835	11	2	58° 24.0'	148° 02.0'	206	956	2	3

† averaged

Table 4. UW Acoustic Survey Summary, *Acona*, Leg II

Date (1976) (GMT)	Time (GMT)	Station	Total Recording Time (min)	Magnetic Recording Time (min)	Comments
9 July	1833	1	--	--	Rough seas; abandoned sta 1; ran for sta 8
9 July	2310	8	80	10	Tested, towed XDCR; sonic taping from both towed XDCR and hull-mounted XDCR
10 July	0330	7	65	5	
10 July	0850	3	123	7	Possible layer at 18-27 m
10 July	1525	4	85	5	
10 July	2319	5	81	5	
11 July	0353	6	1485	29	1715 ADT: strong layer 37-55 m 0010 ADT: layer migrated up to 0-27 m early morning: layer migrated down to 22-46 m 1005 ADT: layer 33-55 m
12 July	0800	--	--	--	Cross-sectional transect of Lower Cook Inlet between sta 6, 2, 7; many fish targets
12 July	1140	2	58	5	Fish targets, layer 22-37 m
12 July	2110	--	--	--	Transect out of Lower Cook Inlet, sta 8-1; many individual targets and layering
13 July	0119	1	64	5	Individual fish targets and layering
13 July	0515	9	125	5	Scattered fish layers

Table 4. (continued)

Date (1976) (GMT)	Time (GMT)	Station	Total Recording Time (min)	Magnetic Recording Time (min)	Comments
13 July	1200	10	67	5	Many strong fish targets and layers covering most of the water column; chart picture slightly distorted due to slow paper takeup
13 July	2235	11	1430	22	1350 ADT: zooplankton and fish targets concentrated only in top 18 m 2200 ADT: migrating layers appear on 0-50 fm scale 2345 ADT: layers stabilized at 0-37 m
14 July		11			0130-2000 ADT: layers starting to migrate downwards

Table 5. UW Haul Summary Sheet, *Surveyor*, Leg II

Bongo Tows

Date (1976) (GMT)	Time (GMT)	Station	Haul	Latitude (N)	Longitude (W)	Depth (m)	Volume Filtered† (m^3)	Jars from mesh size (µm) 505	333
25 Aug	0840	1	1	58° 53.2'	152° 46.2'	162	476	2	3
25 Aug	1206	2	1	59° 22.1'	152° 40.0'	70	--	1	1
25 Aug	1952	3	1	59° 59.5'	152° 11.0'	48	217	2	1
26 Aug	0400	4	1	60° 42.1'	151° 36.5'	90	322	1	1
26 Aug	1040	5	1	59° 34.9'	151° 50.6'	30	277	1	1
26 Aug	2203	6	1	59° 36.5'	151° 17.7'	40	488	1	1
27 Aug	1000	6	2	59° 36.5'	151° 17.7'	50	370	1	1
28 Aug	0650	7	1	59° 30.1'	153° 07.7'	48	1190	2	1
28 Aug	0330	8	1	59° 14.3'	153° 40.5'	34	33	1	1
28 Aug	1832	9	1	59° 02.2'	151° 58.6'	100	1387	2	1
28 Aug	1919	9	2	59° 02.2'	151° 58.6'	115	1989	2	3
29 Aug	0459	10	1	58° 51.5'	150° 40.2'	135	1907	1	1
29 Aug	1922	11	1	58° 24.4'	148° 06.2'	270	3645	1	1
31 Aug	0600	13	1	60° 41.2'	147° 40.7'	165	848	4	2
30 Aug	0559	14	1	59° 24.9'	149° 05.0'	170	468	2	2

† averaged

Table 6. Number of fish eggs and larvae at each station

Lower Cook Inlet Bongo Tows, *Discoverer*, Leg V

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae
6 May	1325	1	1	333	21	17
6 May	1325	1	1	505	24	28
6 May	1552	2	1	333	0	26
6 May	1552	2	1	505	3	14
6 May	2117	3	1	333	41	13
6 May	2117	3	1	505	39	14
7 May	0259	4	1	333	0	3
7 May	0259	4	1	505	0	2
7 May	1030	5	2	333	40	119
7 May	1030	5	2	505	68	436
7 May	1312	6	1	333	992	290
7 May	1312	6	1	505	1616	326
7 May	1709	6	2	333	1296	352
7 May	1709	6	2	505	364	236
8 May	0020	5a	1	333	48	184
8 May	0020	5a	1	505	50	167
8 May	0402	7	1	333	52	4
8 May	0402	7	1	505	60	12
8 May	0734	8	1	333	366	17
8 May	0734	8	1	505	355	20
8 May	1315	9	1	333	19	16
8 May	1315	9	1	505	18	16

Table 7.- Summary of Taxonomic categories of fish eggs, larvae, young and adults found in Bongo net samples collected on Lower Cook Inlet *Discoverer* cruise, Leg V, 05-09 May 1976.

A total of 11 samples were collected. Samples from stations 1 through 6 are identified and summarized. Samples from stations 7 through 9 have yet to be analyzed. The eggs thus far were distributed into 3 families, 7 genera and 4 species. The fish were distributed into 15 families, 14 genera and 11 species:

Family Ammodytidae

337 larvae sandlance[1] *Ammodytes* sp.
618 larvae sandlance *Ammodytes hexapterus* Pallas

Family Argentinidae

1 egg argentine *Argentina* sp.

Family Bathymasteridae

14 larvae genus? species?

Family Cottidae

2 larvae cabezon *Scorpaenichthys marmoratus* (Ayres)
71 larvae genus? species?

Family Cyclopteridae

12 larvae genus? species?

Family Gadidae

1 egg Alaska pollock *Theragra chalcogramma* (Pallas)
9 eggs genus? species?
15 larvae Alaska pollock *Theragra chalcogramma* (Pallas)
17 larvae genus? species?

Family Hexagrammidae

2 larvae genus? species?

Family Liparidae

1 larva snailfish *Liparis* sp.

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[1] The common name is presented for the first time for each species; thereafter only the scientific name is recorded.

Table 7. (cont.)

Family Myctophidae

11 larvae northern lampfish *Stenobrachius leucopsarus* (Eigenmann and Eigenmann)
3 larvae genus? species?

Family Osmeridae

6 larvae capelin *Mallotus villosus* (Müller)
2 young capelin *Mallotus villosus* (Müller)
2 larvae longfin smelt *Spirinchus thaleichthys* (Ayres)
11 larvae genus? species?

Family Pholidae

4 larvae penpoint gunnel *Apodichthys flavidus* Girard
4 larvae gunnel *Pholis* sp.
20 larvae genus? species?

Family Pleuronectidae

1 egg rex sole *Glyptocephalus zachirus* Lockington
41 eggs sole *Hippoglossoides* sp.
4404 eggs butter sole *Isopsetta isolepis* (Lockington)
1 egg sole *Limanda* sp.
7 eggs slender sole *Lyopsetta exilis* (Jordan and Gilbert) (2 eggs identification uncertain)
9 larvae butter sole *Isopsetta isolepis* (Lockington)
11 larvae slender sole *Lyopsetta exilis* (Jordan and Gilbert)

Family Scorpaenidae

11 larvae rockfish *Sebastes* sp.
3 larvae genus? species?

Family Stichaeidae

49 larvae daubed shanney *Lumpenus maculatus* (Fries)
42 larvae snake prickleback *Lumpenus sagitta* Wilimovsky
760 larvae prickleback *Lumpenus* spp.

Family Tetragonuridae

1 larva genus? species

136 eggs unidentified
134 larvae unidentified

Table 8. Identification of Fish Eggs and Larvae by Station

Lower Cook Inlet Bongo Tows, *Discoverer*, Leg V

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
6 May	1325	1	1	333	21[a]	17[a]	19 eggs 2.90–3.20 mm[b] *Hippoglossoides* sp. (3 of the eggs broken without shell)
							1 egg 1.60 mm *Theragra chalcogramma*
							1 egg damaged, unidentified
							2 larvae 32.0, 42.0 mm *Mallotus villosus*
							4 larvae 3.6–5.2 mm *Theragra chalcogramma*
							4 larvae 4.4 mm *Stenobrachius leucopsarus*
							3 larvae 5.5 mm Myctophidae
							1 larva 9.7 mm *Sebastes* sp.
							1 larva 10.0 mm elongate unidentified
							2 larvae heads unidentified

[a] All specimens are classified into four main categories: eggs include all stages of eggs prior to hatching; larvae include newly hatched and all stages prior to metamorphosis; young include fish after metamorphosis to acquisition of adult fin rays and adult body configuration; adults include fish that are sexually mature.

[b] Eggs are measured to the nearest hundredths of a millimeter in diameter. Fish or larvae, if less than 10 mm in length, are measured to the nearest tenth of a millimeter under a microscope using a calibrated micrometer eye piece. If 10 mm or greater in length, the fish or larvae are measured by a metric ruler to the nearest millimeter. When there are more than three eggs, fish or larvae, the largest and the smallest are measured. Larvae are measured by standard length.

Table 8. (cont.) Lower Cook Inlet Bongo Tows, *Discoverer*, Leg V

Date (1976) (GMT)	(GMT)	Station	Haul	Mesh size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
6 May	1325	1	1	505	24	28	21 eggs 2.97-3.52 mm *Hippoglossoides* sp. (19 whole eggs, 2 yolksac embryos without membrane)
							3 eggs 1.28 mm unidentified
							2 young 49.0, 54 mm *Mallotus villosus*
							2 larvae 7.2 mm *Mallotus villosus*
							2 larvae 8.8, 11.3 Gadidae
							5 larvae 4.0 mm *Stenobrachius leucopsarus*
							4 larvae 3.6-5.2 mm *Theragra chalcogramma*
							1 larva 8.0 mm Scorpaenidae
							1 larva 4.8 mm Gadidae?
							3 larvae 5.0 mm damaged, unidentified
							8 larvae 6.0-7.0 mm Bathymasteridae
6 May	1552	2	1	333	0	26	4 larvae 7.7-18.0 mm *Sebastes* sp.
							1 larva 5.6 mm Cottidae
							1 larva 6.0 mm Scorpaenidae
							2 larvae 3.8 mm *Theragra chalcogramma*
							2 larvae 6.0 mm *Stenobrachius leucopsarus*
							9 larvae 7.7-8.1 mm Osmeridae
							5 larvae 3.8-5.0 mm Gadidae
							2 Larvae 5.6-18.0 mm Bathymasteridae

Table 8. (cont.) Lower Cook Inlet Bongo Tows, *Discoverer*, Leg V

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
6 May	1552	2	1	505	3	14	1 egg 1.68 mm *Argentina* sp.
							1 egg 1.48 mm *Glyptocephalus zachirus*
							1 egg 0.93 mm *Limanda* sp.
							2 larvae 3.8, 4.0 mm *Theragra chalcogramma*
							5 larvae 7.0-9.0 mm *Ammodytes* sp.
							2 larvae 4.8 mm *Sebastes* sp.
							1 larva 5.6 mm Scorpaenidae
							3 larvae 4.0 mm Gadidae
6 May	2117	3	1	333	41	13	5 eggs 1.33-1.50 mm unidentified
							36 eggs 0.97-1.10 mm unidentified
							9 larvae 4.8-6.0 mm *Ammodytes* sp.
							1 larva 4.8 mm damaged, unidentified
							2 larvae 3.6 mm, 4.0 mm Cottidae
6 May	2117	3	1	505	39	14	28 eggs 0.93-1.10 mm in blastodermal cap stage, unidentified
							5 eggs 0.93-1.10 mm with embryo, unidentified
							4 eggs 1.30-1.40 mm in blastodermal cap stage, unidentified
							1 larva 4.0 mm Cottidae

Table 8. (cont.) Lower Cook Inlet Bongo Tows, Discoverer, Leg V

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
6 May	2117	3	1	505	39	14	13 whole larvae + ½ tail 4.4-7.7 mm *Ammodytes* sp.
7 May	0259	4	1	333	0	3	1 larva 4.4 mm Cottidae
							1 larva ∿ 5 damaged Gadidae, may be *Theragra chalcogramma*
							1 larva > 6 mm extensively damaged, elongate unidentified
7 May	0259	4	1	505	0	2	2 larvae 5.2 mm *Ammodytes* sp.
7 May	1030	5	2	333	40	119	35 eggs 0.96-1.03 mm unidentified
							2 eggs 1.84-1.91 mm *Lyopsetta exilis*
							1 egg 1.20 mm opaque w/ no embryo
							2 eggs 1.76-1.84 mm *Lyopsetta exilis?*
							3 larvae 9.0 mm *Lyopsetta exilis*
							2 larvae 9.0-10.5 mm Cottidae
							1 larva 9.0 mm *Liparis* sp.
							1 larva 40.0 mm *Mallotus villosus*
							2 larvae 5.0 mm unidentified
							63 whole larvae 5.0-10.7 mm *Ammodytes* sp. plus ½ larvae head

Table 8. (cont.) Lower Cook Inlet Bongo Tows, *Discoverer*, Leg V

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
7 May	1030	5	2	333	40	119	1 larva 10.0 mm Tetragonuridae
							12 larvae 12.0-23.0 mm *Lumpenus sagitta*
							12 larvae 12.0-20.0 mm *Lumpenus maculatus*
							20 larvae 10.0-15.0 mm Pholidae
							1 larva 10.0 mm Cottidae
							1 larva 10.0 mm *Scorpaenichthys marmoratus*
7 May	1030	5	2	505	68	436	30 eggs 0.96-1.03 mm with embryos *Isopsetta isolepis*
							31 eggs 0.96-1.03 mm without embryos, probably *Isopsetta isolepis*
							3 eggs 1.80-1.88 mm *Lyopsetta exilis*
							1 egg 1.52 mm unidentified
							2 eggs 1.84-1.92 mm unidentified
							1 egg 1.20 mm unidentified
							8 larvae 8.1-10.0 mm *Lyopsetta exilis*
							1 larva 43.0 mm *Mallotus villosus*
							4 larvae unidentified
							30 larvae 12.0-23.0 mm *Lumpenus sagitta*
							37 larvae 12.0-24.0 mm *Lumpenus maculatus*
							105 larvae 8.0-10.0 mm *Ammodytes* sp.

Table 8. (cont.) Lower Cook Inlet Bongo Tows, *Discoverer*, Leg V

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
7 May	1030	5	2	505	68	436	138 larvae 6.0-10.0 mm *Ammodytes* sp.
							2 larvae 4.8 mm *Theragra chalcogramma*
							6 larvae 3.2-4.0 mm Gadidae
							5 larvae 9.0-12.0 mm Cottidae
							9 larvae 3.7-5.1 mm Cottidae
							1 larva 10.0 mm *Scorpaenichthys marmoratus*
							9 larvae 4.0-8.5 mm Cottidae
							19 larvae 4.8-6.2 mm Cottidae
							4 larvae 8.0-12.0 mm Cottidae
							2 larvae 9.3 mm *Sebastes* sp.
							2 larvae ∿ 29 mm *Spirinchus thaleichthys*
							38 larvae 9.0-11.0 mm Pholidae
							4 larvae Bathymasteridae
							2 larvae 9.0, 10.0 mm unidentified
8 May	0020	5a	1	333	48	182	45 eggs 0.96-1.03 mm *Isopsetta isolepis* (Lockington)
							3 eggs 1.28-1.36 unidentified
							159 larvae 7.0-10.0 mm *Ammodytes hexapterus* Pallas
							12 larvae 12.0-24.0 mm *Lumpenus* spp.

Table 8. (cont.) Lower Cook Inlet Bongo Tows, *Discoverer*, Leg V

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Fish Eggs and Larvae
8 May	0020	5a	1	333	48	182	3 larvae 3.7, 3.8, 4.8 mm *Isopsetta isolepis* (Lockington)
							5 larvae 4.7-9.6 mm Cottidae
							1 larva 7.9 mm Cottidae
							1 larva unidentified due to extensive damage, elongate
							1 larva 8.2 mm unidentified (2 rows of scutes along each side)
8 May	0020	5a	1	505	50	162	48 eggs 0.91-1.10 mm *Isopsetta isolepis* (Lockington)
							1 egg 1.30 mm Gadidae
							1 egg 1.69 mm unidentified
							143 larvae 5.7-8.5 mm *Ammodytes hexapterus* Pallas
							6 larvae 12.0-21.0 mm *Lumpenus* spp.
							6 larvae 4.0-5.9 mm *Isopsetta isolepis* (Lockington)
							6 larvae 5.0-8.4 mm Cottidae
							1 larva 7.4 mm Cottidae
7 May	1312	6	1	333	992	290	992 eggs 0.96-1.10 mm *Isopsetta isolepis* (Lockington)

Table 8. (cont.) Lower Cook Inlet Bongo Tows, *Discoverer*, Leg V

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Fish Eggs and Larvae
7 May	1312	6	1	333	992	290	84 larvae 4.0-6.3 mm *Ammodytes hexapterus* Pallas 184 larvae 9.0-14.0 mm *Lumpenus* spp. 2 larvae ∿ 4.4 mm *Sebastes* sp. 2 larvae ∿ 20.0 mm Hexagrammidae 18 larvae unidentified due to extensive damage, elongate
7 May	1312	6	1	505	1616	326	1616 eggs 0.98-1.10 mm *Isopsetta isolepis* (Lockington) 96 larvae 4.3-7.7 mm *Ammodytes hexapterus* Pallas 184 larvae 9.0-18.0 mm *Lumpenus* spp. 4 larvae 8.1 - 9.5 mm *Pholis* sp. 2 larvae ∿ 30.0 mm Osmeridae 40 larvae unidentified due to extensive damage, elongate
7 May	1709	6	2	333	1296	352	1280 eggs 0.96-1.08 mm *Isopsetta isolepis* (Lockington) 8 eggs ∿ 1.40 mm Gadidae 8 eggs ∿ 1.83 mm unidentified

Table 8. (cont.) Lower Cook Inlet Bongo Tows, *Discoverer*, Leg V

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Fish Eggs and Larvae
7 May	1709	6	2	333	1296	352	92 larvae 5.1-8.3 mm *Ammodytes hexapterus* Pallas
							220 larvae 9.7-17.0 mm *Lumpenus* spp.
							12 larvae 3.3-3.7 Cyclopteridae
							4 larvae ∿ 4.2 mm Cottidae
							24 larvae unidentified due to extensive damage, elongate
7 May	1709	6	2	505	364	236	362 eggs 0.96-1.10 mm *Isopsetta isolepis* (Lockington)
							2 eggs ∿ 1.95 mm unidentified
							44 larvae 4.4-7.3 mm *Ammodytes hexapterus* Pallas
							154 larvae 9.6-21.0 mm *Lumpenus* spp.
							4 larvae 8.2-9.5 mm *Apodichthys flavidus* Girard
							34 larvae unidentified due to extensive damage, elongate

Table 9. Identification of Fish Eggs and Larvae by Station

Gulf of Alaska 1-m NIO Tows, *Discoverer*, Leg V

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Fish Eggs and Larvae
7 May	1757	6	3	571	1096	352	1096 eggs 0.96-1.10 mm *Isopsetta isolepis* (Lockington)
							134 larvae 5.6-9.4 mm *Ammodytes hexapterus* Pallas
							214 larvae 12.0-22.0 mm *Lumpenus* spp.
							4 larvae 7.1-8.3 mm unidentified (same as unidentified larva from sta 5a, H#1, Bongo 333 μm)

Table 10. Number of fish eggs and larvae at each station

Lower Cook Inlet Bongo Tows, *Discoverer*, Leg VII

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae
24 May	0732	1	1	333	62	109
24 May	0732	1	1	505	62	98
25 May	1150	2	1	333	11	59
25 May	1150	2	1	505	6	58
25 May	1607	3	1	333	88	7
25 May	1607	3	1	505	85	7
25 May	2217	4	1	333	3	4
25 May	2217	4	1	505	1	3
26 May	0541	5a	2	333	28	70
26 May	0541	5a	2	505	85	167
26 May	0835	6	1	333	663	27
26 May	0835	6	1	505	615	30
26 May	1928	6	3	333	315	36
26 May	1928	6	3	505	284	30
27 May	0056	6	4	333	176	80
27 May	0056	6	4	505	183	76
27 May	0708	6	7	333	17	71
27 May	0708	6	7	505	35	75
27 May	1300	7	1	333	767	65
27 May	1300	7	1	505	731	51
27 May	1701	8	1	333	187	27
27 May	1701	8	1	505	206	22
30 May	1813	10	1	333	24	123
30 May	1813	10	1	505	18	59

Table 11. Summary of taxonomic categories of fish eggs, larvae, young and adults found in Bongo net samples collected on Lower Cook Inlet *Discoverer* cruise, Leg VII, 22-30 May 1976.

A total of 24 samples were collected. Samples from stations 2 and 5a are identified and summarized. The rest have yet to be analyzed. The eggs thus far were distributed into 2 families, 3 genera and 1 species. The fish were distributed into 9 families, 8 genera and 4 species.

Family Ammodytidae

140 larvae sandlance[1] *Ammodytes hexapterus* Pallas

Family Bathymasteridae

4 larvae genus? species?

Family Cottidae

7 larvae sculpin genus? species?

Family Cyclopteridae

37 larvae genus? species?

Family Gadidae

7 eggs genus? species?
2 larvae Alaska pollock *Theragra chalcogramma* (Pallas)

Family Pholidae

3 larvae penpoint gunnel *Apodichthys flavidus* Girard

Family Pleuronectidae

119 eggs butter sole *Isopsetta isolepis* (Lockington)
3 eggs *Hippoglossoides* sp.
1 egg *Limanda* sp.
33 larvae butter sole *Isopsetta isolepis* (Lockington)
5 larvae *Hippoglossoides* sp.

Family Scorpaenidae

1 larva rockfish *Sebastes* sp.

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1 The common name is presented for the first time for each species; thereafter only the scientific name is recorded.

Table 11 (cont.)

Family Stichaeidae

- 21 larvae cockscombs *Anoplarchus* sp.
- 8 larvae prickleback *Lumpenus* spp.
- 14 larvae genus? species?

73 larvae unidentified due to extensive damage
6 larvae unidentified

Table 12. Identification of Fish Eggs and Larvae by Station

Gulf of Alaska, Bongo Tows, *Discoverer*, Leg VII

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
25 May	1150	2	1	333	11[a]	59[a]	7 eggs 0.94-1.02 mm[b] *Isopsetta isolepis* (Lockington)
							3 eggs 1.34, 1.34, 1.40 mm Gadidae
							1 egg 3.12 mm *Hippoglossoides* sp.
							16 larvae 7.4-13.0 mm *Ammodytes hexapterus* Pallas
							3 larvae 14.0, 17.0, 18.0 mm *Apodichthys flavidus* Girard
							5 larvae 5.5-11.0 mm *Anoplarchus* sp.
							1 larva 6.7 mm Bathymasteridae
							1 larva 6.5 mm *Theragra chalcogramma* (Pallas)

[a] All specimens are classified into four main categories: eggs include all stages of eggs prior to hatching; larvae include newly hatched and all stages prior to metamorphosis; young include fish after metamorphosis to acquisition of adult fin rays and adult body configuration; adults include fish that are sexually mature.

[b] Eggs are measured to the nearest hundredths of a millimeter in diameter. Fish or larvae, if less than 10 mm in length, are measured to the nearest tenth of a millimeter under a microscope using a calibrated micrometer eye piece. If 10 mm or greater in length, the fish or larvae are measured by a metric ruler to the nearest millimeter. When there are more than three eggs, fish or larvae, the largest and the smallest are measured. Larvae are measured by standard length.

Table 12. (cont.) Gulf of Alaska Bongo Tows, *Discoverer*, Leg VII

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Eggs and Fish Larvae
25 May		2	1	333	11	59	8 larvae 4.9-6.5 mm *Isopsetta isolepis* (Lockington) 17 larvae 4.1-9.1 mm Cyclopteridae 8 larvae unidentified due to extensive damage, elongate
25 May	1150	2	1	505	6	58	6 eggs 0.93-1.00 mm *Isopsetta isolepis* (Lockington) 17 larvae 6.8-13.0 mm *Ammodytes hexapterus* Pallas 2 larvae 5.6, 18 mm *Lumpenus* spp. 3 larvae 5.5, 9.3, 9.5 mm *Anoplarchus* sp. 3 larvae 6.6, 6.7, 7.2 mm Bathymasteridae 1 larva 9.4 mm *Theragra chalcogramma* (Pallas) 1 larva 5.9 mm *Sebastes* sp. 2 larvae 6.9, 7.1 mm Cottidae 2 larvae 5.8, 6.4 mm Cottidae 1 larva 8.3 mm Cottidae 14 larvae 4.8-7.8 mm Cyclopteridae 2 larvae 5.2, 5.5 mm *Isopsetta isolepis* (Lockington)

Table 12. (cont.) Gulf of Alaska, Bongo Tows, *Discoverer*, Leg VII

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Fish Eggs and Larvae
25 May	1150	2	1	505	6	58	1 larva 4.4 mm *Hippoglossoides* sp.
							1 larva 4.7 mm unidentified (very intensely pigmented larva)
							8 larvae unidentified due to extensive damage
26 May	0541	5a	2	333	28	70	26 eggs 0.93-1.02 mm *Isopsetta isolepis* (Lockington)
							1 egg 1.36 mm Gadidae
							1 egg 3.28 mm *Hippoglossoides* sp.
							38 larvae 5.2-11.0 mm *Ammodytes hexapterus* Pallas
							2 larvae 15.0, 24.0 mm *Lumpenus* sp.
							5 larvae 4.7-5.9 mm *Anoplarchus* sp.
							6 larvae 10.0-17.0 mm Pholidae
							5 larvae 2.8-5.5 mm *Isopsetta isolepis* (Lockington)
							2 larvae 4.4, 4.5 mm *Hippoglossoides* sp.
							1 larva 3.4 mm Cottidae
							3 larvae 3.7, 4.3, 5.4 mm Cyclopteridae

Table 12. (cont.) Gulf of Alaska, Bongo Tows, *Discoverer*, Leg VII

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (m)	Eggs	Fish or Larvae	Identification of Fish Eggs and Larvae
26 May	0541	5a	2	333	28	70	2 larvae 1.9, 2.3 (yolk sac absorption has already occurred), unidentified
							6 larvae unidentified due to extensive damage (5 elongate, 1 other)
26 May	0541	5a	2	505	85	167	80 eggs 0.91-1.06 mm *Isopsetta isolepis* (Lockington)
							3 eggs 1.34-1.38 mm Gadidae
							1 egg 2.56 mm *Hippoglossoides* sp.
							1 egg 0.79 mm *Limanda* sp.
							69 larvae 5.5-17.0 mm *Ammodytes hexapterus* Pallas
							4 larvae 19.0-24.0 mm *Lumpenus* sp.
							8 larvae 4.7-7.0 mm *Anoplarchus* sp.
							8 larvae 9.6-18.0 mm Pholidae
							18 larvae 2.1-6.7 mm *Isopsetta isolepis* (Lockington)
							2 larvae 5.3, 6.1 mm *Hippoglossoides* sp.
							1 larva 7.1 mm Cottidae
							3 larvae 3.0, 4.3, 4.7 mm Cyclopteridae
							2 larvae 2.3, 3.4 mm, unidentified

Table 12. (cont.) Gulf of Alaska, Bongo Tows, *Discoverer*, Leg VII

Date (1976) (GMT)	Time (GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae	Identification of Fish Eggs and Larvae
May 26	0541	5a	2	505	85	167	1 larva 6.8 mm, unidentified (2 rows of scutes on each side of body; spines on head) 51 larvae unidentified due to extensive damage (45 elongate, 6 others)

Table 13. Number of fish eggs and larvae at each station

Lower Cook Inlet Bongo Tows, *Acona*, Leg II

Date (1976) (GMT)	(GMT)	Station	Haul	Mesh Size (μm)	Eggs	Fish or Larvae
12 Jul	1133	2	1	333	24	1264
12 Jul	1133	2	1	505	16	1328
12 Jul	0018	5	1	505	346	658

Gulf of Alaska station and then back into Kodiak. The interference lines on the chart record were from the Ross fathometer on the bridge. A total of 9330 minutes of chart records was made, 3663 minutes of which were recorded on station. 103 minutes of magnetic tape records were made.

B. *Surveyor*, Leg II

The *Surveyor*'s hull-mounted transducer was in continual use while underway to give a sonic chart record of transects up Cook Inlet (sta 1-4), across Cook Inlet (sta 6, 3, 8), out to the Gulf of Alaska (sta 7, 9, 10, 11), and a transect up to Prince William Sound (sta 11, 14, 13). Approximately 9,431 minutes of chart records and 70 minutes of magnetic tape records were made.

IV. Preliminary interpretation of results

A. *Acona*, Leg II

Ichthyoplankton was caught at all stations. Phytoplankton was present in large quantities at stations 1, 2, 9 and 10, and to a lesser extent at station 11. Vertical migration was evident at stations 6 and 11 as seen from the sonic chart records and the day and night net tows. Some adult myctophids were caught at station 11. Shrimp and crab larvae were caught at most of the stations.

B. *Surveyor*, Leg II

Ichthyoplankton was caught at almost every station. Shrimp larvae were caught at 10 of the stations and crab larvae were caught at about 1/3 of the stations. Vertical migration was evident at stations 6 and 11 as seen from sonic chart records. A large number of sticklebacks were caught at station 4. Some adult myctophids were caught at stations 11 and 13.

QUARTERLY REPORT

(Supplement to Special Report 13 August)

Research Unit #156/164b
Reporting Period:
1 July 76 - 30 Sept. 76
10 pages

INITIAL ZOOPLANKTON INVESTIGATIONS IN LOWER COOK INLET

Dr. David M. Damkaer

Principal Investigator

Pacific Marine Environmental Laboratory

National Oceanic and Atmospheric Administration

3711 15th Avenue N.E.

Seattle, Washington 98105

28 September 1976

I. TASK OBJECTIVES

A. General scope of the study

Zooplankton are important components of the environment in terms of volume, in terms of their roles in the ecosystem, and in terms of probable sensitivity to the kinds of development anticipated on the Alaska OCS. Zooplankton are necessary for the maintenance of fish, shellfish, and other living resources. Zooplankton are also important in the movement and concentration of environmental contaminants. In the northeastern Pacific, particularly its estuaries and coastal seas, relatively little is known of the distribution and abundance, seasonal cycles, or vertical distributions and migrations of zooplankton. Assessments of these factors are necessary for the study of ecological processes relevant to environmental problems.

B. Specific objectives

The objectives of this project are to determine the seasonal distribution and abundance of zooplankton in selected areas of the Gulf of Alaska, especially Lower Cook Inlet. Particular attention is being given to the distributions of copepods (the most abundant net-plankton and the key grazers), amphipods and euphausids (important food for fishes), chaetognaths (key carnivores), larval decapods, and some other groups. All major taxa are enumerated as such whether or not the individual species can be identified. This work will lead to development of a monitoring strategy. Also, it will ultimately contribute to an ecosystem model by defining pathways and amounts of energy or material flow and indicating the relative importance of the several populations.

II. FIELD AND LABORATORY ACTIVITIES

A. Field Studies

This project was first directed into Lower Cook Inlet in April of this year, and in the six months since, we have taken five cruises to Cook Inlet:

Cruise I	6 - 13 April 1976	NOAA DISCOVERER
Cruise II	5 - 9 May 1976	NOAA DISCOVERER
Cruise III	24 - 30 May 1976	NOAA DISCOVERER
Cruise IV	8 - 15 July 1976	U. of Alaska ACONA (Fig. 1)
Cruise V	24 - 31 Aug. 1976	NOAA SURVEYOR (Fig. 2)

The cruises included transects across the open continental shelf, for comparative purposes. Cruises I, III, and V also included a transect into another inshore area.

On each of these cruises, the project was ably represented by Mr. Douglas B. Dey, Oceanographer, Pacific Marine Environmental Laboratory/ NOAA. Mr. Dey was responsible for the collection of samples and data.

B. Methods

On the five cruises zooplankton was sampled at noon and midnight with closing ring nets of 60 cm diameter and 211 micron mesh. These nets were hauled vertically through strata of varying thicknesses, obtaining discrete samples, depth permitting, as follows: 25-0 m; 50-25 m; 100-50 m; 300-100 m; 500-300 m; the bottom-500m. In addition, at each station samples were obtained with a bongo net. The distribution of the samples between the cruises is as follows:

	Vertically Hauled Net	Bongo Net	
Cruise I (April)	51	26	
Cruise II (early May)	17	22	
Cruise III (late May)	43	28	
Cruise IV (July)	34	24	
Cruise V (August)	30	34	
	175	134	(Total 309)

Volume of water sampled was estimated as the product of wire length and the area of the net, assuming that filtration was 100%. There was little evidence of mesh clogging by phytoplankton, except in Kachemak Bay on Cruise II.

In the laboratory, each zooplankton sample is allowed to settle overnight in a graduated cylinder and the settled volume of the sample is recorded. The large or otherwise conspicuous organisms are then removed and enumerated. The smaller organisms are identified and enumerated from a subsample. Displacement plankton volumes were determined on board during Cruises IV and V.

Laboratory analyses have proceeded primarily on the samples from the vertically-hauled nets from the first 3 cruises. Most of those samples have been sorted to major groups.

III. RESULTS

The 0-25 m plankton volumes from Kachemak Bay (Station 6), Lower Cook Inlet, as a measure of zooplankton biomass, indicate a minimum in early April, and a peak in early May, dropping rapidly by late May and fluctuating around a moderate level through August. Mean plankton volumes from day and night samples are given in Table 1, and these values for the upper 25m are plotted in Figure 3, where they are compared to plankton volumes from the open ocean just off the continental shelf (Station 11). The 0-25 m values for Cruise II Station 6 (Kachemak Bay) do not strictly represent zooplankton volumes, for there was considerable phytoplankton which clogged the meshes and also resulted in an over-estimate of "zooplankton" volume. Therefore, it cannot yet be stated whether or not that value represents a real seasonal zooplankton maximum or if it is more nearly comparable to the moderately high zooplankton volumes found there during Cruise III.

The zooplankton volume in the entire water column of Kachemak Bay (72 m) showed the same trend, a minimum in April, perhaps a maximum in early May, and moderately high and fluctuating values from late May through August (Table 1).

The zooplankton volumes of the upper 25m at Station 11 (open ocean) may not fluctuate seasonally as much as at Kachemak Bay. Also, the seasonal increases at Station 11 may lag behind those of Kachemak Bay. By late August, the mean 0-25 m zooplankton volumes were identical at the two locations (Figure 3).

Because of the irregular occurrence of dense phytoplankton "blooms", it is difficult to interpret the "zooplankton" volumes from other stations within Lower Cook Inlet. Also, because of the great differences in depth between the various stations, only the 0-25 m samples can be strictly compared. In general, the zooplankton volumes were higher in this layer at night than during the day. Before this investigation, it was believed that the abundances and cycles of zooplankton in Kachemak Bay might differ from those of the open parts of Cook Inlet. The 0-25 m day and night mean zooplankton volumes were probably equal in the 2 regions. During Cruise II (early May) it appeared that the zooplankton volume in Kachemak Bay was higher than in the rest of Cook Inlet, but the presence of large amounts of phytoplankton in Kachemak Bay obscures this comparison. The zooplankton volumes during Cruise III (Late May) were probably slightly higher in Kachemak Bay, while during Cruise IV (July) the reverse was true. By Cruise V (late August) the zooplankton volumes in the two regions were comparable.

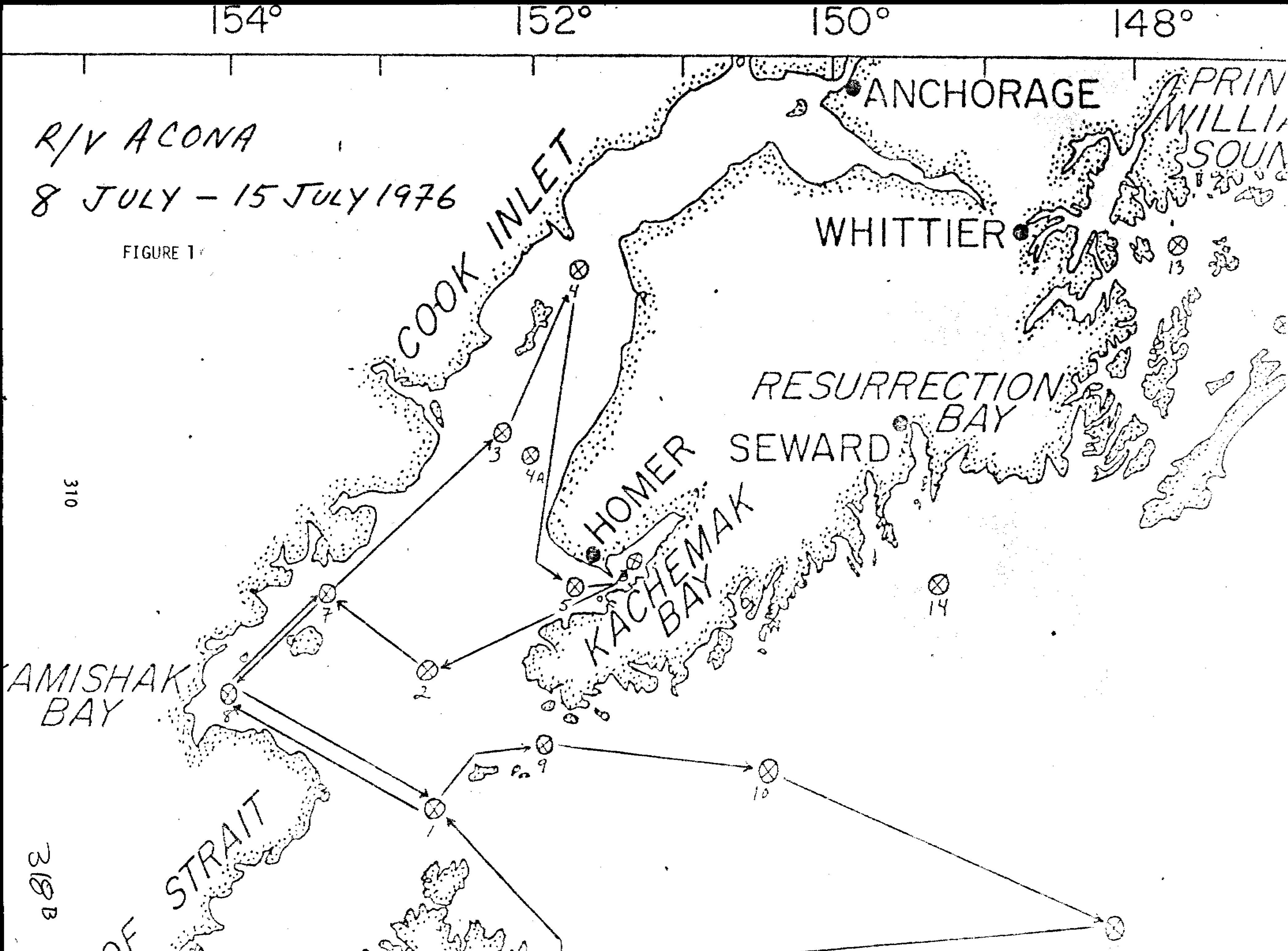
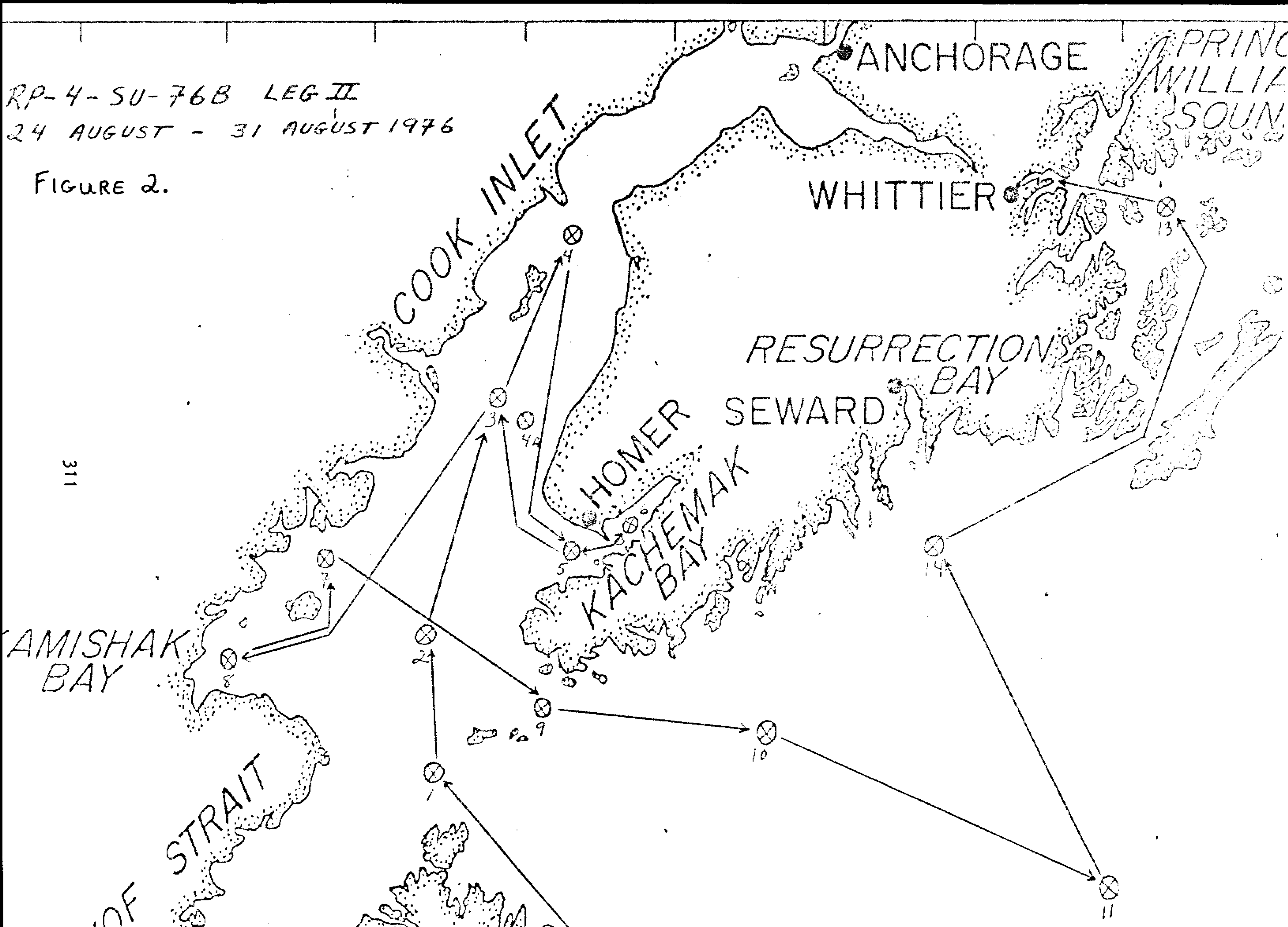

154°
152°
150°
148°
R/V ACONA
8 JULY – 15 JULY 1976
ANCHORAGE
PRINCE WILLIAM SOUND
WHITTIER
COOK INLET
RESURRECTION BAY
SEWARD
HOMER
KACHEMAK BAY
KAMISHAK BAY
STRAIT
1
2
3
4
4A
5
7
8
9
10
13
14

FIGURE 1



RP-4-SU-76B LEG II
24 AUGUST - 31 AUGUST 1976

FIGURE 2.

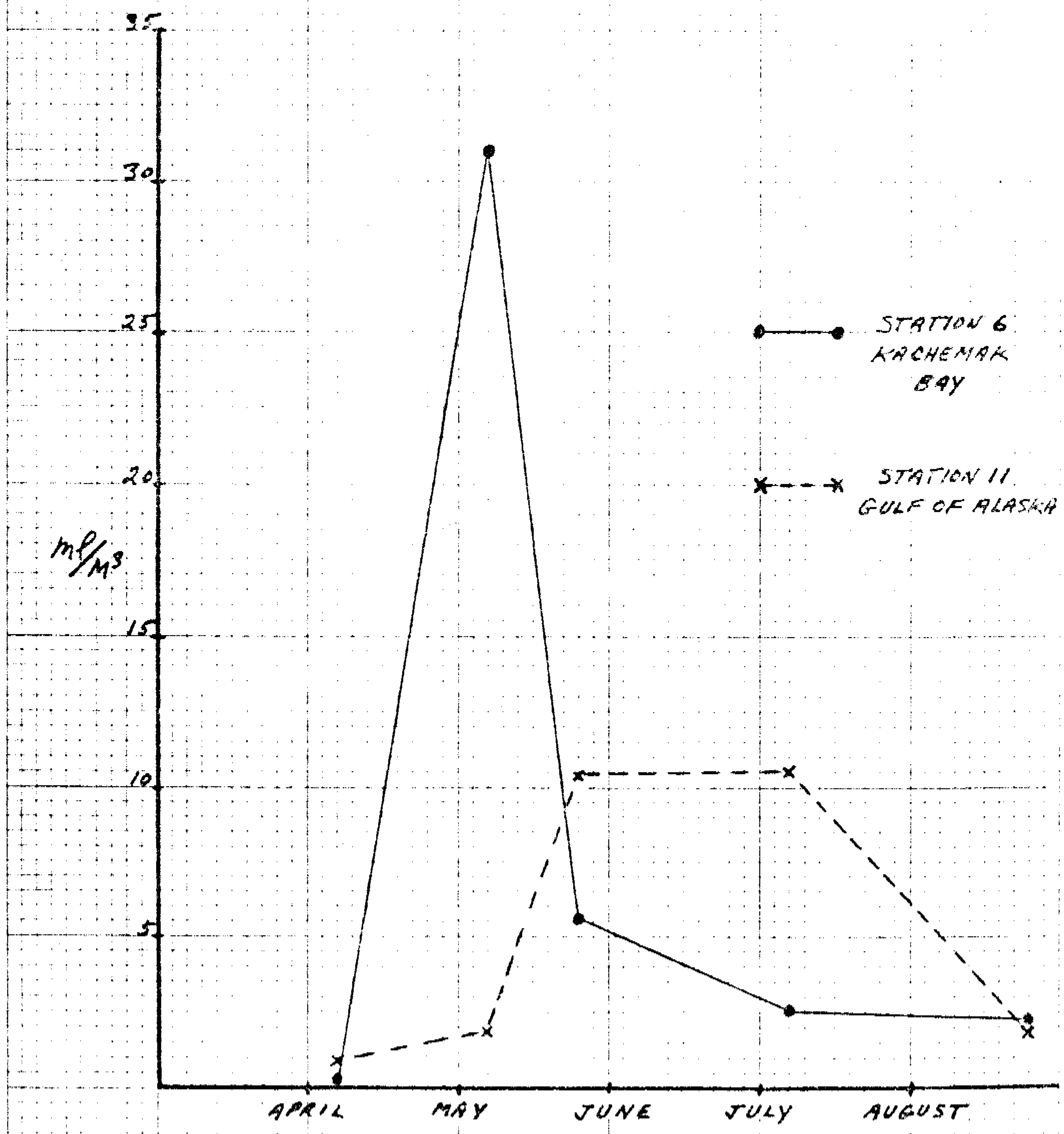


Figure 3. Zooplankton settled volumes, mean of all samples;
Kachemak Bay (Station 6) and Open Ocean (Station 11); upper 25 m.

Table 1. Zooplankton settled volumes, mean of all samples; Kachemak Bay (Station 6) and Open Ocean (Station 11).

		I Early April	II Early May	III Late May	IV Early July	V Late August
Kachemak Bay (Station 6)						
(72 m)	Upper 25 m, ml/m^3	0.3	31.0	5.6	2.6	2.2
	Water column, ml/m^3	0.6	14.3	3.0	1.3	2.8
	Water column, ml/m^2	43.2	1029.6	216.0	93.6	203.6
Open Ocean (Station 11)						
(1400 m)	Upper 25 m, ml/m^3	0.9	1.9	10.4	10.5	1.9
	Upper 500 m, ml/m^3	1.1	1.6	1.3	2.3	2.1
	Water column, ml/m^3	0.5	-	0.6	0.9	-
	Upper 500 m, ml/m^2	550.0	800.0	650.0	1150.0	1030.0
	Water column, ml/m^2	750.0	-	840.0	1260.0	-

Table 2. Zooplankton settled volumes (ml/m^3), mean of day samples and mean of night samples; Kachemak Bay (Station 6) and other Lower Cook Inlet stations (Stations 2-8A); upper 25 m.

		Open Lower Cook Inlet	Kachemak Bay
Cruise I (early April)	Day	0.6	0.1
	Night	0.4	0.4
Cruise II (early May)	Day	0.3	31.0
	Night	4.7	-
Cruise III (late May)	Day	0.6	3.6
	Night	3.1	7.6
Cruise IV (early July)	Day	5.5	1.5
	Night	15.3	3.6
Cruise V (late August)	Day	1.5	1.9
	Night	1.1	2.6

Quarterly Report

Research Unit # ~~425~~ 156/164c

Reporting Period:

July - September, 1976

PHYTOPLANKTON AND PRIMARY PRODUCTIVITY IN THE NORTHEAST GULF OF ALASKA

Principal Investigator: Jerry D. Larrance

Report prepared by: Jerry D. Larrance and David A. Tennant

Pacific Marine Environmental Laboratory

National Oceanic and Atmospheric Administration

3711 15th Avenue N.E.

Seattle, Washington 98105

October 1, 1976

I. TASK OBJECTIVES

The primary objective of the work accomplished during the past quarter was to determine the time succession of primary production, phytoplankton standing stocks and species during the spring in lower Cook Inlet and Prince William Sound. This work has been modified from the original task concerning phytoplankton and primary production which involved broad scale surveys in the Gulf of Alaska.

II. FIELD ACTIVITIES

A. Field Trip Schedule

Cruise Number	Date	Ship
RP4AC76 Leg II	July 8-July 15, 1976	R/V ACONA
RP4DI76B Leg I	July 19-July 31, 1976	OSS DISCOVERER
RP4SU76B Leg II	August 24-August 31, 1976	OSS SURVEYOR

B. Scientific Party

ACONA Cruise

David A. Tennant, PMEL, Oceanographer

Alexander J. Chester, PMEL, Oceanographer

Patricia Ruffio, PMEL, Biological Technician

Mona Beckert, PMEL, Biological Technician

DISCOVERER Cruise

Patricia Ruffio, PMEL, Biological Technician

SURVEYOR Cruise

David A. Tennant, PMEL, Oceanographer

Alexander J. Chester, PMEL, Oceanographer

Patricia Ruffio, PMEL, Biological Technician

Mona Beckert, PMEL, Biological Technician

C. Methods

Phytoplankton and microzooplankton were sampled in Niskin bottles attached to a Rosette sampler during the DISCOVERER and SURVEYOR cruises and to a hydrowire during the ACONA cruise. In both systems, CTD profiles were made simultaneously with the plankton sampling.

Ten depths between the surface and fifty meters were sampled routinely to ascertain pigment and nutrient concentrations and phytoplankton abundance and species identity. Stations 5, 7 and 8 were sampled to about 30 meters depth.

Primary production was measured by simulating *in situ* conditions. Deck incubators constructed of acrylic tubing wrapped at intervals with cloth layers which passed the same amount of light as that reaching the depth of water sampled were used. A Secchi disk and an underwater quantum sensor were used to determine the light penetration within the water column. Eight light depths (92%, 61%, 46%, 24%, 11%, 5.4%, 1.5% and 1%) were sampled and incubated once or twice a day. Incubation time was from sunrise to local apparent noon (LAN) and from LAN to sunset. Production was determined by the Carbon-14 method. Samples were counted in a Packard® [1]/2425 liquid scintillation spectrometer.

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1. ® Packard Instrument Corp., 2200 Warrenville Rd., Downers Grove, Illinois.

Chlorophyll a and phaeopigment concentrations were determined by fluorometric techniques described in Strickland and Parsons (1968) and Yentsch and Menzel (1963). Modifications to the basic techniques were applied so that a smaller sample could be obtained. Seawater was filtered through glass-fiber filters onto which a few mg $MgCO_3$ was applied. The filter was placed in a centrifuge tube with 10 ml of 90% distilled acetone and sonicated for 1 min using a Megason Sonic Disintegrator®[1]. The samples were then refiltered and the fluorescence of the filtrate was determined according to the standard techniques. All pigment analyses were conducted immediately after sampling.

Phytoplankton cells were preserved in a 1% sodium acetate-buffered formalin solution and returned to Seattle for examination. Abundance and identity of the cells were determined by the Utermöhl (1931) inverted microscope technique.

Water was frozen in polyethylene bottles and returned to Seattle for nutrient determination. Nitrate, nitrite, phosphate, ammonia and silicate were determined by the Auto Analyzer®[2] method at the University of Washington, Department of Oceanography.

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1. ® Ultrasonic Instruments, International, Ltd., Farmingdale, New York.

2. ® Technicon Instrument Corp., Terrytown, New York

Incident solar radiation was measured with a pyranometer and a quantum sensor, both connected to strip-chart recorders. One of the recorders was fitted with a mechanical integrator which readout provided solar energy per unit time.

D. Sample Localities

ACONA cruise; Figure 1, Stations 1 - 11.

DISCOVERER cruise; Figure 2, All stations.

SURVEYOR cruise; Figure 1, Stations 1 - 14.

E. Data collected and analyzed.

Numbers of observations and samples collected and analyzed are listed in Table 1.. Only a portion of those listed are discussed in this report because analysis of the data is continuing. Results from the entire study will be treated in a forthcoming final report.

Table I - Number and type of samples collected and analyzed.

Sample type	No. of Samples	No. of Analyses	Cruise
Incident solar radiation (pyranometer)	6 days 7 days	6 days 7 days	ACONA SURVEYOR
Incident solar radiation (quantum sensor)	6 days 7 days	6 days 0	ACONA SURVEYOR
Water Transparency (quantum sensor)	5 casts 5 casts	5 casts 5 casts	ACONA SURVEYOR
Water Transparency (Secchi disk)	15 casts 13 casts	15 casts 13 casts	ACONA SURVEYOR
Conductivity-temperature-depth (CTD)	18 casts 25 casts	18 casts 0	ACONA SURVEYOR
Surface chlorophyll _a_ (_in vivo_)	6 days 1/2 day	0 0	ACONA SURVEYOR
Chlorophyll _a_	202 samples 330 samples 192 samples	202 samples 330 samples 192 samples	ACONA DISCOVERER SURVEYOR
Phaeopigments	202 samples 330 samples 192 samples	202 samples 330 samples 192 samples	ACONA DISCOVERER SURVEYOR
Nutrients (five nutrients/sample)	203 samples 184 samples	203 samples 184 samples	ACONA SURVEYOR
Phytoplankton I.D. and abundance	203 samples 192 samples	0 0	ACONA SURVEYOR
Microzooplankton I.D. and abundance	16 samples 24 samples	0 0	ACONA SURVEYOR
Primary Production	168 samples 240 samples	168 samples 0	ACONA SURVEYOR

III. RESULTS AND INTERPRETATION

Much of the data on hand has been reduced and listed in Tables II, III and IV. Primary productivity and plant pigments are integrated over depth in the upper layers and daily totals of incident radiation are listed. Nitrate concentrations (Table IV) were selected for discussion because they are most often the critical of the plant nutrients when nutrient limitation of primary production occurs. Chlorophyll *a* data was collected on the DISCOVERER cruise to the Gulf of Alaska in support of suspended particulate matter studies by Dr. Feely and will be discussed elsewhere.

Lower Cook Inlet.

The changes in chlorophyll *a* from April through August were typical of spring and summer successions of phytoplankton quantities in northern temperate waters (figure 3). Chlorophyll *a* throughout lower Cook Inlet was low (< 25 mg/m^2) in early April, increased steadily through early July (25-240 mg/m^2) then decreased to less than 25 mg/m^2 again by late August. Average values of chlorophyll, nitrate and insolation for stations 1-9 are shown in figure 4. During early April there were sufficient amounts of nitrate for vigorous phytoplankton growth but sunlight values were low. As light energy increased with time there was a concomitant increase in chlorophyll *a* and decrease in nitrate concentration until early July. By late August chlorophyll *a* was less than one-third of what it was in July, nitrate decreased slightly, and insolation decreased sharply. Corresponding average productivity values for April, early and late May, and July were 250, 1720, 4880, and 2470.

Figures 5 and 6 show the vertical distribution of chlorophyll a and nitrate and the extent of nitrate depletion in the euphotic zone. Sigma-T plotted in figure 5 indicates that the water column is partially mixed to stratified. The strong tidal circulation in Cook Inlet might prevent a well-developed pycnocline in localized areas.

Kachemak and Kamishak Bays.

Kachemak Bay (stations 5 and 6) is the most productive area in lower Cook Inlet. Primary productivity and chlorophyll a concentrations were consistently greater than elsewhere in lower Cook Inlet by as much as two orders of magnitude (figure 3). Productivity in Kachemak Bay increased about ten-fold between early April and late May and remained about that level through early July then decreased to about one-half its peak by late August. Chlorophyll a concentrations increased at a similar rate and returned to nearly the April concentrations by late August.

Primary productivity in Kamishak Bay increased almost 100 times from April to July while chlorophyll a concentrations increased about ten fold. Chlorophyll a concentrations were typically 0.1 as high as those in Kachemak Bay and primary productivity was about 0.1 to 0.5 as great in Kamishak as in Kachemak Bay.

Nitrate concentrations in Kachemak Bay decreased rapidly from early April to late May, then remained very low in the surface layer through late August. Nitrate concentrations decreased sharply in Kamishak Bay between late May and early July and increased rapidly by late August.

A pronounced pycnocline developed in Kachemak Bay by late May and persisted at least through early July (figures 5 and 7). A well-developed pycnocline in Kamishak Bay, however, was never observed.

Stations 3 and 4.

These stations were characterized by turbidity and low productivity. The euphotic zone at station 4 was extremely shallow, ranging from 1 - 3m. The high turbidity was primarily due to terrigenous material. Maximum production at station 3 was about one-tenth that in Kachemak Bay and occurred during early July. Chlorophyll a values increased five-fold from early April to late May and early July; maximum values were about one-third of those in Kachemak Bay.

Prince William Sound.

Station 13 was sampled only during early April, late May and late August and primary production values are available for only the first two of those cruises. A phytoplankton bloom was in progress during early April; chlorophyll a concentrations were about 100 mg/m^2 (0-50m) and primary production was about 1000 $mg/m^2/day$ (0-1% light depth). Nitrates were plentiful and the water column was well mixed. By late May the chlorophyll a concentration had roughly doubled, primary production was 2-4 times greater, the water had stratified considerably and nitrates were about half the April concentrations. By late August the chlorophyll a concentration had decreased to 39 mg/m^2 (0-50m) and nitrates were depleted in the surface layer. Insolation increased five-fold between April and July. The progression of events at station 13 was much the same as in Kacheimak Bay but the bloom started earlier in Prince William Sound.

Station 11.

Station 11 appears to be of quasi-oceanic nature. Being about 200 miles offshore, the suspended load (not measured) is nil and the euphotic zone relatively deep (28-35m). Chlorophyll a concentrations approximately doubled between early April and late May then decreased

20% by late August. Nitrate concentrations were depleted in the surface layers by early July, then increased slightly by late August.

SUMMARY

1. Kachemak Bay (stations 5 and 6) and station 13 in Prince William Sound appear to be the most productive areas sampled and remain highly productive for the longest period of time.

2. Primary productivity at stations 3 and especially 4 was relatively low presumably because the heavy suspended load restricted light penetration (see OCSEP quarterly report April - June, 1976).

3. At most stations, chlorophyll a concentrations and primary production increased about an order of magnitude between early April and late May, maintained a high level through early July, then decreased to near the early April level by late August. Concomitantly, nitrate concentrations tended to be high in early April, diminish rapidly after early May, became depleted in surface layers by early July and were slightly replenished by late August. Daily insolation increased several fold and the water column became stratified as the season progressed. Thus, the succession of events from early April through late August was rather typical of northern temperate waters. That is, a spring phytoplankton bloom is generated by greater daily insolation and seasonal density stratification of the upper waters which combine to provide more light energy to the cells. Subsequently, nutrient depletion occurs in the upper mixed layer caused by intense photosynthesis and production, and standing stocks decrease in mid summer.

Table II. Primary production (mg C/m^2/day) values integrated from surface to the one-per-cent-light depth obtained during late May, 1976.

Station	Production	1% LD(m)
2	7522	17
6B	2970	10 (assumed)
6D	6652	11
7	2321	5.5
11	7176	35 (assumed)
13B	1885	16
13F	3978	15 (assumed)

Table III. Data Summary. July 1 - Sept. 30, 1976.

Pigment values are integrated 0-50m for ACONA-SURVEYOR cruises and 0-60 m for DISCOVERER cruise unless otherwise indicated. Production values are integrated 0-1% light depth.

Cruise/ Station	Chlorophyll *a* (mg/m^2)	Phaeo-pigments (mg/m^2)	Carbon uptake ($mg/m^2/day$)	Incident Radiation (ly/day)	1% Light Depth (m)
ACONA/1	181	26			
2	137	15		353	16
3	26	27	548	587	14
4	78	18			3 (assumed)
5	238	45 (0-30M)			16
6A	55	17			8
6B	57	21			
6C	74	17	2825	358	8 (assumed)
6D	69	14			10
6E	93	11	2988	358	12
6F	85	13			8
6G	127	15			8
7A	71	3 (0-30m)			16
7B	63	3 (0-23m)			16
8A	57	9 (0-23m)			18
8B	91	11 (0-25m)	3641	353	17
9	240	37			16
10	75	9	1566	351	16 (assumed)
11A	61	6			36
11B	40	10			22
11C	35	4	2402	348	
11D	51	5			36
SURVEYOR/1	26	5			41
2	32	3			
3A	34	13			14
3B	44	20			10
4	61	44			3
5	68	11 (0-40m)			
6A	57	13			14
6B	50	13			8
6C	42	12			
6D	64	13			10
6E	42	13			
6F	29	9			
7	26	8 (0-30m)			
8	50	5 (0-30m)			
9	48	9			14
10	35	6			31

Table III. Continued

Cruise/ Station	Chlorophyll a (mg/m^2)	Phaeo-pigments (mg/m^2)	Carbon uptake ($mg/m^2/day$)	Incident Radiation (ly/day)	1% Light Depth (m)
SURVEYOR /11A	29	4			
11B	48	6			24
13	38	4			38
14	56	7			35
DISCOVERER /1	46	13			
2	38	18			
3	60	10			
4	42	14			
5	15	4			
6	37	6			
7	37	5			
8	38	9			
9	37	7 (0-21M)			
10	133	11			
11	71	19			
12	44	12			
13	13	21			
14	7	37			
15	6	29			
16	20	28			
17	24	30			
18	20	27			
19	62	10			
20	44	12			
22	63	21			
25	57	20 (0-45m)			
27	29	10			
28	98	17			
29	78	11			
30	27	7			
31	72	11			
32	103	27			
33	70	9			
34	42	10			
36	59	12			
37	45	10			
38	47	7 (0-44m)			
39	31	4 (0-25m)			
40	43	7 (0-25m)			

Table III. Continued

Cruise/ Station	Chlorophyll a (mg/m^2)	Phaeo-pigments (mg/m^2)	Carbon uptake ($mg/m^2/day$)	Incident Radiation (ly/day)	1% Light Depth (m)
DISCOVERER/41	40	5			
42	31	4			
43	32	11			
44	51	10			
45	33	7			
46	35	6			
47	48	16			
48	96	9			
49	45	25			
50	30	12			
51	53	14			

Table IV. Nitrate concentrations (mg at/m^2) integrated from surface to 25 m., April - August, 1976.

Station	Early April	Early May	Late May	Early July	Late August
1		414	288	128	87
2A	534	419	296	138	115
2B	356				
3A	473	368	268	175	135
3B					292
4	430	406	406	245	238
5A	435	234	2	68	125
5B	342	195			
6A	390	186	66	90	59
6B	326	226	66	90	67
6C	319	128	51	92	81
6D	310		49	80	61
6E	426		63	70	88
6F	358		38	98	
6G	408				
7A	298	372	216	56	286
7B				38	
8A	332	383	240	52	309
8B				33	
9	330	424		79	158
10	307	370	294	44	114
11A	304	434	281	109	131
11B	307		238	122	135
11C	342		216	144	
11D				111	
13A	239		98		3
13B	291	151			
13C	280		112		
13D	272		109		
13E	278		109		
13F	275		117		
14	434		296		71

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Utermöhl, H. (1931). Neue Wege in der quantitativen Erfassung des Planktons. Verh. int. Verein, theor. angew. Limnol. 5: 567-596.

Yentsch, C. S. and D. W. Menzel (1963). A method for the determination of phytoplankton chlorophyll and phaeophytin by fluorescence. Deep Sea Res. 10: 221-231.

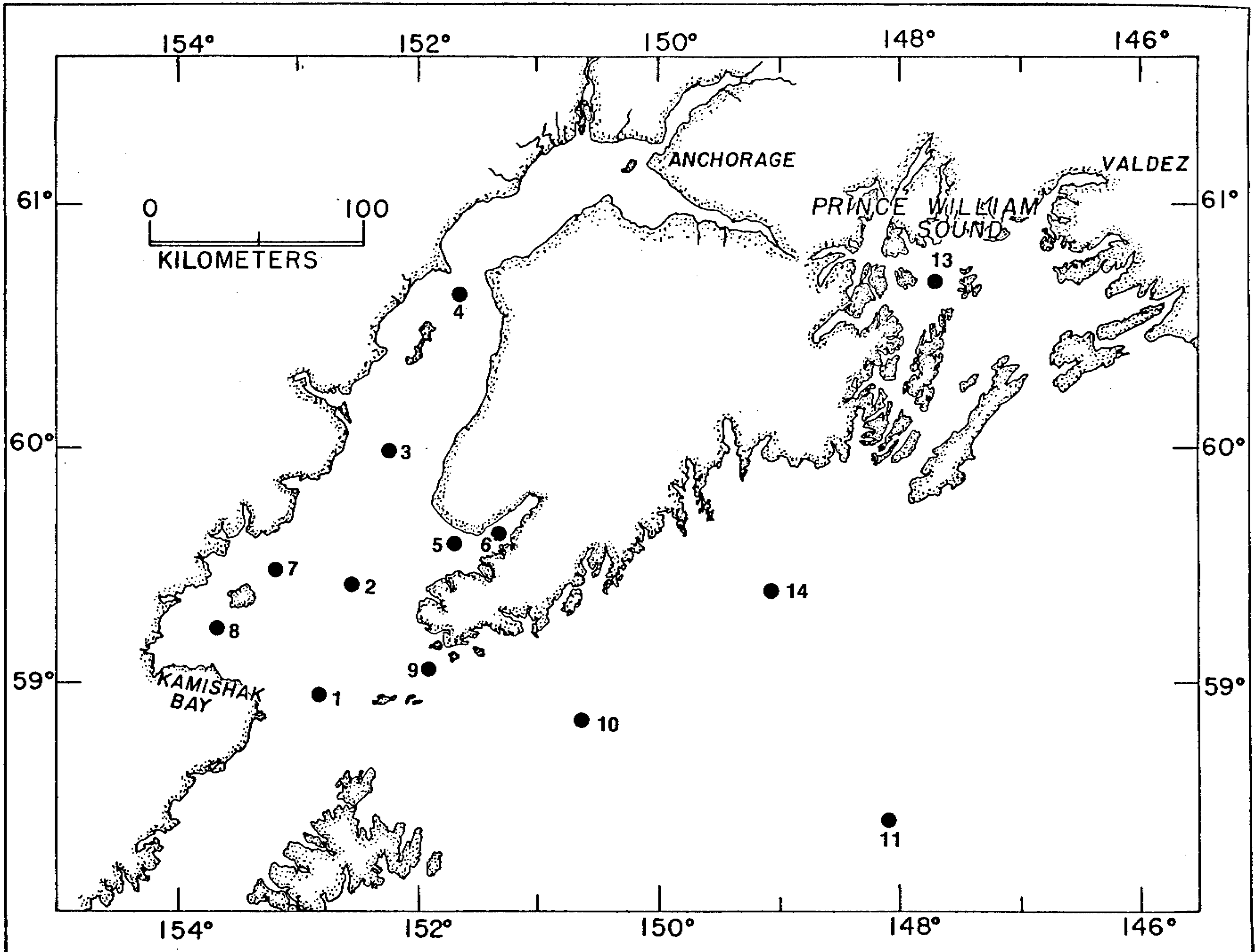


FIGURE 1. Station locations for ACONA and SURVEYOR cruise.

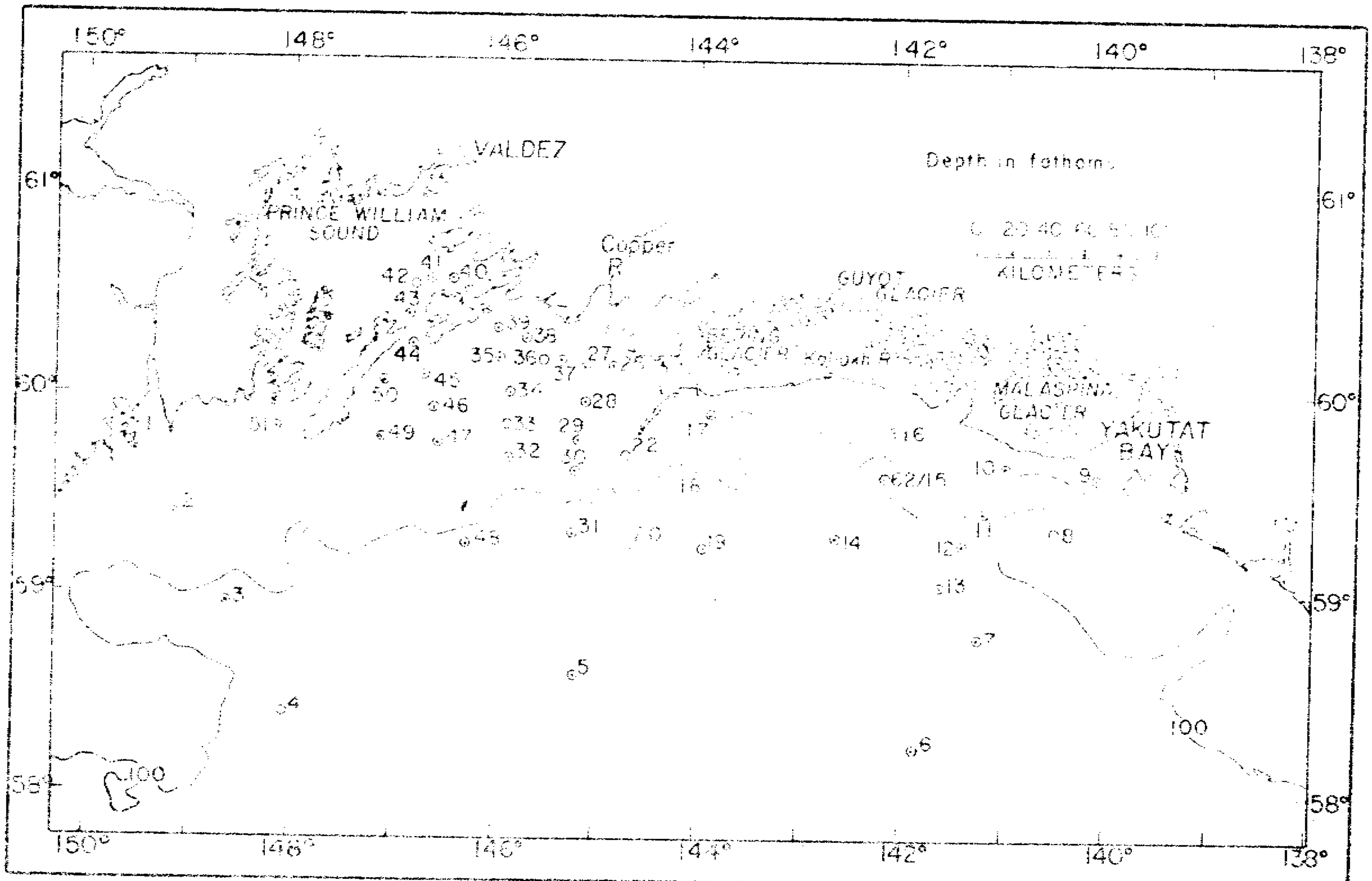


Figure 2. Stations sampled on DISCOVERER cruise.

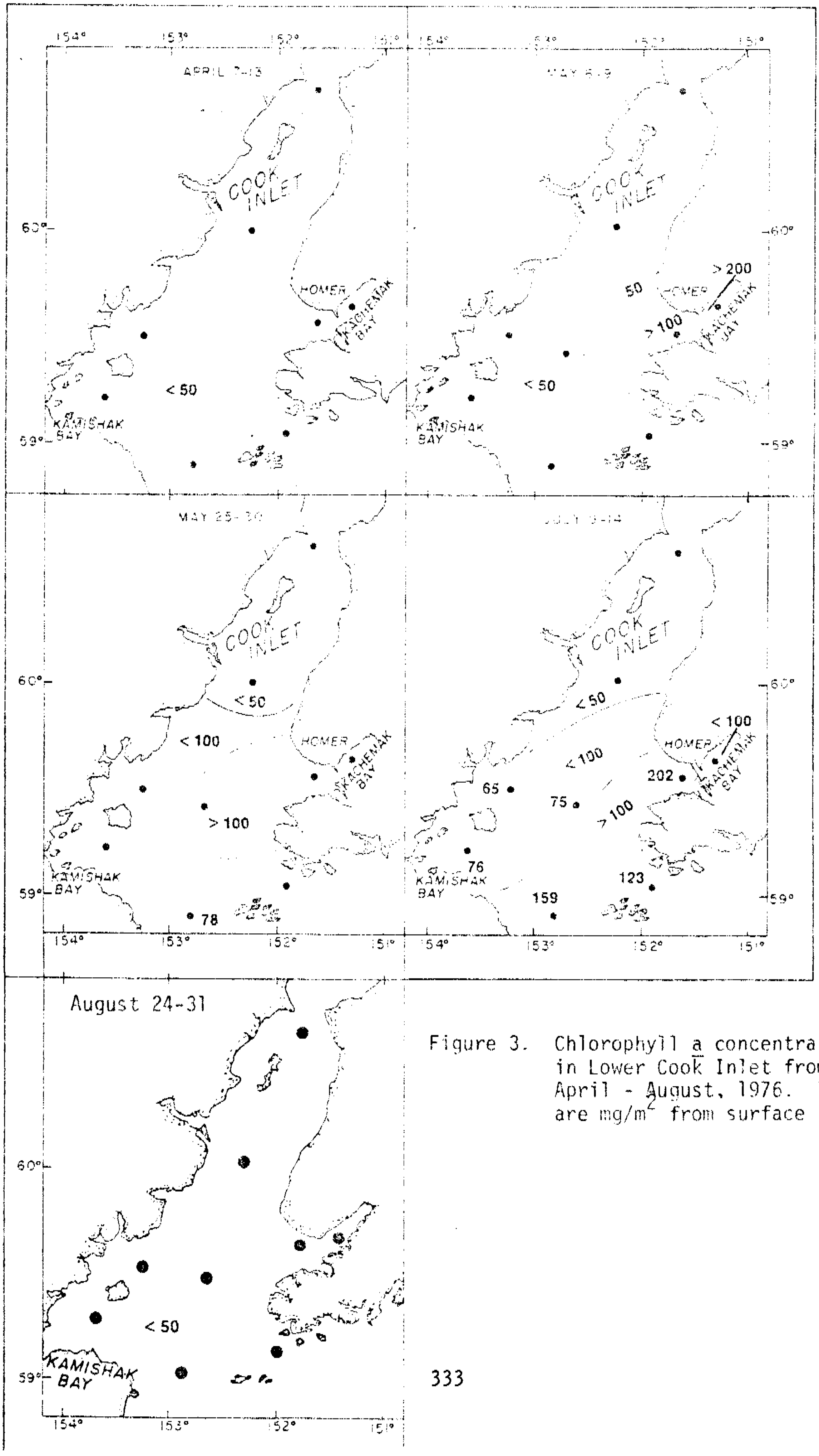


Figure 3. Chlorophyll a concentrations in Lower Cook Inlet from April - August, 1976. Values are mg/m^2 from surface to 25m.

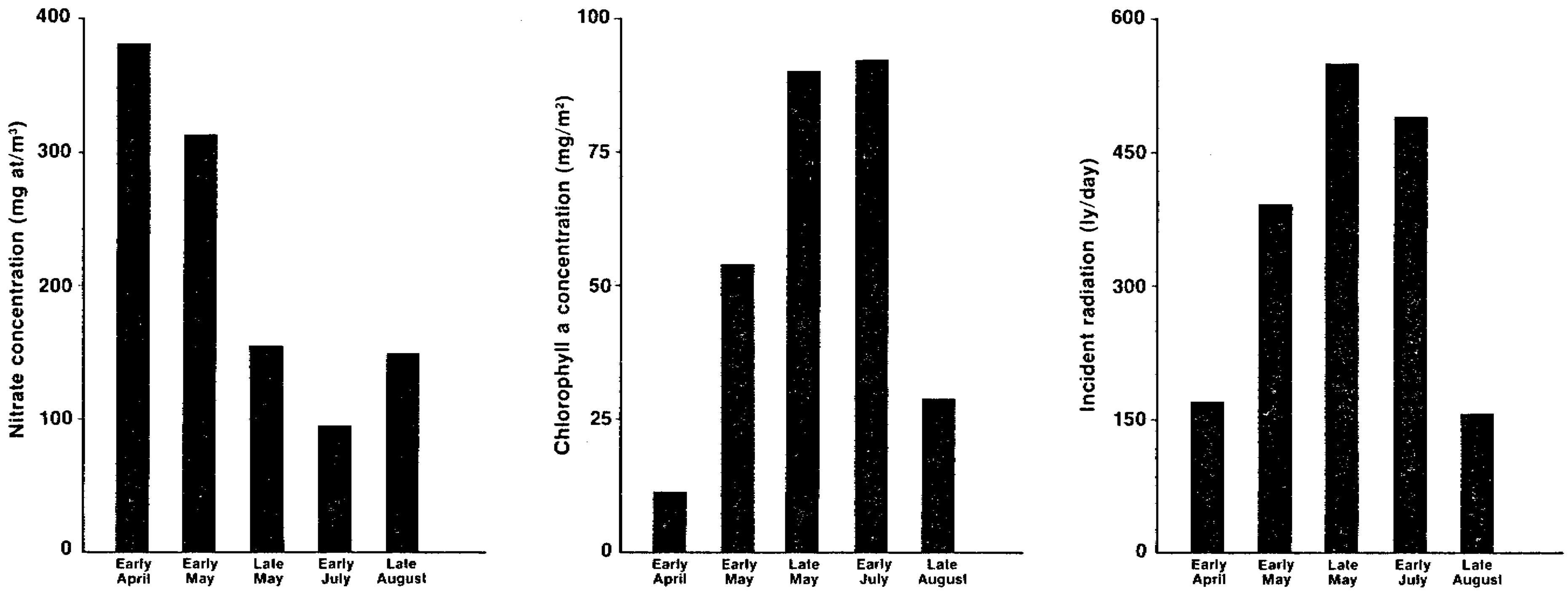


FIGURE 4. Nitrate, chlorophyll a and insolation values from Cook Inlet. Nitrates and chlorophyll a are averages from stations 1-9 and integrated from surface to 25m. Insolation values are averages from stations 1-9.

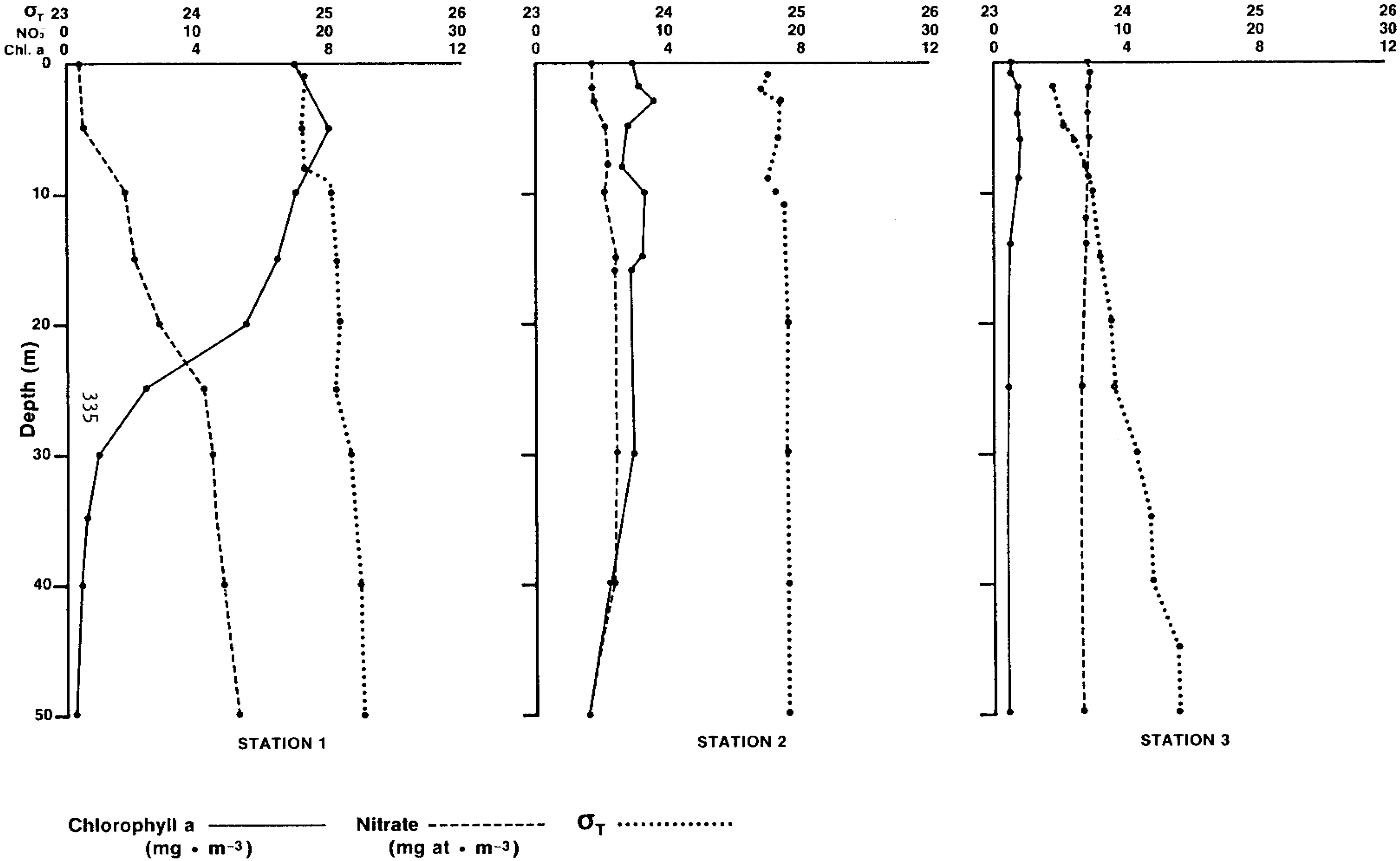
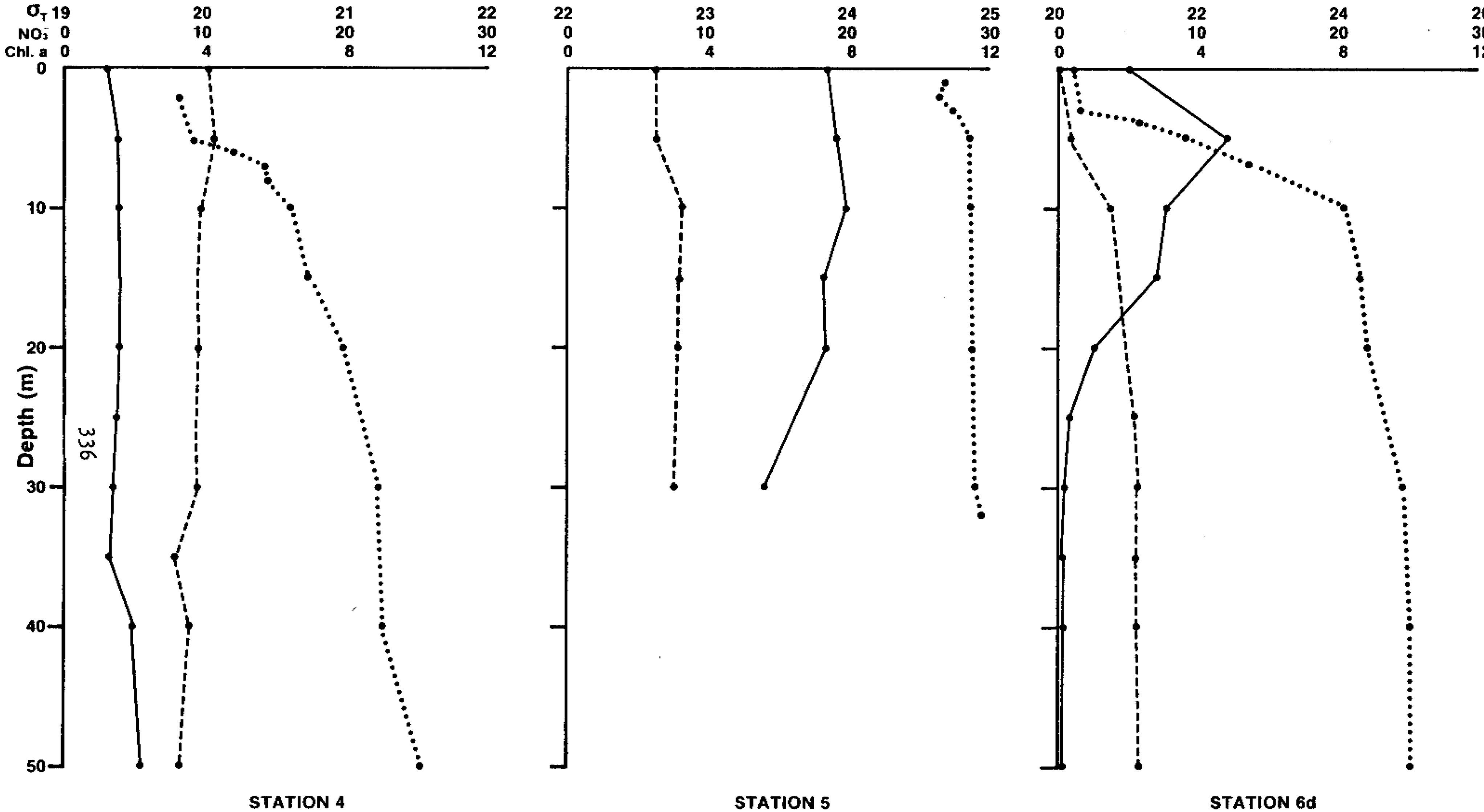


FIGURE 5. Vertical distribution of chlorophyll a, nitrate and σ_T from ACONA cruise (early July, 1976).



Chlorophyll a ———— (mg • m⁻³)   Nitrate - - - - - (mg at • m⁻³) σ_T ··········

FIGURE 5, continued

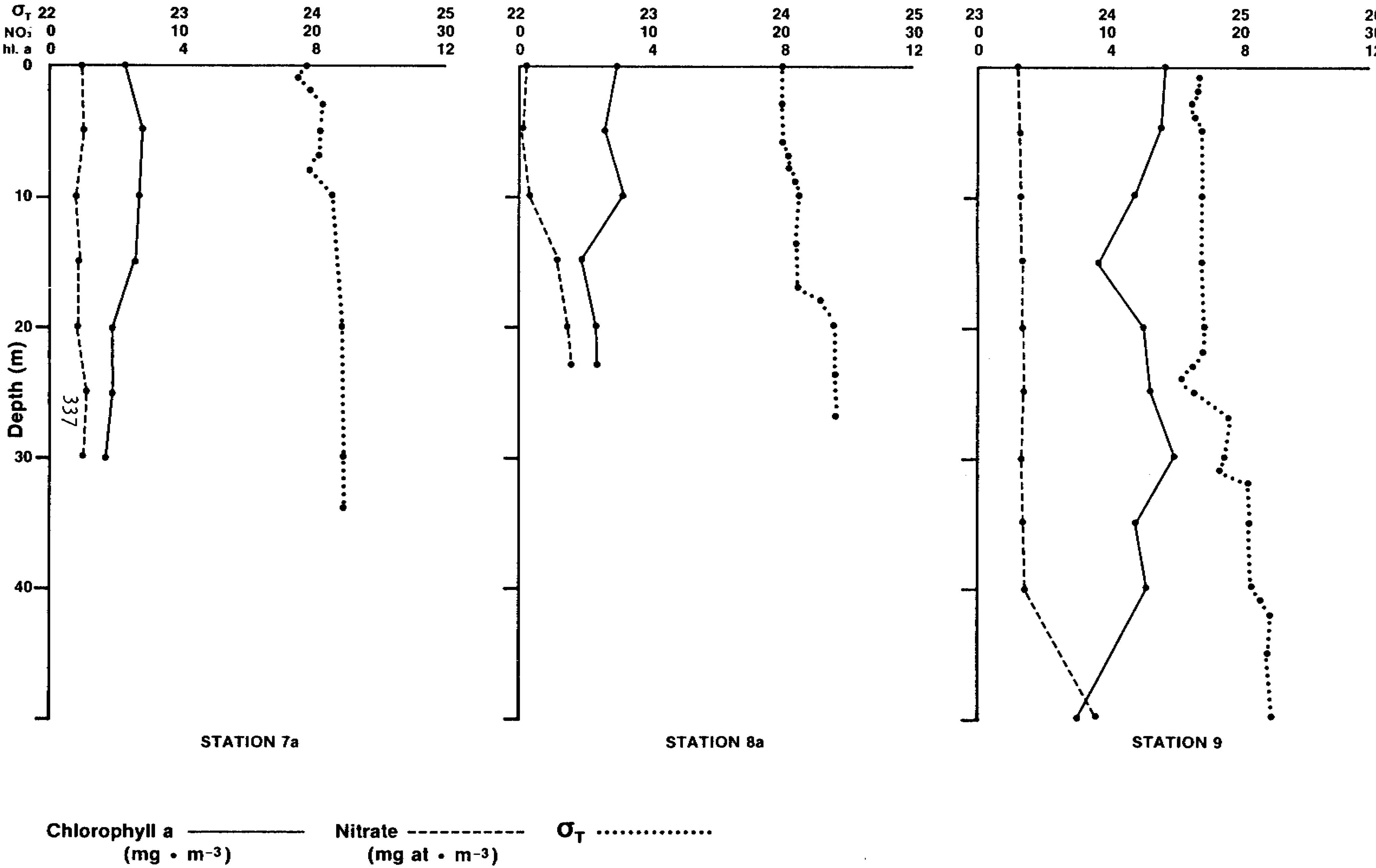


FIGURE 5, continued

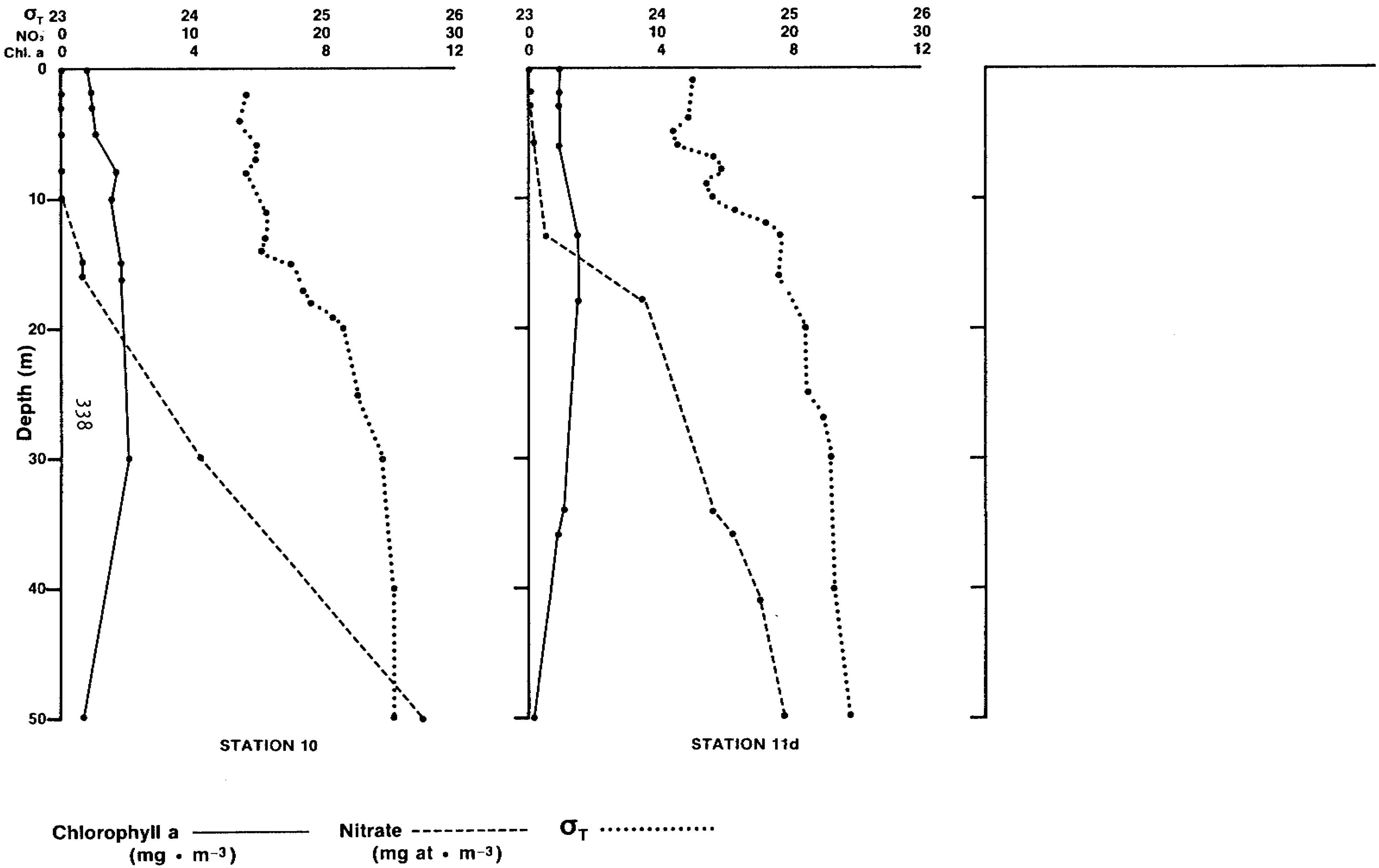


FIGURE 5, continued

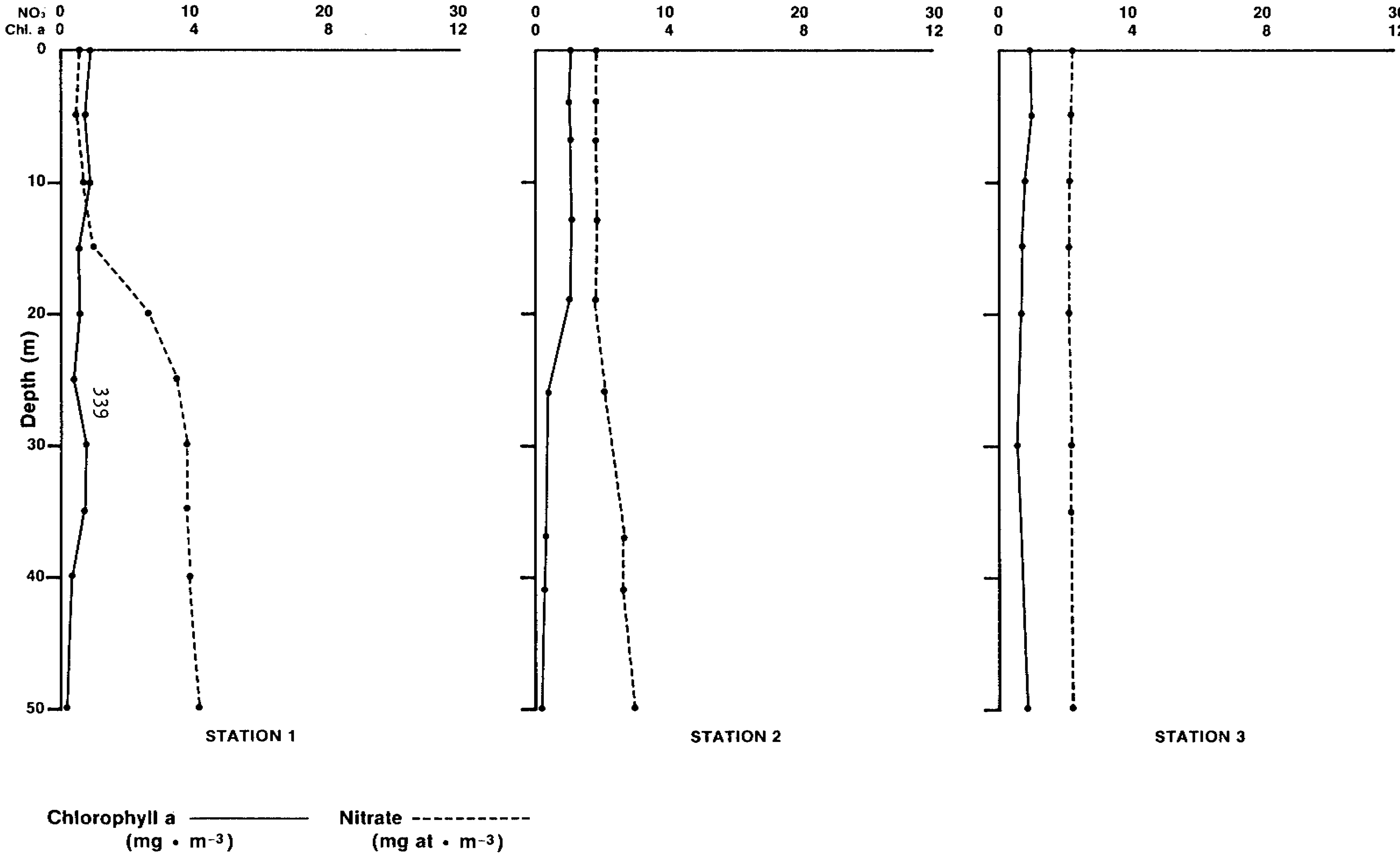


FIGURE 6. Vertical distribution of chlorophyll a and nitrate from SURVEYOR cruise (late August, 1976).

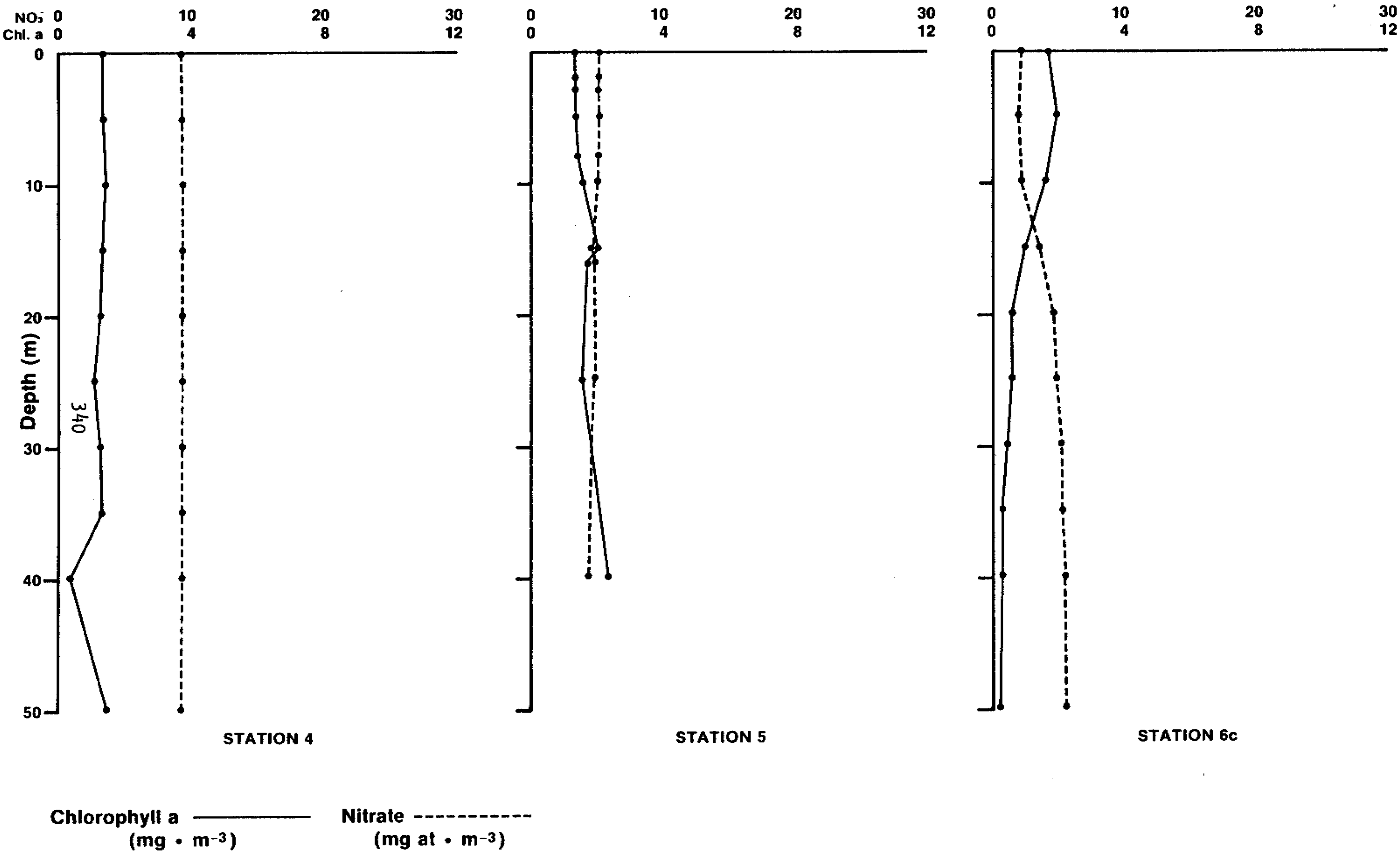


FIGURE 6, continued

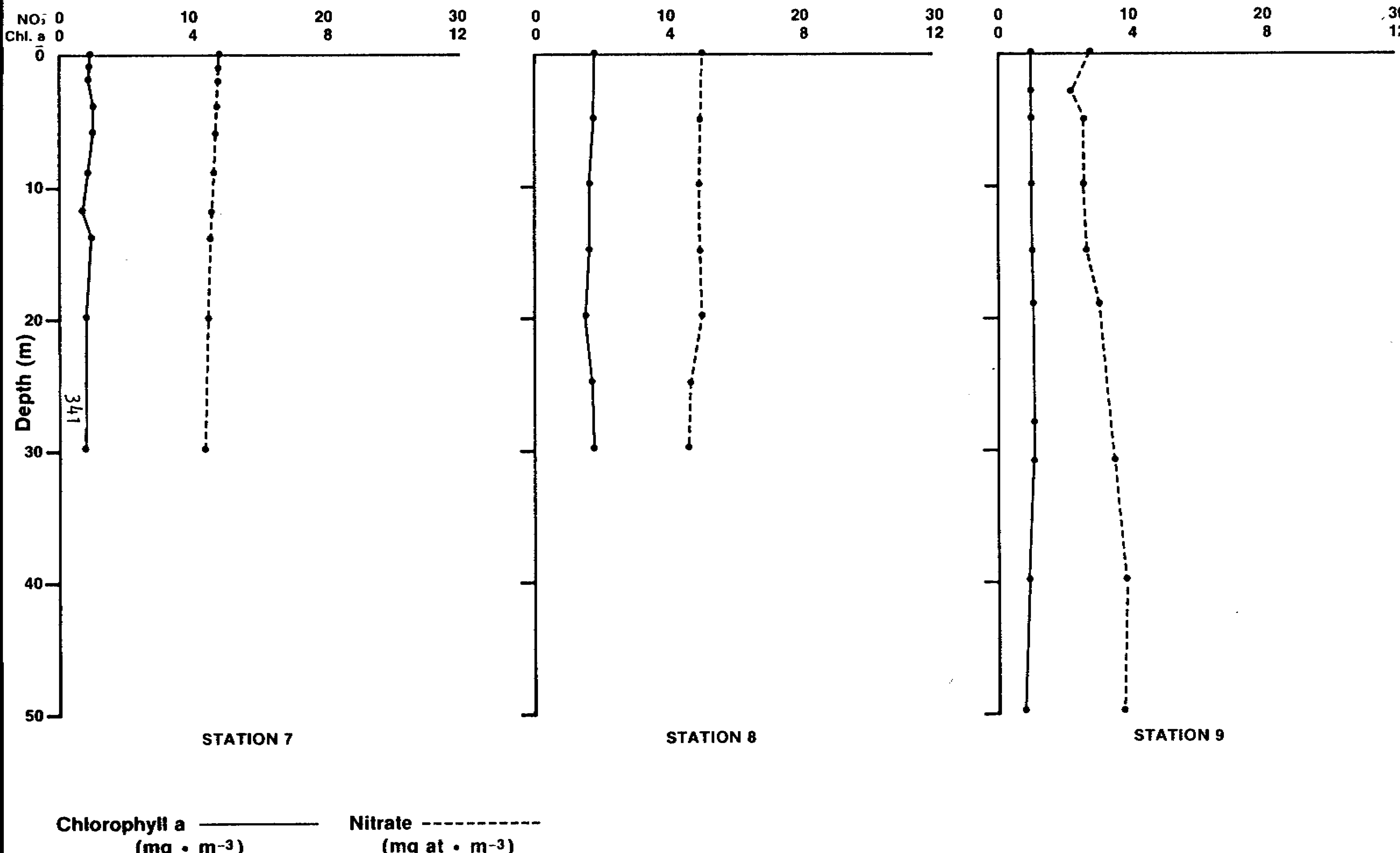
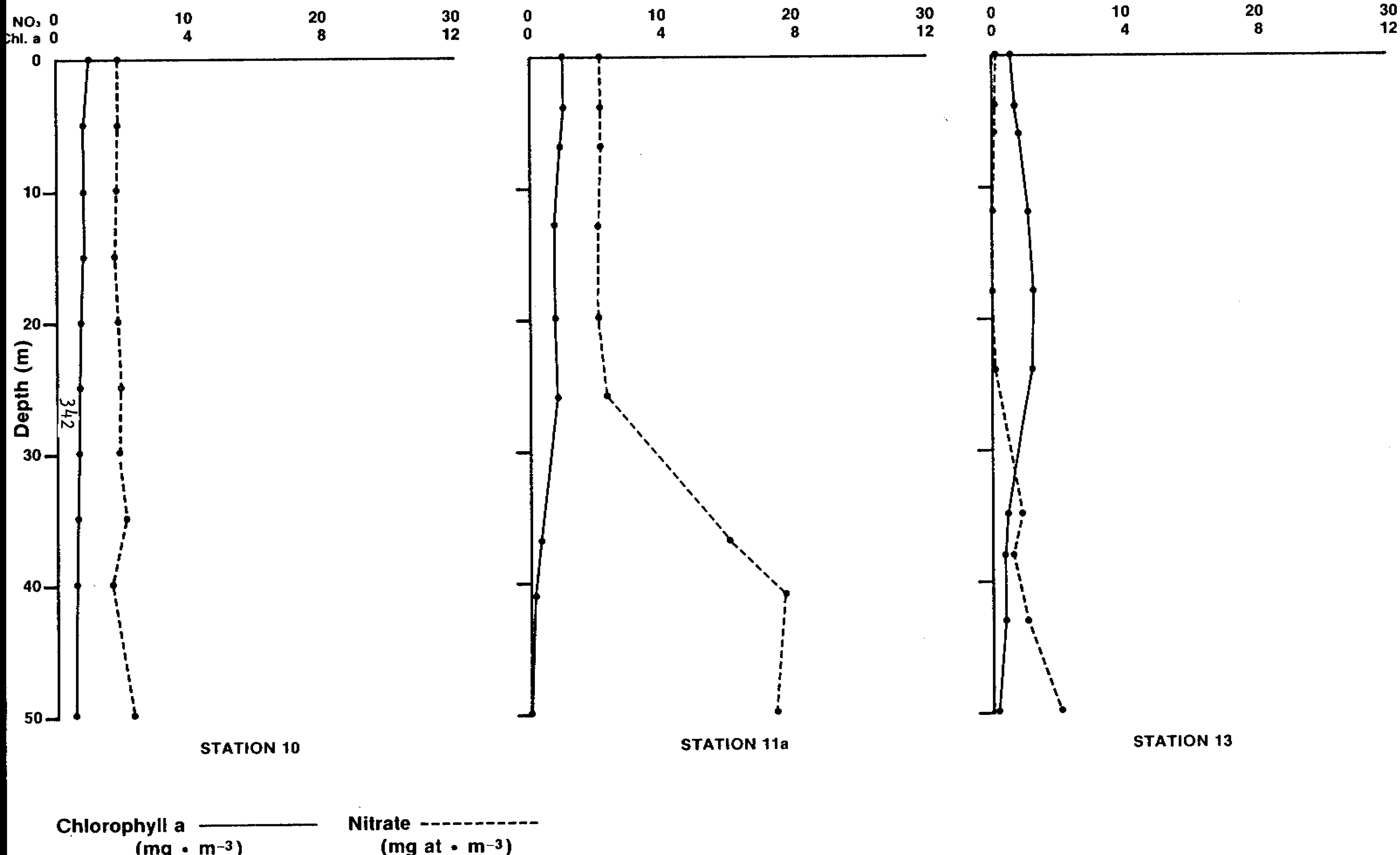
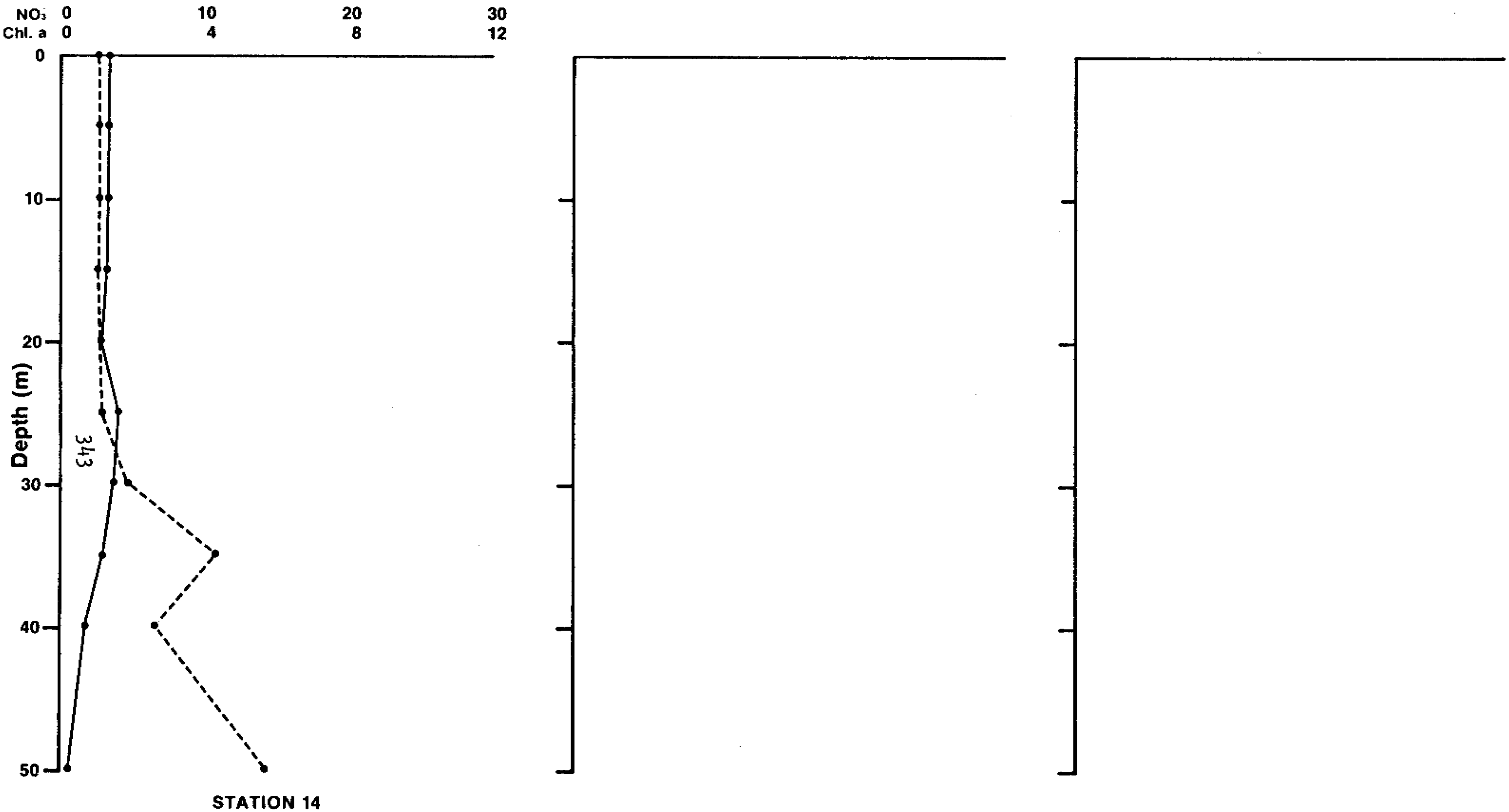


FIGURE 6, continued



342

FIGURE 6, continued



Chlorophyll a ———— (mg • m^{-3})   Nitrate ---------- (mg at • m^{-3})

FIGURE 6, continued

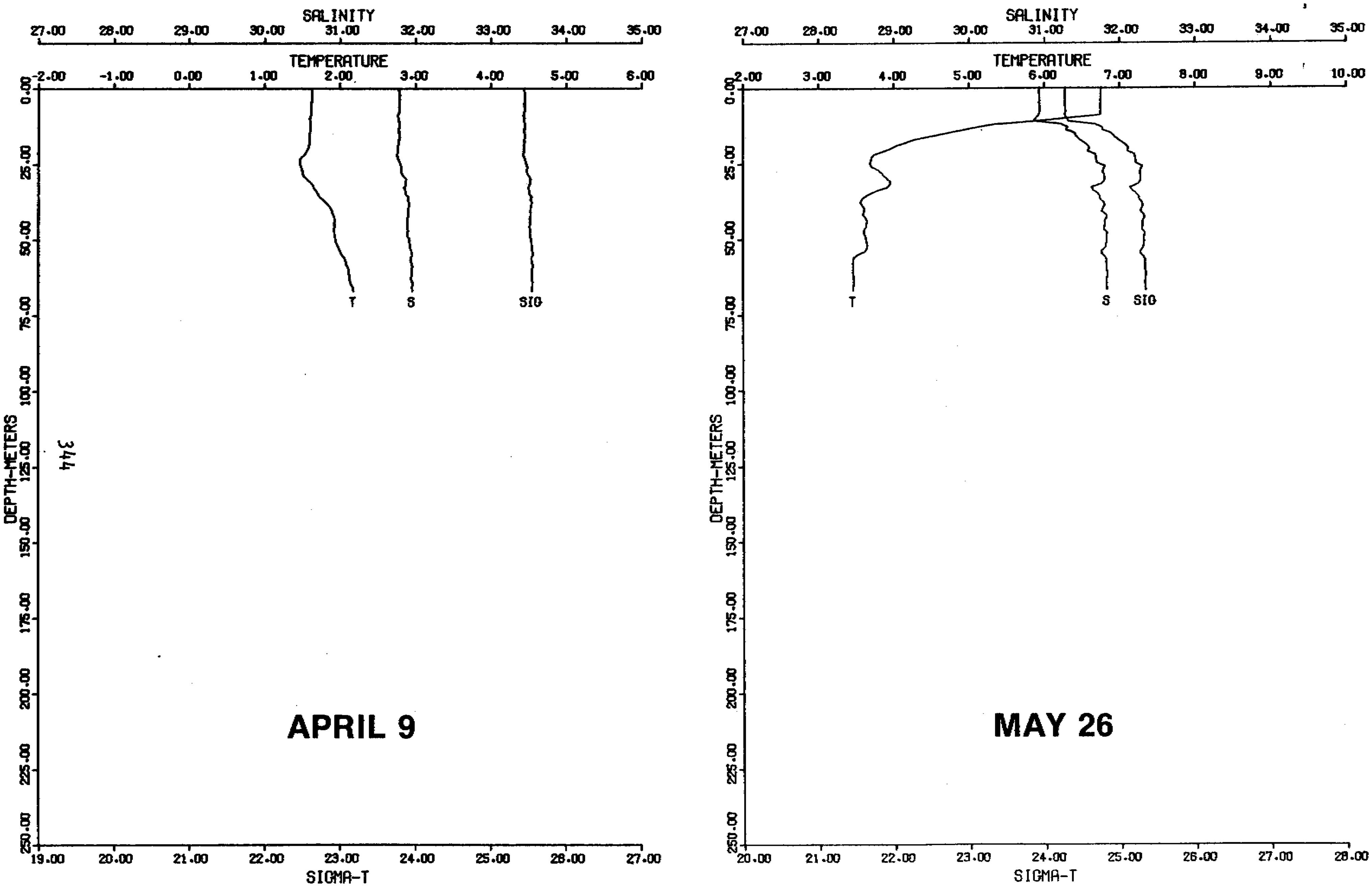


FIGURE 7. Temperature, salinity and σ_T at station 6 during early April and late May, 1976.

Quarterly Report

Contract #03-5-022-56
Research Unit #156/164 d
Reporting Period 7/1 - 9/30/76
Number of Pages 3

ZOOPLANKTON AND MICRONEKTON STUDIES IN THE BERING - CHUKCHI/BEAUFORT SEAS

Dr. R. Ted Cooney
Associate Professor of Marine Science
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

October 1, 1976

QUARTERLY REPORT

I. Task Objectives

This research addresses six (6) tasks (or parts thereof) pertaining to zooplankton and micronekton in the Bering - Chukchi/Beaufort Seas.

A. A-9; describe the food dependencies of commonly occuring species of pelagic fishes as this task applies to dielly migrating bathypelagic species samples with bongo nets and NIO Tucker mid-water trawls.

B. A-22; summarize the existing literature and unpublished data on the transfer of synthesized organic matter of zooplankton and micronekton (including ichthyoplankton).

C. A-23; determine seasonal density distributions and environmental requirements of principal species of zooplankton, micronekton, and ichthyoplankton.

D. A-24; identify pathways of matter (energy) transfer between synthesizer and consumers.

E. A-25; identify and characterize critical regions and habitats required by egg and larval stages of fish and shellfish species.

F. A-31; determine the relationships of zooplankton and micronekton populations to the edge of the seasonal icepack as it occurs in the Bering and Chukchi Seas.

II. Field or Laboratory Activities

A. Ship Schedule

Leg II, NOAA vessel *Discoverer*, 3 - 17 August, 1976; Norton Sound/ Chukchi Sea. Bongo-net (0.505-mm); 1-m net (0.333) and 2-m Tucker trawls (1/8-inch knotless nylon) fished between the mouth of the Yukon River and Point Hope.

B. Scientific Party

Mr. Kenneth Coyle, IMS, University of Alaska (Chief Scientist)
Ms. Liz Clarke, IMS, University of Alaska
Mr. Tom Bellamore, IMS, University of Alaska
Mr. William Kopplin, IMS, University of Alaska
* Mr. Lee Neimark, IMS, University of Alaska

*Mr. Lee Neimark returned September 18 after spending the summer with an Alaska Department of Fish and Game Field party in Eastern Norton Sound. Mr. Neimark collected zooplankton at specific locations between St. Michael and Nome. He also obtained a large collection of fish stomachs in cooperation with the ADF&G crew.

C. Methods

Details of the methodology are listed in the OCSEAP program work statement "Environmental Assessment of the Alaska Continental Shelf" No. 3, *Fish, Plankton, Benthos, and Littoral*; pp. 89 - 103.

D. Sample Localities

Station locations and cruise tracklines have been described in detail in the cruise report submitted for this effort; *Surveyor*, Legs I and II, March - April, 1976.

E. Data Collected or Analysed

Number and type of samples/observations

1. 10 60-cm Bongo-net tows
2. 105 1-m net tows (vertical)
3. 31 2-m Tucker trawl hauls.

III. Results

On-site observations documented large numbers of hydomedusae and gaddoid fishes in the nearshore waters of both Norton and Kotzebue Sounds. Also many specimens of the scyphozoans *Chysaora melanaster* and *Cyarea capillata* were counted and discarded from samples. The amphipod *Parathemisto libellula* was extremely abundent in many of the samples taken well off shore, while a marine Cladocern appeared to dominate the net zooplankton close to the beach. This latter observation was born out in the "rowboat" oceanography conducted in the very shallow water north and south of Unalakleet (Lee Neimark).

IV. Preliminary Interpretation of Results

The nearshore zooplankton community around the periphery of Norton and Kotzebue Sounds differs in species composition and abundance from that of the waters further out over the shelf. These areas in addition to being shallower are probably "fresher" in terms of salt content than the more open shelf regions which would be selected for a more niretic community. The presence of large jellyfish in abundance may be indicative of a restricted circulation in these areas also.

V. Problems Encountered/Recommended Changes

As has been our experience in the past, the officers and crew of the *Discoverer* were very supportive of the mission. There was some initial hesitation to take the large vessel into the shallow waters off Norton Sound although with careful navigation, the ship was able to get most of the observations as planned. Mr. Neimark reports a few minor problems in the integrated University of Alaska/ADF&G nearshore study, but nothing that was not worked out in the field. Very poor communications (phone, radio, mail) with Unalakleet were experienced.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: September 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 13 R.U. NUMBER: 156/164

PRINCIPAL INVESTIGATOR: Dr. R. T. Cooney

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]		
	From	To	Batch 1		
Discoverer Leg I #808	5/15/75	5/30/75	submitted		
Discoverer Leg II #808	6/2/75	6/19/75	submitted		
Discoverer Leg I #810	8/9/75	8/28/75	submitted		
Miller Freeman #815	11/10/75	11/26/75	submitted		
Contract #03-5-022-34	Last	Year	submitted		
Surveyor 001/2	3/76	4/76	submitted		
Discoverer 002	8/3/76	8/17/76	12/30/76[a]		

Notes: [1] Data Management Plan has been approved and made contractual. Format has been received and approved by all parties.

[a] Date of submission is dependent upon continuation and funding of this project in FY '77.

Quarterly Report

Contract #03-5-022-56
Research Unit #159/164e
Reporting Period 7/1 - 9/30/76
Number of Pages 2

PHYTOPLANKTON STUDIES IN THE BERING SEA

Dr. Vera Alexander
Professor of Marine Science
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

October 1, 1976

QUARTERLY REPORT

I. Task Objectives

To study the dynamics of phytoplankton populations at the edge of the retreating ice pack in the Bering Sea in order to assess the significance of the ice edge in the productivity of the Bering Sea. Studies away from the ice edge are carried out in order to provide data for comparison.

II. Field Activities

No cruises have been undertaken since the last report. The principal activity has been data organization, sample processing and analysis. All primary productivity samples have been counted and calculated, chlorophyll samples analyzed and calculated and alkalinity titrations performed. Phytoplankton counting and identification is underway and will be completed shortly. Nutrient analyses will be carried out during October, since moving the laboratory into new quarters has damaged the autoanalyzer, and repairs have been necessary. We anticipate that all data from the *Surveyor* cruise, March - April 1976, will be complete by the end of November. All nutrient analyses for the Beaufort and Gulf of Alaska projects of Drs. Atlas and Morita have been completed.

III. Proposed Work for This Next Quarter

We have been requested to attend an organization meeting in Oregon early in October. Future work depends on the outcome of the discussions.

IV. Personnel

Laboratory work has been carried out by Cindy Mildbrand, Tom Chapman, David Brickell, Carl Tobin. Phytoplankton counts have been done by Linda Schandelmeier.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: September 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 1 R.U. NUMBER: .159/164

PRINCIPAL INVESTIGATOR: Dr. Vera Alexander

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]			
	From	To	Batch 1	2	3	4
Discoverer Leg I #808	5/15/75	5/30/75	submitted	submitted	None	None
Discoverer Leg II #808	6/2/75	6/19/75	submitted	submitted	None	None
Discoverer Leg I #810	8/9/75	8/28/75	submitted	submitted	None	None
Miller Freeman #815	11/10/75	11/26/75	submitted	submitted	None	None
Surveyor Su/001/2	3/76	4/76	(a)	(a)	None	None

Note: [1] Data Management Plan and data Formats have been approved and are considered contractual.

(a) These samples will be processed, pending funding for October - December 1977, as requested by proposal submitted 9/13/76. Data submission will be made 120 days after end of processing as per contract.

RU# 174

NO REPORT AVAILABLE AT THIS TIME

FIFTH QUARTERLY REPORT

Contract No. R7120802
Research Unit #175
Period July 1, 1976 to
September 30, 1976

BASELINE STUDIES OF FISH AND SHELLFISH RESOURCES OF NORTON SOUND AND THE SOUTHEASTERN CHUKCHI SEA

Principal Investigators

Robert J. Wolotira, Jr.
Walter T. Pereyra

Northwest Fisheries Center
National Marine Fisheries Service
Seattle, Washington 98112

October 1, 1976

Research Unit 175-A-14

Fifth Quarterly Report, July - September, 1976

I. Task Objectives

The objectives of RU 175-A-14 are to determine the distribution and abundance of fish and shellfish resources in the southern Chukchi Sea and Norton Sound, estimate the productivity, length, weight and age distribution of selected demersal fish and shellfish to develop growth models and to provide a data base against which later changes in these parameters may be compared.

II. Field and Laboratory Activities

A. Ship or field trip schedule

1. Ship surveys and personnel

(a) Miller Freeman -- August 29 - September 24; eastern Norton Sound, Port Clarence and southern Chukchi Sea; Mr. Robert J. Wolotira, Mr. R. N. McBride, Mr. Martin Morin, Ms. Sandra Wakefield, all from Resource Assessment and Conservation Engineering Division, NWFC, NMFS. September 28 - October 13; western Norton Sound and northern Bering Sea; Mr. Norman Parks, Mr. Richard MacIntosh, Ms. Nikki Newcome, Mr. Terry Sample, all from Resource Assessment and Conservation Engineering Division, NWFC, NMFS.

B. Methods

1. Ship cruises. A stratified-systematic sampling design was used for the baseline demersal trawl survey. Station densities were established on the basis of potential for environmental impact.

One-half hour trawl hauls were performed at each station to quantitatively examine demersal fish and shellfish stocks.

A qualitative assessment of near surface fish stocks was conducted with nightly gillnet sets and occasional pelagic trawling. Locations of gillnet sets were determined by the ship's progress along the cruise track line and sampling while pelagic trawling was on a target availability basis.

2. Laboratory activities. All shore time during the fifth quarter was spent obtaining sampling equipment, establishing the scientific operation plan for survey and reviewing historic information on the survey region.

III. Results

Considerable information on demersal and near-surface fish stocks was obtained during Leg I of the FRS Miller Freeman Cruise 76B in Norton Sound and the Chukchi Sea. One hundred seventy-four (174) of the entire survey's 240 demersal trawling sites were examined with bottom trawls during the period 2 September to 24 September, 1976, completing all scheduled sampling in Kotzebue Sound and the Chukchi Sea as well as most of Norton Sound. In addition to completing the trawl stations, 22 gillnet sets were performed.

Nearly 50 tentatively identified fish species were encountered during Leg I. Specimens of most of these species were preserved for later confirmation of field identification. Of the 162 preserved samples (1 to 15 fish per sample) over half contained members of the family Cottidae. Most of the remaining samples included specimens of the families Cyclopteridae (snailfishes) and Zoarcidae (eelpouts).

Over 28,000 fish were measured for size composition information during Leg I. Length measurements were obtained from several selected fish species including the following:

Species	Number Measured
Saffron cod (*Eleginus gracilis*)	14,698
Arctic cod (*Boreogadus saida*)	2,383
Walleye pollock (*Theragra chalcogramma*)	173
Yellowfin sole (*Limanda aspera*)	3,092
Alaska plaice (*Pleuronectes quadrituberculatus*)	2,383
Starry flounder (*Platichthys stellatus*)	806
Bering flounder (*Hippoglossoides robustus*)	137
Longhead dab (*Limanda proboscidea*)	56
Arctic flounder (*Liopsetta glacialis*)	45
Rainbow smelt (*Osmerus mordax*)	2,959
Pacific Herring (*Clupea harengus pallasi*)	2,302
Capelin (*Mallotus villosus*)	171

Individuals of several infrequently encountered species also were measured.

Information for length-weight relationships and age composition were obtained for six fish species. These data were gathered separately for two major geographic areas, Norton Sound and the Chukchi Sea, to determine whether certain biological parameters for each fish species differed by area.

Numbers of age-length-weight samples obtained by area and species are as follows:

Species	Norton Sound	Chukchi Sea	Total
Saffron cod	137	254	391
Herring	115	146	261
Arctic cod	118	161	279
Yellowfin sole	180	108	288
Rainbow smelt	108	55	163
Alaska plaice	186	94	280

Additional age-length-weight samples of these species will be obtained in Norton Sound during Leg II which commenced on September 28.

IV. Preliminary interpretation of results

Trawling operations during Leg I were conducted on a 24-hour/day basis and generated substantial amounts of information. Since Leg I terminated during this week, only very terse observations can be made from the data.

The number of species encountered per trawl haul in the Chukchi Sea generally was lower than numbers taken per haul in Norton Sound. Overall, Chukchi Sea trawl hauls averaged 10 fish species while catches made in Norton Sound averaged between 12 to 13. It should be mentioned, however, that the number of species per trawl haul in most of Norton Sound was much higher than 12-13. Very small catches in the southeastern portion of the Sound substantially reduced the overall average.

V. Problems encountered/recommended changes

None.

Quarterly Report

Contract #03-5-022-69
Research Unit #233
Reporting Period - July through October 1976
2 Pages

Beaufort Sea Estuarine Fishery Study

Principal Investigator:

Terrence N. Bendock
Fisheries Biologist
Sport Fish Division
Alaska Department of Fish and Game
1300 College Road
Fairbanks, Alaska 99701

10 October 1976

OCS Quarterly Report - October 1976

I. Task objectives

The objectives of the Beaufort Sea Estuarine Fishery Study are as follows:

A. To determine the seasonal distribution, relative abundance, size and species composition, growth rates, feeding habits and reproductive capabilities of Beaufort Sea nearshore fishes in the area from the Colville to the Canning Rivers and between shore and the barrier islands, including river deltas.

B. To determine migration patterns and timing of these fishes.

C. To identify critical habitats including spawning, overwintering, feeding, rearing and migration areas.

D. To determine the interrelationship of Arctic fishes to lower food-web organisms.

E. To determine the present rate of exploitation of the anadromous fishes of the area and to monitor changes in this usage as developement of the area's petroleum resource progresses.

II. Field or laboratory activities

Field activities during the summer of 1976 were directed towards identifying the migration patterns, timing of movements and seasonal abundances of Beaufort Sea fish within our study area. Activity was concentrated in the vicinity of Prudhoe Bay and along the Beaufort Sea coast and barrier islands westward to the Colville River.

Six trap stations were monitored daily near Prudhoe Bay between June and September. Daily captures were organized by species and enumerated. All salmonids over 200 mm in length were tagged with numbered Floy FD 67 internal anchor tags and released. Physical parameters monitored daily included: air temperature, water temperature, salinity, conductivity, bottom type, outer depth of set, present weather, cloud amount, sea state, wind direction, wind force, current direction and current force. The fish were captured in either fyke traps or multifilament variable mesh gill nets. Thirty sampling and recapture stations were monitored along the westward coastal area and barrier islands and two stations were monitored in the lower Sagavanirktok River.

Fish samples needed for our continuing life history investigations were preserved in 10% formalin or frozen and shipped back to our Fairbanks laboratory.

Analysis of fish carcass, tagging and capture data is presently underway in Fairbanks however, detailed results are not available at this time. All of the daily capture data has been formatted and is being submitted to the University of Alaska Computer Center, Geophysical Institute. All data collected during the 1975-1976 field season was organized and submitted to the Computer Center this past summer.

III. Following is a list of the species captured, number caught and number tagged during the 1976 summer season at Prudhoe Bay and coastal stations.

Species		Number Captured	Number Tagged
Arctic char	*Salvelinus alpinus*	3,607	808
Grayling	*Thymallus arcticus*	47	1
Humpback whitefish	*Coregonus pidschian*	167	150
Broad whitefish	*C. nasus*	703	190
Least cisco	*C. sardinella*	8,243	3,185
Arctic cisco	*C. autumnalis*	1,139	628
Round whitefish	*Prosopium cylindraceum*	12	
Arctic cod	*Boreogadus saida*	5,238	
Saffron cod	*Elginus gracilis*	14	
Fourhorned sculpin	*Myoxocephalus quadricornus*	7,778	
Arctic flounder	*Liopsetta glacialis*	35	
Boreal smelt	*Osmerus mordax*	16	
Capelin	*Mallotus villosus*	54	
Ninespine stickleback	*Pungitius pungitius*	2	
Totals	14 Species	27,055	4,962

IV. The preliminary interpretation of results will be presented in the next quarterly report.

V. To date we have encountered no problems in conducting the field studies of this project.

Quarterly Report

Contract #03-5-022-56
Research Unit #281
Reporting Period 7/1 - 9/30/76
Number of Pages 51

THE DISTRIBUTION, ABUNDANCE, DIVERSITY, AND PRODUCTIVITY OF BENTHIC ORGANISMS IN THE GULF OF ALASKA

Dr. Howard M. Feder
Professor of Marine Science
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

October 1, 1976

Quarterly Report

I. Task Objectives

A. Inventory and census of dominant species.

B. Description of spatial and seasonal distribution patterns of selected species.

C. Provide comparison of dominant species distribution with physical, chemical and geological factors.

D. Provide preliminary observations of biological interrelationships between selected segments of benthic marine communities.

GRAB PROGRAM

II. Field and Laboratory Activities

A. No cruise was scheduled during the last quarter.

B. A continuation of the analysis of samples taken in the past year is in progress at the Marine Sorting Center. All data is being keypunched as it becomes available. Refinement of computer programs for future analysis is in progress. The methods used in Cluster Analysis are outlined in the Annual Report for 1976; one change was made, and this is discussed under Results below.

C. The grab data from the first series of stations (cruises of early 1975) occupied were examined in detail, and discussed at the Alaska Science Conference at the University of Alaska in the summer of 1976 in a paper entitled "The Distribution, Abundance and Diversity of Infaunal Invertebrates of the Northeast Gulf of Alaska."

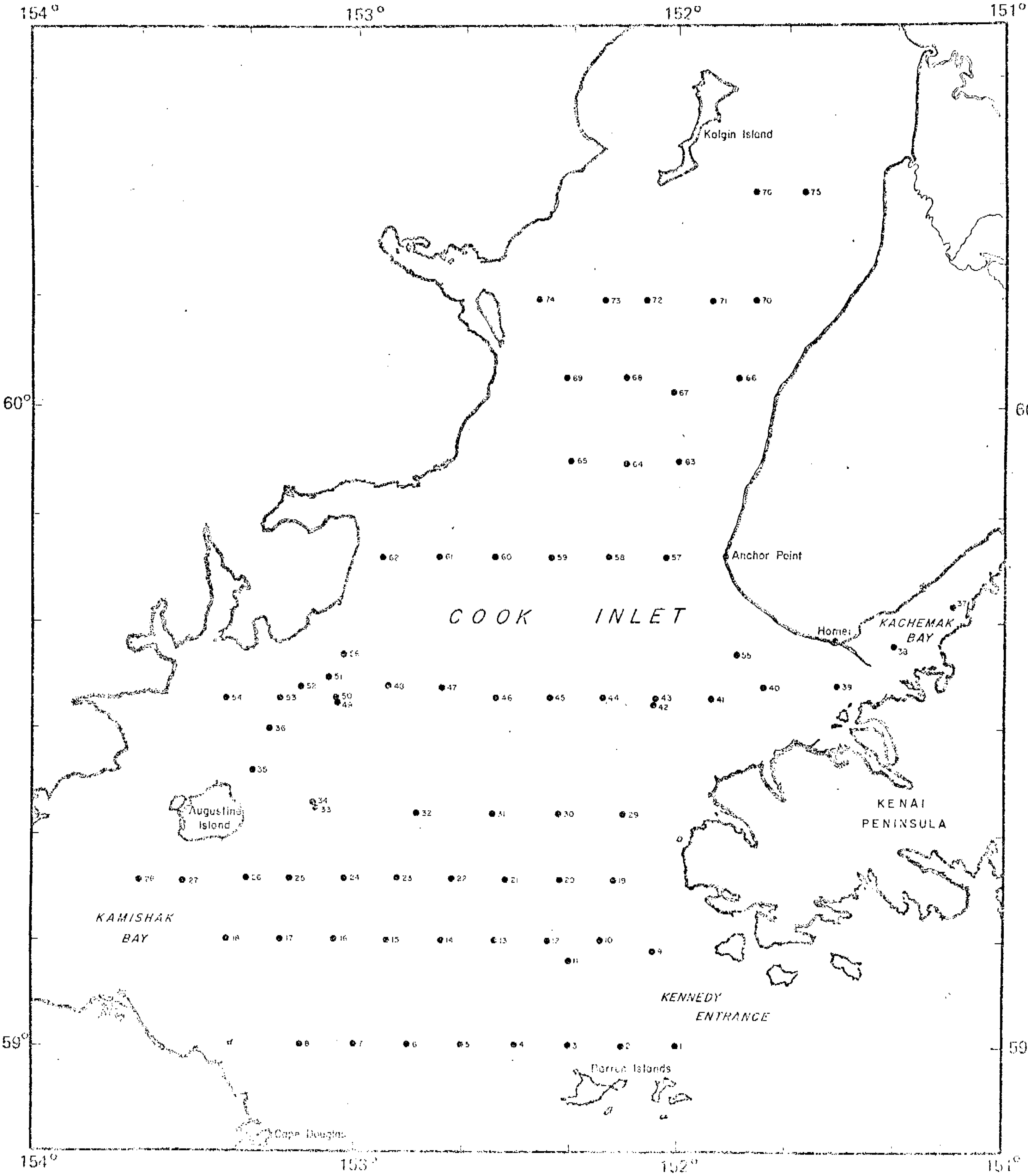
III. Results

A. Northeast Gulf

1. The Marine Sorting Center has completed analysis of grab samples taken during the *USNS Silas Bent* cruise of 1-17 September 1975 and the NOAA ship *Discoverer* cruise of 23 Nov. - 8 Dec. 1975. This data has been punched on cards and will be processed following verification and correction of the cards. Additional data collected on the NOAA ship *Discoverer* cruise of 10-16 October 1976 in the Northwestern Gulf of Alaska has been submitted.

B. Cook Inlet

1. A number (13) of stations were selected for detailed analysis, and will be henceforth considered Cook Inlet quantitative stations.


154°
153°
152°
151°
60°
59°
Kalgin Island
Anchor Point
COOK INLET
Homer
KACHEMAK BAY
KENAI PENINSULA
Augustine Island
KAMISHAK BAY
KENNEDY ENTRANCE
Barren Islands
Cape Douglas

2. Field notes based on a qualitative assessment of all grab stations were included in a Special Data Submission to OCSEAP.

3. A table listing all stations occupied and a map of these stations were completed in this quarter (see attached Table I and Fig. 1).

IV. Preliminary Interpretation of Results

Cluster analyses were run on all the data collected from July 1974 through May 1975. The methods used were essentially those outlined in the annual report; however, the elimination of all species except the Biologically Important Taxa (BIT) was not used as a data reduction technique this time. We felt that using only the BIT (93 taxa) eliminated too many species and caused an unacceptably high loss of information. Instead the data was reduced by eliminating all organisms which could not be identified at least to genus and those organisms that occurred only at one station and in such low numbers that they would have little effect on the analysis. This reduced the number of taxa from 315 to 173. Analyses were run using five different types of data. These were both untransformed and natural log transformed numbers/m^2 and weight/m^2 data as well as presence-absence data. An analysis was performed using presence-absence data so that those stations which could not be sampled quantitatively could be included in the analysis. (Figures depicting the composition of the two station groups are not included in this report due to the time and expense required to make glossy prints at this time; figures showing composition of station groups will be included in the final report). In all the analyses two to three station groups occur. Two of the groups consist of inshore stations and a third group consists of stations that are at or near the shelf break. These major station groups remain fairly constant, and change only slightly in composition when different types of data are used for the analysis. When an analysis was carried using only presence/absence data (which obviously is less discriminating than meristic data) the inshore station groups merge to form a larger group of inshore stations. However, with the inclusion of stations that were qualitatively sampled, two new groups of stations were formed. These groups consisted of stations which were further off-shore (on the slope) than the inshore and shelf break groups.

A station group-species group coincidence table was constructed to elucidate the species and species groups which are characteristic of the various station groups. Station groups were not uniquely defined by the presence of a species group that occurred nowhere else, but there were obvious quantitative differences between station groups. One of the station groups, composed of stations located near the shelf break, was characterized by two species groups whose members were absent or present only in greatly reduced quantities in other stations. Correspondingly, a large group of stations, located inshore of the shelf stations, were characterized by species which were present in reduced quantities at the shelf break stations. Stations located geographically between the two major station groups appeared to occupy an intermediate position between these stations groups in terms of species composition and abundance. The results of these analyses indicate that there is a change in the composition of the infaunal community along a gradient that is related to changes in depth. Gross observation of the sediment characteristic of each station group suggests that one of the controlling factors in the composition of the fauna is grain-size distribution.

Table II shows some of the characteristics of the stations in the major station groups delineated by cluster analysis using untransformed numbers per m^2 data. Note that the shelf break stations and stations 56 and 57 have a higher diversity, a higher percentage of sand and gravel and a higher percentage of suspension feeders than the inshore groups.

V. Problems Encountered

None.

TRAWL AND PIPE DREDGE PROGRAM

II. Field and Laboratory Activities

A. No cruise was scheduled during the last quarter.

B. The trawl and pipe dredge material collected in the cruise of March 30 - April 15, 1976 on the *R/V Moana Wave* was examined intensively during this quarter.

C. Final details for the trawl material taken in the summer of 1975 on the *M/V North Pacific* were attended to during this quarter.

D. Assessment of the possibility of using the grab cluster program on trawl data was considered during this period.

III. Results

A preliminary, but detailed, examination of the trawl data collected in the north Pacific on the *M/V North Pacific* in the summer of 1975 was made. This assessment of data was included in a paper presented at the Alaska Science Conference in August 1976; the paper was entitled "The Distribution, Abundance and Diversity of Epibenthic Invertebrates of the Northeast Gulf of Alaska." The manuscript is attached as Appendix I.

One run of the cluster program with the trawl data was completed, and the results are being examined.

All of the Cook Inlet trawl and pipe dredge materials was examined, and final taxonomic determinations made on most species. The material is being prepared for final analysis and for biological interpretation.

A preliminary report of the Cook Inlet trawl and pipe dredge material was submitted to OCSEAP during this quarter as a Special Data Submission on August 13, 1976.

IV. Preliminary Interpretation of Results

See the Annual Report. Additional interpretations are included in the manuscript report attached as Appendix I.

V. Problems Encountered

No serious problems.

Table I. COOK INLET BENTHIC STATIONS*
OCS Environmental Survey

Station Name	Latitude	Longitude	Depth (M)
1†	-	-	-
2†	-	-	-
3†	-	-	-
4	59° 00'	152° 30'	152
5	59° 00'	152° 40'	151
6	59° 00'	152° 50'	167
7	59° 00'	153° 00'	155
8	59° 00'	153° 09.4'	137
9	59° 09'	152° 04'	117
10	59° 10'	152° 14'	133
11	59° 08'	152° 20'	116
12	59° 10'	152° 24'	100
13	59° 10'	152° 34'	113
14	59° 10.3'	152° 45'	139
15	59° 10'	152° 54'	139
16	59° 10'	153° 04'	102
17	59° 10'	153° 13.5'	67
18	59° 10'	153° 23.7'	35
19†	-	-	-
20†	-	-	-
21†	-	-	-
22†	-	-	-
23†	-	-	-
24†	-	-	-
25†	-	-	-
26	59° 15.8'	153° 20'	42
27	59° 15.5'	153° 33'	35
28	59° 15.4'	153° 40'	31
29	59° 22'	152° 10'	90
30	59° 22.1'	152° 22.2'	82
31	59° 21.9'	152° 34.5'	71
32	59° 22.2'	152° 22.2'	78
33	59° 22.7'	153° 07.3'	53

COOK INLET BENTHIC STATIONS
(continued)

Station Name	Latitude	Longitude	Depth(M)
34	59° 23'	153° 07.6'	51
35	59° 26.2'	153° 19'	33
36	59° 30'	153° 15.7'	33
37	59° 41.6'	151° 08.9'	59
38†	–	–	–
39†	–	–	–
40	59° 34'	151° 44'	72
40A	59° 37.6	151° 50'	32
41	59° 33'	151° 54'	53
42	59° 33'	152° 04'	40
43†	–	–	–
44	59° 33'	152° 14'	61
45	59° 33'	152° 24'	59
46	59° 33'	152° 34'	68
47	59° 34'	152° 44'	59
48	59° 34'	152° 54'	42
49	59° 33'	153° 04'	37
50†	–	–	–
51	59° 35'	153° 05'	36
52	59° 34'	153° 10'	35
53	59° 33'	153° 14'	29
54	59° 33'	153° 24'	25
55	59° 40'	152° 00'	34
56	59° 37'	153° 02'	35
57	59° 46'	152° 02'	34
58	59° 46.1'	152° 13.0'	58
59	59° 46.0'	152° 23.0'	90
60	59° 46.3'	152° 34.2'	35
61	59° 46.5'	152° 44.5'	36
62	59° 46.2'	152° 55'	26
63	59° 54.6'	152° 00'	40
64	59° 55'	152° 10'	72

COOK INLET BENTHIC STATIONS
(continued)

Station Name	Latitude	Longitude	Depth (M)
65†	–	–	–
66	60° 03.0'	151° 49'	34
67	60° 01.5'	152° 01'	51
68	60° 03.0'	152° 10'	49
69	60° 03'	152° 21'	52
70†	–	–	–
71†	–	–	–
72†	–	–	–
73†	–	–	–
74†	–	–	–
75	60° 20'	151° 36.9'	31
76	60° 20'	151° 46'	27

* Stations occupied on R/V *Moana Wave* March 30 – April 15, 1976

† Stations without latitude, longitude and depth data have not been occupied, but are plotted on a working chart (see attached map)

Table II. A Comparison of Diversity Index, Sediment Type and Feeding Type Characteristic of Clustered Benthic Stations on the Gulf of Alaska Shelf.

	BRILLOUIN	SEDIMENT				FEEDING TYPE			
STATION GROUPS	INDEX OF DIVERSITY	% GRAVEL	% SAND	% SILT	% CLAY	% SF	% DF	% P	% S
Inshore Group 1	1.11 ± 0.05	0	5.21	40.67	59.92	4	61	21	14
Inshore Group 2	1.12 ± 0.12	0.63	7.48	40.55	47.22	15	65	12	3
Station 56	1.31	26.59	14.20	29.39	26.83	28	21	34	7
Station 57	1.42	24.39	42.49	18.05	15.07	38	34	8	20
Shelf Break Group	1.38 ± .09	9.39	24.56	35.39	30.69	32	26	12	30

SF = Suspension Feeder
DF = Deposit Feeder
P = Predator
S = Scavenger

Appendix I. Stephen C. Jewett and Howard M. Feder, THE DISTRIBUTION, ABUNDANCE AND DIVERSITY OF EPIBENTHIC INVERTEBRATES OF THE NORTHEAST GULF OF ALASKA. A talk given at the Pacific Science Conference, University of Alaska, Fairbanks in August 1976.

TABLE OF CONTENTS

ABSTRACT

A qualitative and quantitative inventory census of dominant epibenthic invertebrates is examined from the northeast Gulf of Alaska. All material was collected using a commercial size 400-mesh Eastern otter trawl with one-hour tows made at predetermined stations. Subsequent taxonomic analysis delineated 168 species with the molluscs, crustaceans and echinoderms dominating in species representation with 47, 42, and 36 species taken respectively in each group. Molluscs were represented by 28 families with the family Neptuneidae the most common; *Colus halli*, *Neptunea lyrata*, and *Pyrulofusus harpa* were dominant. Among the decapod crustacean representatives the families Pandalidae, Crangonidae, Paguridae, and Majidae were most abundant. The tanner crab, *Chionoecetes bairdi* of the family Majidae normally comprised a considerable portion of the invertebrate biomass with the pink shrimp *Pandalus borealis* consistently next in importance. Sea stars made up a conspicuous portion of the echinoderm fauna in the area investigated. Stations showed a considerable diversity of sea-star species, but generally a small number of individuals of each species. The most abundant and widely distributed sea star was *Ctenodiscus crispatus* which was generally collected with its stomach full of mud. *Pycnopodia helianthoides* was another widely distributed sea star, and was observed to feed on a wide variety of infaunal benthic species. The brittle star *Ophiura sarsi* was another dominant echinoderm found throughout much of the surveyed area. A description of the spatial patterns of selected species is presented with emphasis on assessing patchiness and correlation with habitat.

CHAPTER I

INTRODUCTION

1.1 General Nature and Scope of Study

The operations connected with oil exploration, production, and transportation in the Gulf of Alaska present a wide spectrum of potential dangers to the marine environment (see Olson and Burgess, 1967, for general discussion of marine pollution problems). Adverse effects on the environment of the Gulf cannot be quantitatively assessed, or even predicted, unless background data pertaining to the area are recorded prior to industrial development.

Insufficient long-term information about an environment, and the basic biology and recruitment of species in that environment can lead to erroneous interpretations of changes in types and density of species that might occur if the area becomes altered (see Nelson-Smith, 1973; Pearson, 1971, 1972; Rosenberg, 1973; for general discussions on benthic biological investigations in industrialized marine areas). Populations of marine species fluctuate over a time span of a few to 30 years (Lewis, 1970, and personal communication). Such fluctuations are typically unexplainable because of absence of long-term data on physical and chemical environmental parameters in association with biological information on the species involved (Lewis, 1970, and personal communication).

Benthic organisms (primarily the infauna and sessile and slow-moving epifauna) are particularly useful as indicator species for a disturbed area because they tend to remain in place, typically react to long-range environmental changes, and by their presence, generally reflect the nature of the substratum. Consequently, the organisms of the infaunal benthos have frequently been chosen to monitor long-term pollution effects, and are believed to accurately reflect the biological health of a marine area (see Pearson, 1971, 1972, and Rosenberg, 1973 for discussions on long-term usage of benthic organisms for monitoring pollution).

The presence of large numbers of benthic epifaunal species of actual or potential commercial importance (crabs, shrimps, scallops, snails, fin fishes) in the Gulf of Alaska further dictates the necessity of understanding benthic communities since many commercial species feed on infaunal and small epifaunal residents of the benthos (see Zenkevitch, 1963 for a discussion of the interaction of commercial species and the benthos). Any drastic changes in density of the food benthos would affect the health and numbers of these fisheries organisms.

Experience in pollution-prone areas of England (Smith, 1968), Scotland, (Pearson, 1972) and California (Straughn, 1971) suggests that at the completion of an initial exploratory study, selected stations should be examined regularly on a long-term basis to determine any changes in species content, diversity, abundance, and biomass. Such long-term data acquisition should make it possible to differentiate between normal ecosystem variation and pollutant-induced biological alteration. An intensive investigation of the benthos of the Gulf is also essential to an understanding of the trophic interactions involved there and the potential changes that may take place once oil-related activities are initiated. The ongoing benthic biological program has emphasized the development of a qualitative and quantitative inventory of prominent species of the benthos as part of the overall examination of the biological, physical and chemical components of the portions of the Gulf of Alaska shelf slated for oil exploration and drilling activity. In addition, initiation of a program designed to quantitatively assess assemblages (communities) of benthic species on the shelf will expand the understanding of distribution patterns of species here. A developing investigation concerned with the biology of selected species will also further the overall Gulf of Alaska trophic dynamics program.

1.2 Relevance to Problems of Petroleum Development

The effects of oil pollution on subtidal benthic organisms have been seriously neglected, although a few studies, conducted after serious oil spills, have been published (see Boesch *et al.*, 1974 for review of these papers). Thus, lack of a broad data base elsewhere makes it difficult at present to predict the effects of oil-related activity on the subtidal benthos of the Gulf of Alaska. However, the rapid expansion of research activities in the Gulf should ultimately enable us to point with some confidence at certain species or areas that might bear closer scrutiny once industrial activity becomes a reality. It must be emphasized that a considerable time frame is needed to understand long-term fluctuations in density of many marine benthic species, and it cannot be expected that a short-term research program will result in total predictive capabilities. Assessment of the environment must be conducted on a continuing long-term basis.

Data indicating the effects of oils on most subtidal benthic invertebrates are fragmentary, but echinoderms are "notoriously sensitive to any reduction in water quality" (Nelson-Smith, 1973). Echinoderms (ophiuroids, asteroids, and holothuroids) are conspicuous members of the benthos of the Gulf (see Feder and Mueller, 1975 for references to relevant stations), and could be affected by oil activities there. Asteroids (sea stars) and ophiuroids (brittle stars) are often important components of the diet of large crabs (for example king crab feed on sea stars) and demersal fishes. The tanner snow crab (*Chionoecetes bairdi*) is a conspicuous member of the shallow shelf of the Gulf, and supports a commercial fishery of considerable importance there. Laboratory experiments with this species have shown that postmolt individuals lose most of their legs after exposure to Prudhoe Bay oil; obviously this aspect of the biology of the snow crab must be considered in the continuing assessment of this benthic species in the Gulf (J. Karinen and S. Rice, in press: cited in Evans and Rice, 1974). Little other direct data based on laboratory experiments is available for subtidal benthic species (see Nelson-Smith, 1973). Experimentation on toxic effects of oil on other common members of the subtidal benthos should be strongly encouraged for the near future in the overall Outer Continental Shelf program.

A direct relationship between trophic structure (feeding type) and bottom stability has been demonstrated by Rhoads (see Rhoads, 1974 for review). A diesel-fuel oil spill resulted in oil becoming adsorbed on sediment particles with the resultant mortality of many deposit feeders living on sublittoral muds. Bottom stability was altered with the death of these organisms, and a new complex of species became established in the altered substratum. The most common members of the infauna of the Gulf of Alaska are deposit feeders; thus, oil-related mortality of these species could result in a changed nearbottom sedimentary regime with alteration of species.

1.3 Current State of Knowledge

Little is known about the biology of the invertebrate benthos of the Gulf of Alaska, although a compilation of some relevant data on the Gulf of Alaska is available (Rosenberg, 1972). A short but intensive survey in the summer of 1975 added some specific benthic biological data for an area south of the Bering Glacier (Bakus and Chamberlain, 1975). Results of the latter study are similar to those reported by Feder and Mueller (1975). Some scattered data based on trawl surveys by the National Marine Fisheries Service is available, but much of the information on the invertebrate fauna is so general so as to have little value. Some unpublished information on the epifauna is available (i.e., Alaska Department of Fish and Game King Crab Indexing Surveys in the vicinity of Kodiak Island).

In the summer and fall of 1961 and spring of 1962 otter trawls were used to survey the bottomfish and shellfish on the Continental Shelf and upper continental slope in the Gulf of Alaska (Hitz and Rathjen, 1965). The survey was part of a long-range program begun in 1950 to determine the size of bottomfish stocks in the northeastern Pacific Ocean between southern Oregon and northwest Alaska. Invertebrates taken in the trawls were of secondary interest, and only major groups and/or species were recorded. Invertebrates that comprised 27 percent of the total catch were grouped into eight categories; heart urchins (Echinoidea), snow crab (*Chionoecetes bairdi*), starfish (Asteroidea), Dungeness crab (*Cancer magister*), scallop (*Pecten caurinus*), shrimp (*Pandalus borealis*, *P. platypus*, and *Pandalopsis dispar*), king crab (*Paralithodes camtschatica*), and miscellaneous invertebrates (shells, sponges, etc.) (Hitz and Rathjen, 1965). Heart urchins accounted for about 50 percent of the invertebrate catch and snow crab ranked second representing about 22 percent. Approximately 20 percent of the total invertebrate catch was composed of starfish.

Further knowledge of invertebrate stocks in the north Pacific is scant. The International Pacific Halibut Commission (IPHC) surveys parts of the Gulf of Alaska annually and records selected commercially important invertebrates but non-commercial species are discarded. Distribution and abundance of commercially important invertebrates from the northeast Gulf of Alaska (NEGOA) integrated trawl program was reported by Ronholt *et al.*, (1976). The benthic investigations of Feder *et al.*, (1976) represent the first intensive qualitative and quantitative examination of the biota of the infauna and epifauna of the Gulf of Alaska.

1.4 Acknowledgements

We would like to thank the following for assistance onboard ship: Max Hoberg, University of Alaska; the research crew from the Northwest Fisheries Center of National Marine Fisheries Service, Seattle, Washington; and the crew of the M/V *North Pacific*. We are also thankful for the intensive assistance of the Marine Sorting Center, University of Alaska. Thanks also to the assistance of Rosemary Hobson, Data Processing, University of Alaska, who helped with coding problems and ultimate resolution of those problems.

1.5 Specific Objectives

1) A qualitative and quantitative inventory census of dominant epibenthic species within identified oil-lease sites in the northeast Gulf of Alaska.

2) Preliminary observations of biological interrelationships between selected segments of the benthic biota in the designated study area.

CHAPTER II

STUDY AREA, METHODS AND RATIONALE OF DATA COLLECTION

A large number of stations were occupied in conjunction with the integrated northeast Gulf of Alaska (NEGOA) benthic trawling investigations which sampled a grid existing from the western tip of Montague Island (148° longitude) to Yakutat Bay (140° longitude) (Fig. 1). The survey sampled to a maximum depth of approximately 500 meters (250 fathoms).

The integrated NEGOA trawl program consisted of collection of demersal fishes, benthic invertebrates, fish stomachs, meristic analysis of fish species, trace metals and hydrocarbon. The only aspect treated here is the benthic invertebrates. This paper is the result of expansion and deletion of information from Feder *et al.*, 1976.

Trawl material was collected with commercial gear on board the M/V *North Pacific*. One-hour tows were made at stations (Fig. 1) using a commercial size 400-mesh Eastern otter trawl. All invertebrates of non-commercial importance were sorted out on shipboard, given tentative identifications, counted, weighed when time permitted and aliquot samples of individual species preserved and labeled for final identification at the Institute of Marine Science, University of Alaska. All epifaunal invertebrates were typically counted, although in some cases only weights were taken for very abundant species. At some stations it was possible to count and weigh most invertebrate species. Conversion factors have been developed to approximate wet weights for all invertebrate species at all stations. All weights of the family Paguridae (hermit crabs) from the Gulf of Alaska were inclusive of their shells. Counts and weights of commercially important invertebrate species were recorded by the National Marine Fisheries Service biologists

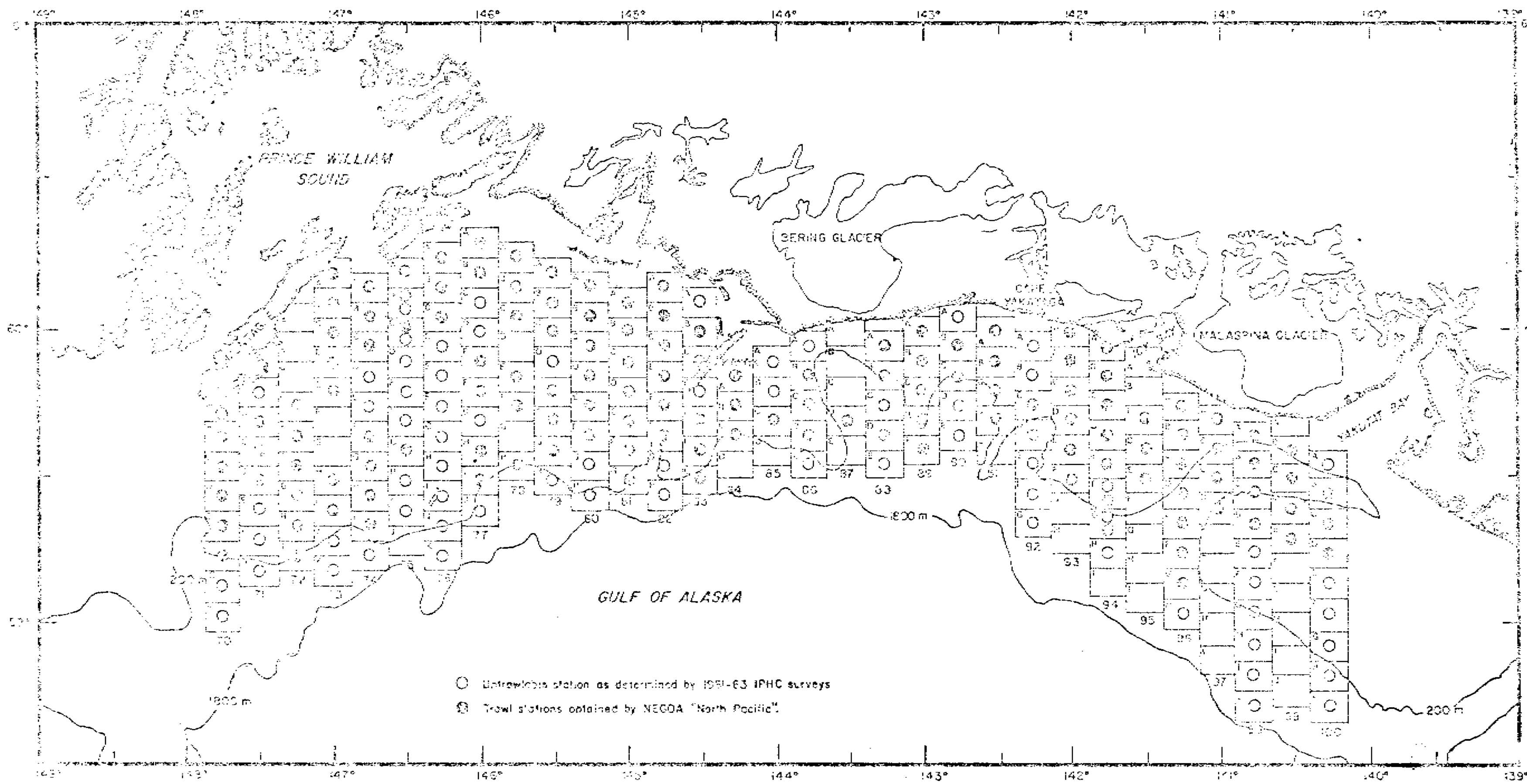


Figure 1. Station grid established for the trawl survey on the continental shelf of the northeastern Gulf of Alaska (NEGOA), summer 1975.

(Ronholt *et al.*, 1976) and the data was made available to the benthic invertebrate program.

For obvious logistic reasons all invertebrates could not be returned to the laboratory for verification. Therefore, a subsample of each field identification was returned to the University. Closer laboratory examination often revealed more than one species of what was designated in the field as one species (e.g., field identifications of *Pandalus borealis* was later found to also contain *P. montagui tridens*). The difficulty is apparent in assessing total counts and weights of each taxon. In such cases the counts and weights of the species in question were arbitratily expanded from the laboratory species ratio to the entire catch of the trawl.

The major limitations of the survey were those imposed by the selectivity of the otter trawl used, and the seasonal movements of certain species taken. Otter trawls of the type used can be fished only on relatively smooth bottom. Thus, rocky-bottom areas were never sampled.

CHAPTER III

RESULTS

Taxonomic analysis has delineated nine (9) phyla, 19 classes 82 families, 124 genera and 168 species of invertebrates from the collections made on the M/V *North Pacific* (Table 1). The molluscs and crustaceans dominated in species representation with 47 and 42 species taken respectively. Three invertebrate phyla which made up 95% of the invertebrate biomass were arthropoda (71.4%), echinodermata (19.0%), and mollusca (4.6%) (Table 2).

Among the arthropod representatives, the families Majidae, Pandalidae, Lithodidae, Paguridae, and Crangonidae were most abundant. The most ubitquitous species, *Chionoecetes bairdi* of the family Majidae, contributed most to the invertebrate biomass (66.2%) (Table 2). The density of this crab was as much as 19.778 g/m^2 or 892.8 kg (1968 pounds) taken per hour at Station 82-A (Figs. 1 and 2). The average catch per unit of effort (CPUE) was 69 kg/hr. Sex composition was 53% male 47% females. The pink shrimp, *Pandalus borealis*, also consistently made up an important segment of the invertebrate biomass (Table 2), i.e. as much as 2.476 g/m^2 or 167.7 kg (370 pounds) taken per hour at Station 83-C (Figs. 1 and 3). The average CPUE was 7 kg/hr. The box crab, *Lopholithodes foraminatus*, was the third most important arthropod in weight composition (Table 2). In a one-hour tow at Station 86-D, 55 of these crabs weighed 25.4 kg (0.288 g/m^2) (Figs. 1 and 4). The average CPUE was 4 kg/hr.

The three most important members of the echinoderm biomass were the brittle star, *Ophiura sarsi*, the mud star, *Ctenodiscus crispatus*, and the sea cucumbers of family, Cucumariidae (Table 2). The stations showed a considerable diversity of echinoderm species and with the exception of *O. sarsi* and *C. crispatus*. The most important group of echinoderms was the sea

Table 1. A list of species taken by trawl from the Northeast Gulf of Alaska (NEGOA) on board the National Marine Fisheries Serivce charter vessel M/V *NORTH PACIFIC*, 25 April - 7 August 1975.

Phylum Porifera

Phylum Cnidaria
- Class Hydrozoa
- Class Scyphozoa
  - Family Palagiidae
    - *Chrysaora melanaster* Brandt
- Class Anthozoa
  - Subclass Alcyonaria
    - *Eunephthya rubiformis* (Pallas)
  - Family Virgulariidae
    - *Stylatula gracile* (Gabb)
  - Family Pennatulidae
    - *Ptilosarcus gurneyi* (Gray)
  - Family Actiniidae
    - *Tealia crassicornis* (O. F. Müller)

Phylum Annelida
- Class Polychaeta
  - Family Polynoidae
    - *Arctonoe vittata* (Grube)
    - *Eunoe depressa* Moore
    - *Eunoe oerstedi* Malmgren
    - *Harmothoe multisetosa* Moore
- Hololepida magna Moore
    - *Lepidonotus squamatus* (Linnaeus)
    - *Lepidonotus* sp.
    - *Polyeunoe tuta* (Grube)
  - Family Polynodontidae
    - *Peisidice aspera* Johnson
  - Family Euphrosinidae
    - *Euphrosine hortensis* Moore
  - Family Syllidae
  - Family Nereidae
    - *Ceratonereis paucidentata* (Moore)
    - *Ceratonereis* sp.
    - *Cheilonereis cyclurus* (Harrington)
    - *Nereis pelagica* Linnaeus
    - *Nereis vexillosa* Grube
    - *Nereis* sp.
  - Family Nephtyidae
  - Family Glyceridae
    - *Glycera* sp.
  - Family Eunicidae
    - *Eunice valens* (Chamberlin)
  - Family Lumbrineridae
    - *Lumbrineris similabris* (Treadwell)
  - Family Opheliidae
    - *Travisia pupa* Moore
  - Family Sabellariidae
    - *Idanthyrsus armatus* Kinberg

Family Terebellidae

Amphitrite cirrata O. F. Müller

Family Sabellidae

Euchone analis (Kröyer)

Family Serpulidae

Crucigera irregularis Bush

Family Aphroditidae

Aphrodita japonica Marenzeller

Aphrodita neglegens Moore

Aphrodita sp.

Class Hirudinae

Notostomobdella sp.

Phylum Mollusca

Class Polyplacophora

Family Mopaliidae

Class Pelecypoda

Family Nuculanidae

Nuculana fossa Baird

Family mytilidae

Mytilus edulis Linnaeus

Musculus niger (Gray)

Modiolus modiolus (Linnaeus)

Family Pectinidae

Chlamys hastata hericia (Gould)

Pecten caurinus Gould

Delectopecten randolphi (Dall)

Family Astartidae

Astarte polaris Dall

Family Carditidae

Cyclocardia ventricosa (Gould)

Family Cardiidae

Clinocardium ciliatum (Fabricius)

Clinocardium fucanum (Dall)

Serripes groenlandicus (Bruguière)

Family Veneridae

Compsomya subdiaphana Carpenter

Family Mactridae

Spisula polynyma (Stimpson)

Family Myidae

Family Hiatellidae

Hiatella arctica (Linnaeus)

Family Teredinidae

Bankia setacea Tryon

Family Lyonsiidae

Class Gastropoda

Family Bathybembix

Solariella obscura (Couthouy)

Lischkeia cidaris (Carpenter)

Family Naticidae

Natica clausa Broderip and Sowerby

Polinices monteronis Dall

Polinices lewisii (Gould)

Family Cymatiidae

Fusitriton oregonensis (Redfield)

Family Muricidae
Trophonopsis stuarti (Smith)
Family Buccinidae
Buccinum plectrum Stimpson
Family Neptuneidae
Beringius kennicotti (Dall)
Colus halli (Dall)
Morrisonella pacifica (Dall)
Neptunea lyrata (Gmelin)
Neptunea pribiloffensis (Dall)
Plicifusus sp.
Pyrulogusus harpa (Mörch)
Volutopsius filosus Dall
Family Columbellidae
Mitrella gouldi (Carpenter)
Family Volutidae
Arctomelon stearnsii (Dall)
Family Turridae
Oenopota sp.
Leucosyrinx circinata (Dall)
Family Dorididae
Family Tritoniidae
Tritonia exsulans Bergh
Tochuina tetraquetra (Pallas)
Family Flabellinidae
Flabellinopsis sp.
Class Cephalopoda
Family Sepiolidae
Rossia pacifica Berry
Family Gonatidae
Gonatopsis borealis Sasaki
Gonatus magister Berry
Family Octopodidae
Octopus sp.

Phylum Arthropoda
Class Thoracica
Family Lepadidae
Lepas pectinata pacifica Henry
Family Balanidae
Balanus hesperius
Balanus rostratus Hoek
Balanus sp.
Class Isopoda
Family Aegidae
Rocinela angustata Richardson
Family Bopyridae
Argeia pugettensis Data
Class Decapoda
Family Pandalidae
Pandalus borealis Kröyer
Pandalus jordani Rathbun
Pandalus montagui tridens Rathbun
Pandalus platyceros Brandt
Pandalus hypsinotus Brandt
Pandalopsis dispar Rathbun

Family Hippolytidae

Spirontocaris lamellicornis (Dana)

Spirontocaris arcuata Rathbun

Eualus barbata (Rathbun)

Eualus macrophthalma (Rathbun)

Eualus suckleyi (Stimpson)

Eualus pusiola (Kröyer)

Family Crangonidae

Crangon communis Rathbun

Argis sp.

Argis dentata (Rathbun)

Argis ovifer (Rathbun)

Argis alaskensis (Kingsley)

Paracrangon echinata Dana

Family Paguridae

Pagurus ochotensis (Benedict)

Pagurus aleuticus (Benedict)

Pagurus kennerlyi (Stimpson)

Pagurus confragosus (Benedict)

Elassochirus tenuimanus (Dana)

Elassochirus cavimanus (Miers)

Labidochirus splendescens (Owen)

Family Lithodidae

Acantholithodes hispidus (Stimpson)

Paralithodes camtschatica (Tilesius)

Lopholithodes foraminatus (Stimpson)

Rhinolithodes wosnessenskii Brandt

Family Galatheidae

Munida quadrispina Benedict

Family Majiidae

Oregonia gracilis Dana

Hyas lyratus Dana

Chionoecetes bairdi Rathbun

Chorilia longipes Dana

Family Canceridae

Cancer magister Dana

Cancer oregonensis (Dana)

Phylum Ectoprocta

Phylum Brachiopoda

Class Articulata

Family Cancellothridae

Terebratulina unguicula Carpenter

Terebratalia transversa (Sowerby)

Family Dallinidae

Laqueus californianus Koch

Phylum Echinodermata

Class Asteroidea

Family Asteropidae

Dermasterias imbricata (Grube)

Family Astropectinidae

Dipsacaster borealis Fisher

Family Benthopectinidae
Luidiaster dawsoni (Verrill)
Nearchaster pedicellaris (Fisher)
Family Goniasteridae
Ceramaster patagonicus (Sladen)
Hippasterias spinosa Verrill
Mediaster aequalis Stimpson
Pseudarchaster parelii (Düben and Koren)
Family Luiidae
Luidia foliolata Grube
Family Porcellanasteridae
Ctenodiscus crispatus (Retzius)
Family Echinasteridae
Henricia aspera Fisher
Henricia sp.
Poraniopsis inflata Fisher
Family Pterasteridae
Diplopteraster multipes (Sars)
Pteraster tesselatus
Family Solasteridae
Crossaster borealis (Fisher)
Crossaster papposus (Linnaeus)
Lophaster furcilliger Fisher
Lophaster furcilliger vexator Fisher
Solaster dawsoni Verrill
Family Asteridae
Leptasterias sp.
Lethasterias nanimensis (Verrill)
Stylasterias forreri (de Loriol)
Pycnopodia helianthoides (Brandt)
Class Echinoidea
Family Schizasteridae
Brisaster townsendi
Family Strongylocentrotidae
Allocentrotus fragilis (Jackson)
Strongylocentrotus droebachiensis (O. F. Müller)
Class Ophiuroidae
Family Amphiuridae
Unioplus macraspis (Clark)
Family Gorgonocephalidae
Gorgonocephalus caryi (Lyman)
Family Ophiactidae
Ophiopholis aculeata (Linnaeus)
Family Ophiuridae
Amphiophiura ponderosa (Lyman)
Ophiura sarsi Lütkin
Class Holothuroidea
Family Molpadiidae
Molpadia sp.
Family Cucumariidae
Family Psolidae
Psolus chitinoides H. L. Clark
Class Crinoidea

Table 2 Taxonomic delineation of invertebrates and percentage composition by weight of leading invertebrate taxa, collected during Northeast Gulf of Alaska (NEGOA) trawling investigations, summer 1975.

9 Phyla - 19 Classes - 82 Families - 124 genera - 168 species

Phyla	Percentage of Weight	Taxa	Average Weight per taxa		Percentage within Phylum	Percentage from all Phyla
Arthropoda (42 species)	71.4%	*Chionoecetes bairdi*	454 g		92.6	66.2
		Pandalus borealis	8 g		4.0	2.9
		Lopholithodes foraminatus	420 g		0.6	0.4
				Total	97.2	69.5
Echinodermata (36 species)	19.0%	*Ophiura sarsi*	6 g		23.2	4.4
		Ctenodiscus crispatus	10 g		15.7	2.9
		Cucumariidae	400 g		15.0	2.8
				Total	53.9	10.1
Mollusca (47 species)	4.6%	*Pecten caurinus*	350 g		43.4	2.0
		Neptunea lyrata	180 g		12.5	0.6
		Fusitriton oregonensis	100 g		11.5	0.5
				Total	67.4	3.1
GRAND TOTAL	95%					82.6%

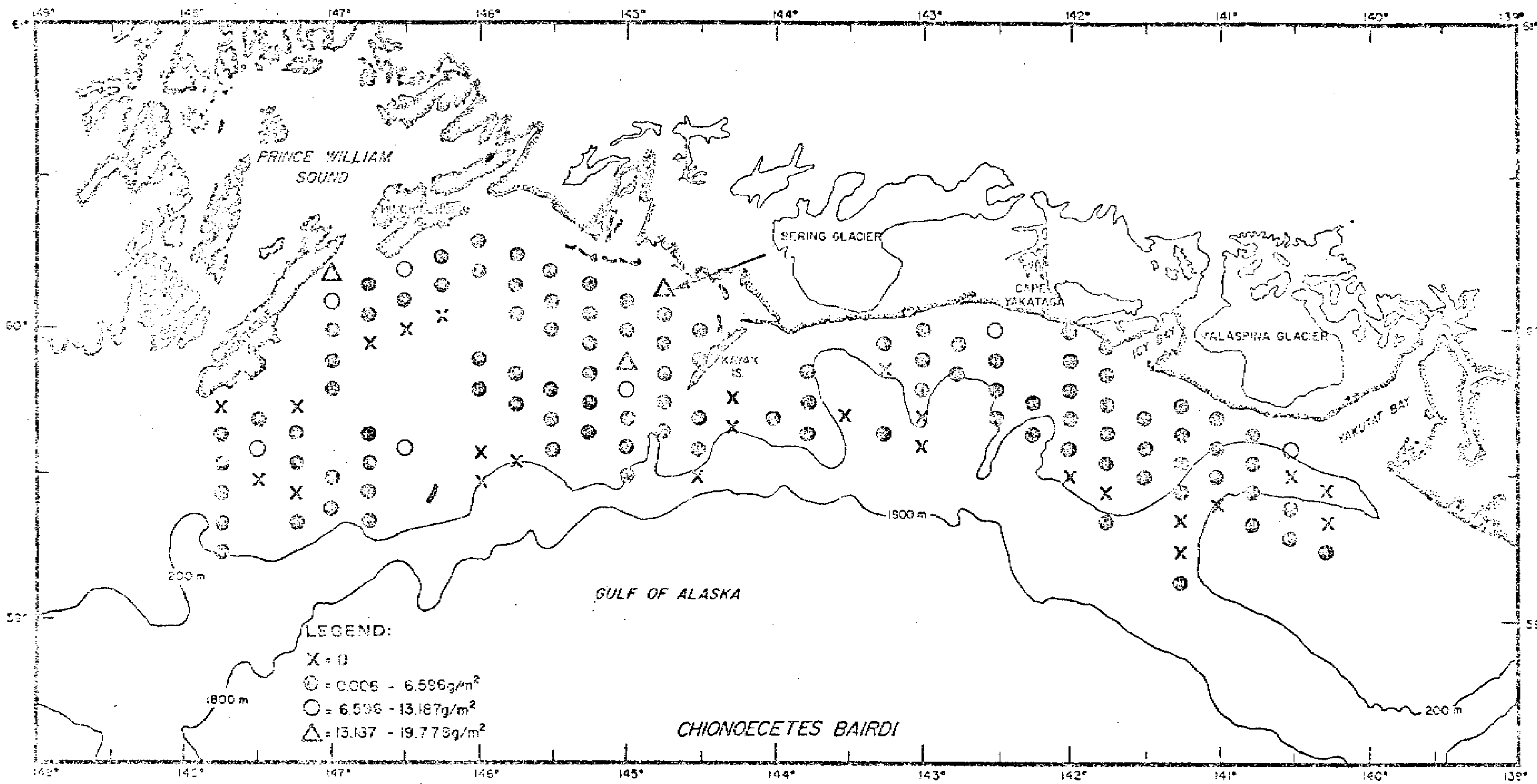


Figure 2. Distribution and abundance of the snow crab, *Chionoecetes bairdi*, from the northeastern Gulf of Alaska (NEGOA) trawl survey, summer 1975.

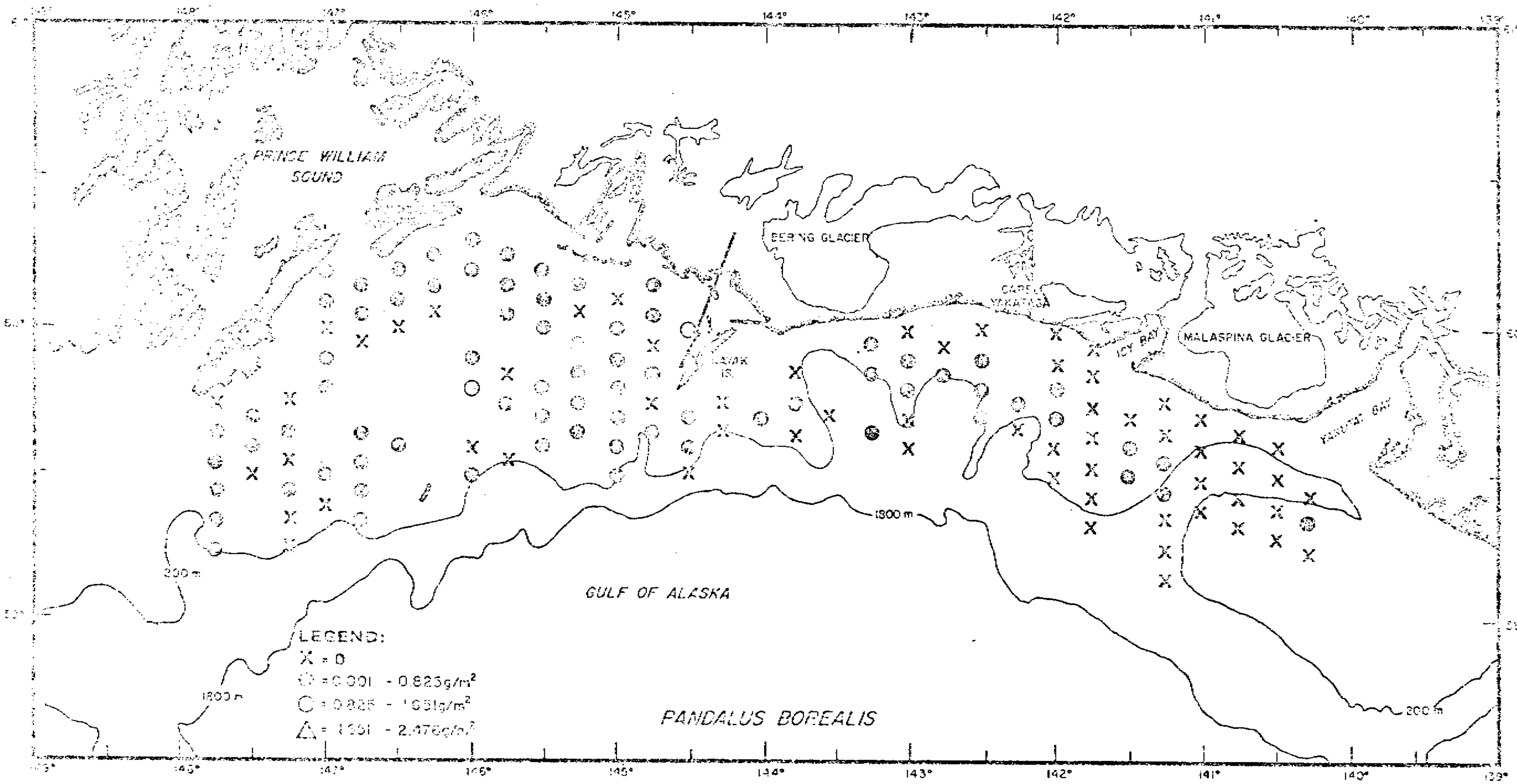


Figure 3. Distribution and abundance of the pink shrimp, *Pandalus borealis*, from the northeastern Gulf of Alaska (NEGOA) trawl survey, summer 1975.

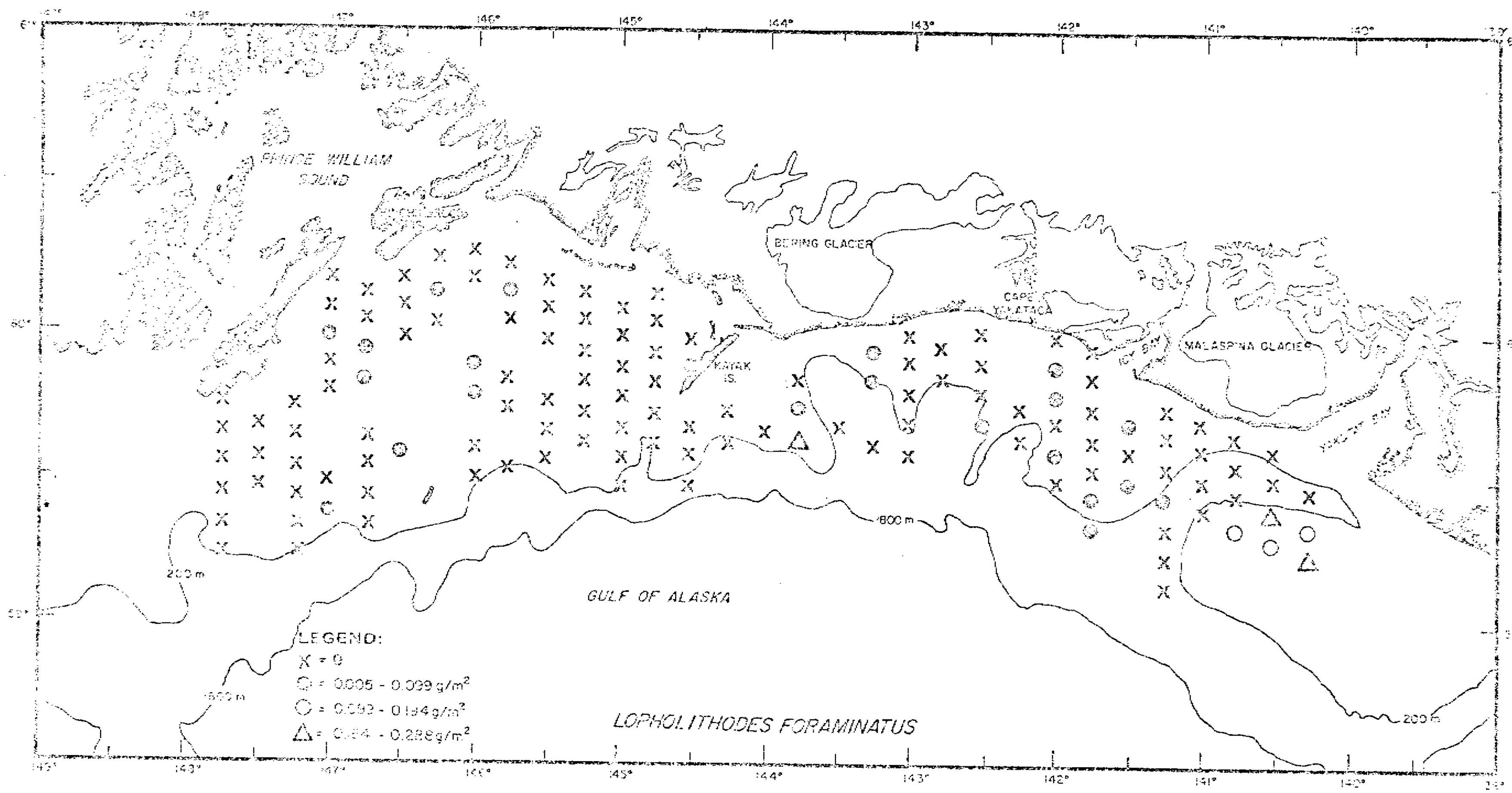


Figure 4. Distribution and abundance of the box crab, *Lopholithodes foraminatus*, from the northeastern Gulf of Alaska (NEGOA) trawl survey, summer 1975.

stars which consisted of 20 genera and 21 species. The percentage weight composition of sea stars as part of all echinoderms and all invertebrate species was 35.3% and 6.7% respectively. *Ophiura sarsi*, which has an average weight of 6 g, was most abundant at Station 81-D where the catch was a remarkable 11.447 g/m^2 or 750 kg (1653 pounds) per hour (Figs. 1 and 5). The average CPUE was 19.2 kg/hr. The greatest density of the small asteroid, *Ctenodiscus crispatus*, (average weight of 10 g) was at Station 80-B with 0.825 g/m^2 or 55.8 kg (123 pounds) per hour (Figs. 1 and 6). The average CPUE was 8.3 kg/hr. This sea star was normally found in muddy bottoms with its stomach full of mud. Although Cucumariidae was only found in seven stations, it still ranked third in echinoderm weight composition. Station 99-D contained approximately 2600 individuals weighing 9.599 g/m^2 or 650 kg (1433 pounds) per one-hour tow (Figs. 1 and 7). The average CPUE was 96 kg/hr.

Pycnopodia helianthoides was another widely distributed sea star. One hundred and seventy (170) of these large sea stars (average weight of 0.453 kg or 1 pound) were taken at station 93-C (Figs. 1 and 8). The average CPUE was 9.2 kg/hr. Several of the stomachs of these sea stars were examined, and it was determined that *Ctenodiscus crispatus* and the brittle star *Ophiura sarsi* were the most frequently occurring food items. Other food items of lesser importance used by *P. helianthoides* in order of diminishing frequence occurrence are the gastropods *Colus halli*, *Mitrella gouldi*, *Solariella obscura*, *Oenopota* sp. and *Natica clausa*, and the pelecypods *Serripes groenlandicus* and *Clinocardium ciliatum*.

Another important echinoderm in terms of biomass was the heart urchin, *Brisaster townsendi*. Station 97-C yielded the largest catch of this urchin with 2.940 g/m^2 or 212.7 kg (469 pounds) per hour 21,272 urchins per hour (Figs. 1 and 9). The average CPUE was 27 kg/hr.

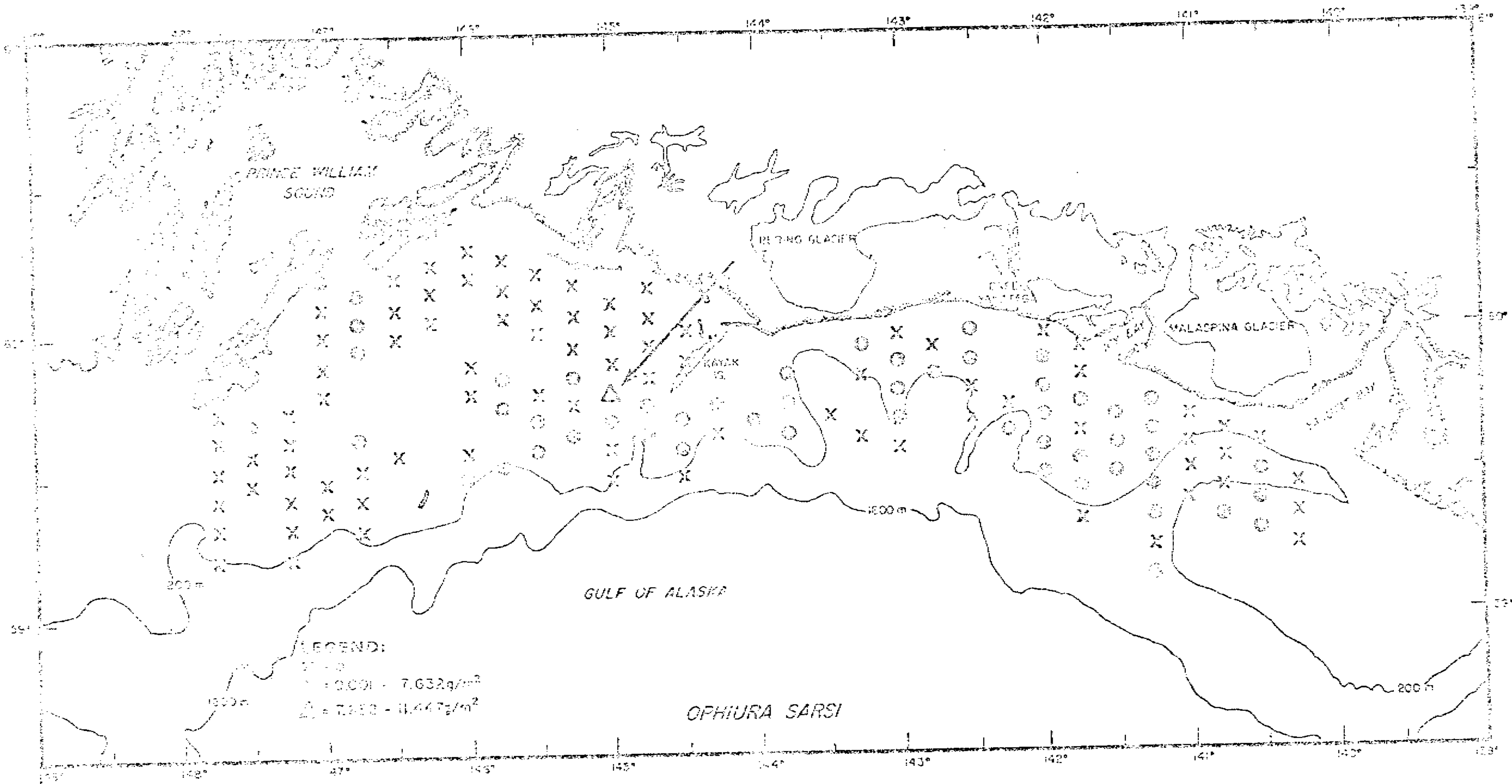


Figure 5. Distribution and abundance of the brittle star, *Ophiura sarsi*, from the northeastern Gulf of Alaska (NEGOA) trawl survey, summer 1975.

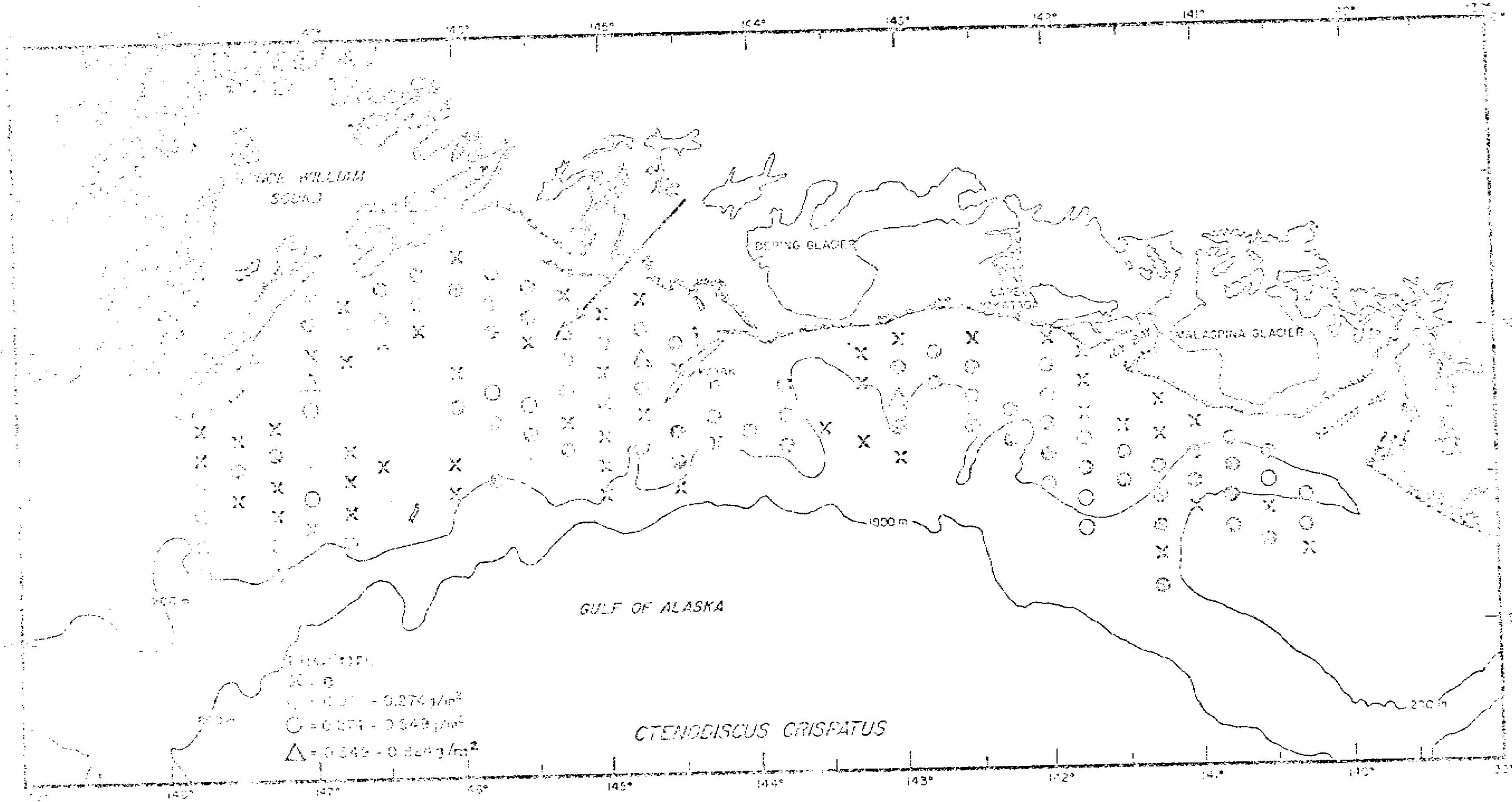


Figure 6. Distribution and abundance of the sea star, *Ctenodiscus crispatus*, from the northeastern Gulf of Alaska (NEGOA) trawl survey, summer 1975.

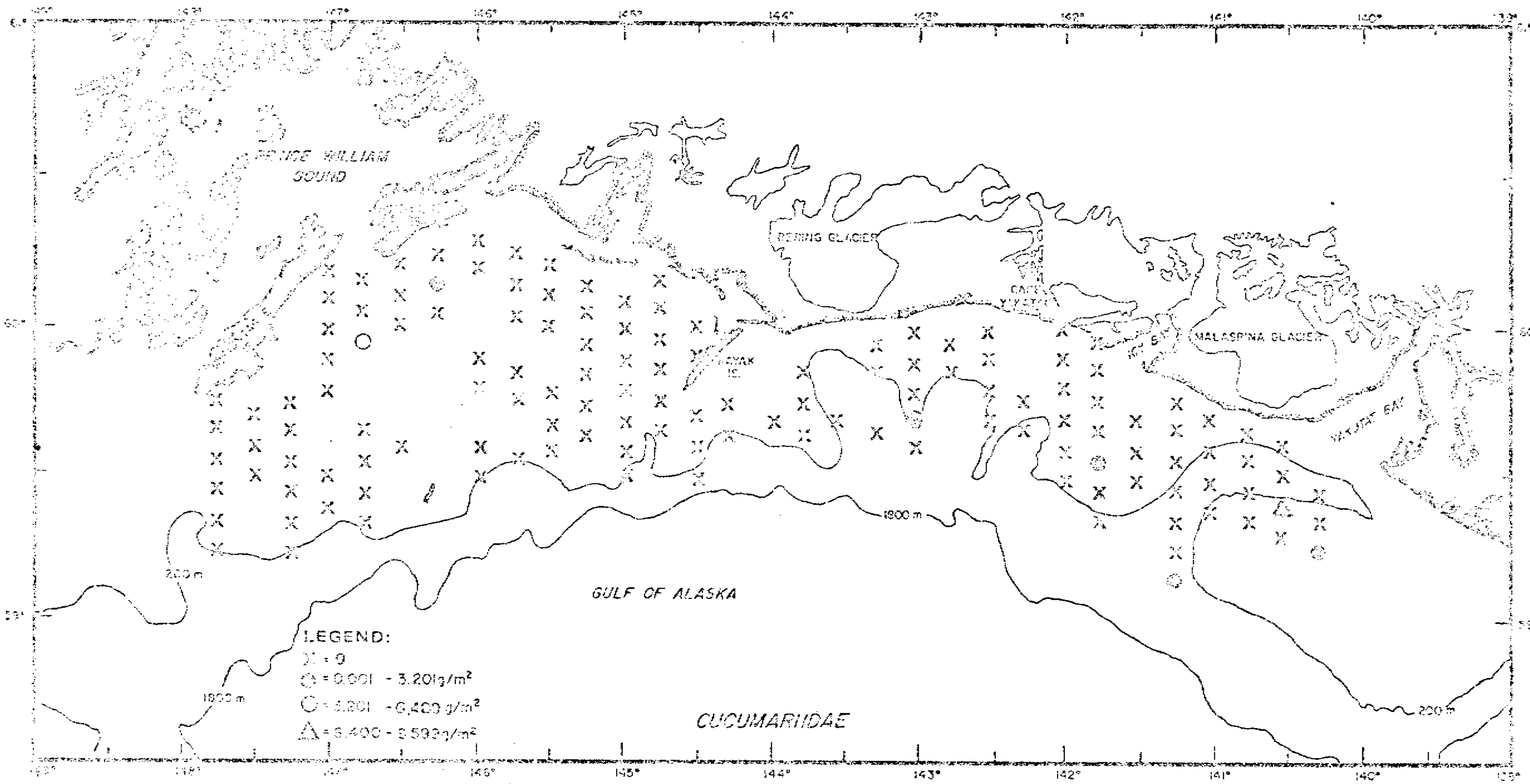


Figure 7. Distribution and abundance of the sea cucumber, family Cucumariidae, from the northeastern Gulf of Alaska (NEGOA) trawl survey, summer 1975.

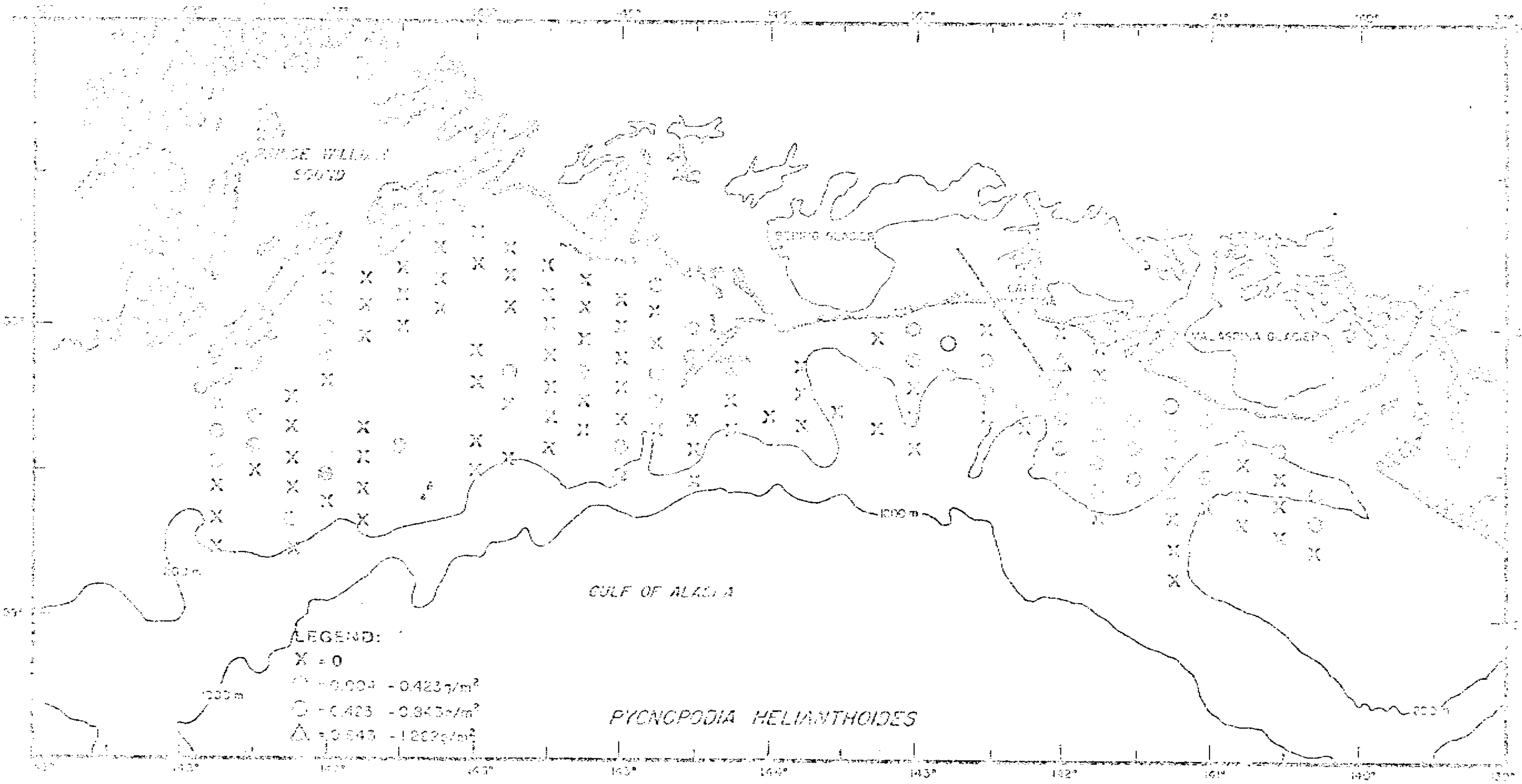


Figure 8. Distribution and abundance of the sea star, *Pycnopodia helianthoides*, from the northeastern Gulf of Alaska (NEGOA) trawl survey, summer 1975.

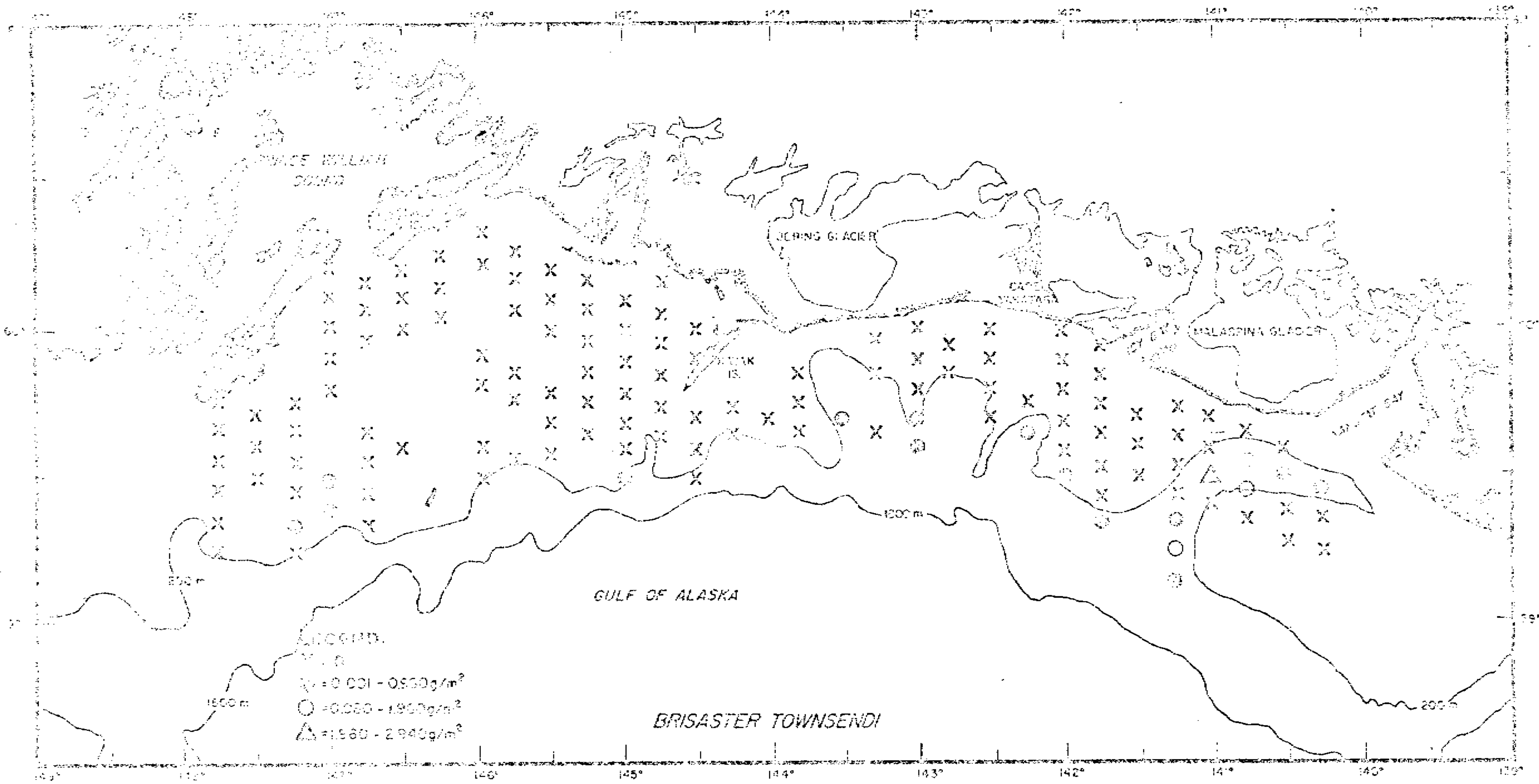


Figure [illegible]. Distribution and abundance of the heart urchin, *Brisaster townsendi*, from the northeastern Gulf of Alaska (NEGOA) trawl survey, summer 1975.

Molluscs were presented by 28 families with families Pectinidae, Neptuneidae and Cymatiidae leading respectively by weight composition. Important members of these families were the scallop, *Pecten caurinus* and the snails, *Neptunea lyrata* and *Fusitriton oregonensis* respectively (Table 2). The weathervane scallop, *Pecten caurinus*, constituted 2% of the total invertebrate biomass and 43% of the Molluscan biomass. *Pecten caurinus* was generally present in the nearshore stations from Kayak Island to Icy Bay. Station 83-E provided the largest catch of scallops with 1.705 g/m^2 or 116 kg (370 pounds) taken per hour (Figs. 1 and 10). The average CPUE was 10.7 kg/hr. The family Neptuneidae was most common gastropod family with *Neptunea lyrata, Pyrulofusus harpa* and *Colus halli* dominant. The greatest abundance of *Neptunea lyrata* was found at Station 89-A with 0.462 g/m^2 or 32.4 kg (71 pounds) taken per hour (Figs. 1 and 11). The average CPUE was 2.2 kg/hr. The gastropod, *Arctomelon stearnsii*, which is considered rare in museum collections (Rice, 1973), was relatively common in the Gulf of Alaska stations. The Oregon triton, *Fusitriton oregonensis*, was the only member of the family Cymatidae. This snail was widely distributed with the most dense stations at the west end of the grid, specifically, Station 74-C where the density was 0.368 g/m^2 or 19.4 kg (43 pounds) taken in 35 minutes (Figs. 1 and 12). The average CPUE was 2 kg/hr.

Fifty-seven percent ($\frac{33}{58}$) of the stations contained pollutants which consisted primarily of plastic materials such as brown or green trash bags, pieces of clear plastic (bait wrappers), and plastic straps which are normally used as cargo binding material. Numerous plastics were of Japanese or Korean origin. A variety of other pollutants consisted of tarred paper, bottles, a steel cable, rubber gloves, a rubber tire and two derelict snow crab pots.

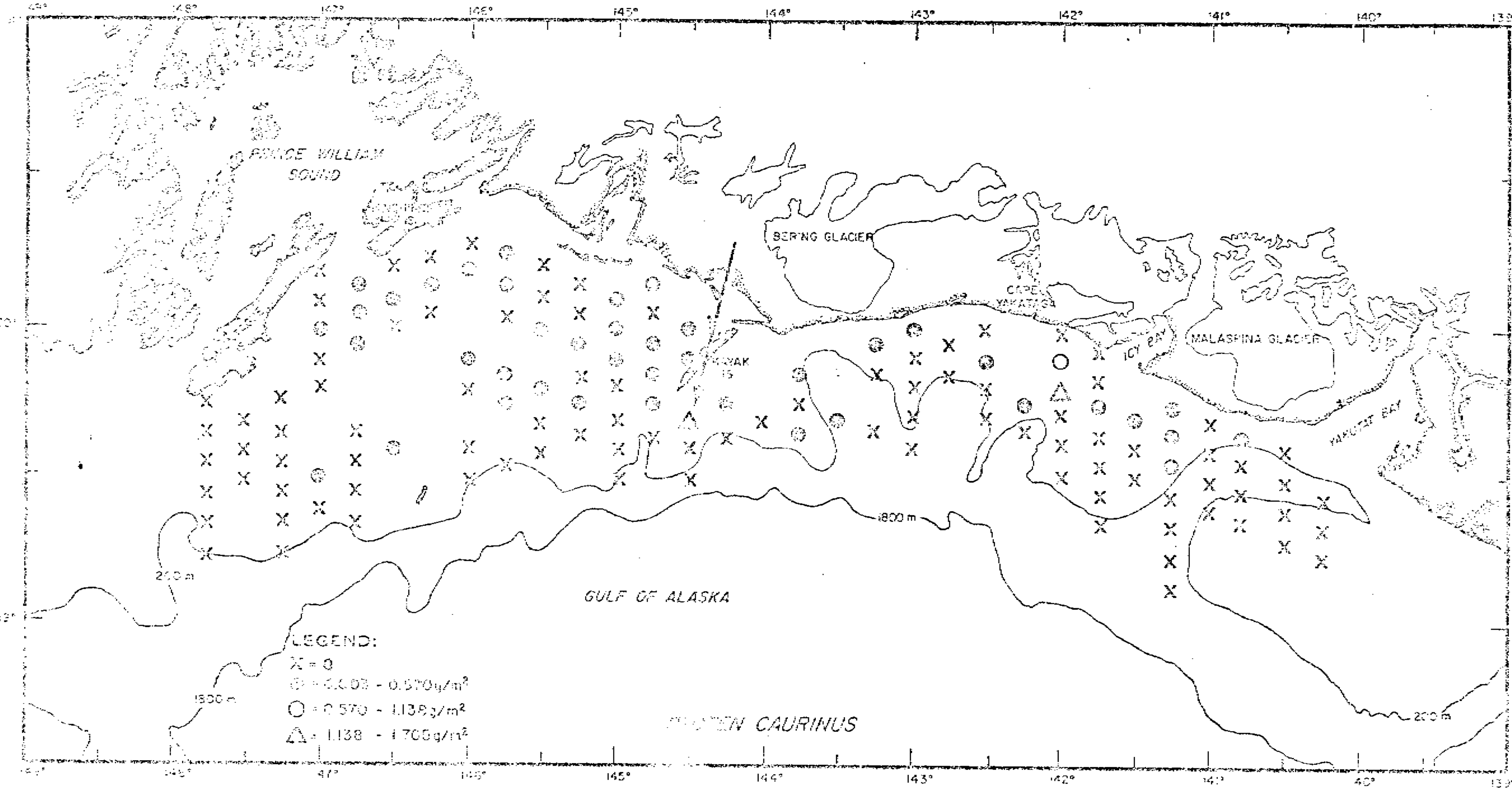


Figure 10. Distribution and abundance of the scallop, *Pecten caurinus*, from the northeastern Gulf of Alaska (NEGOA) trawl survey, summer 1975.

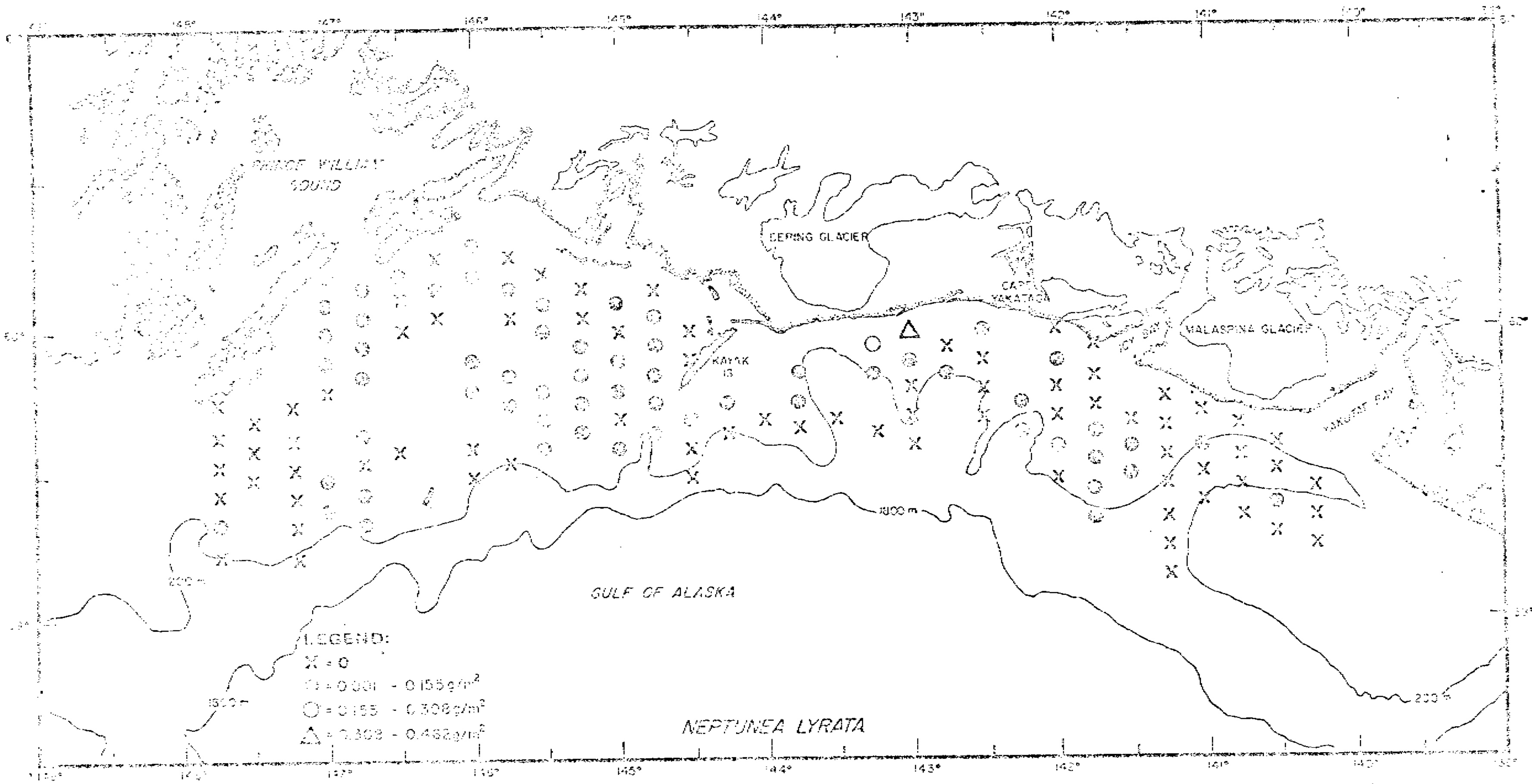


Figure 11. Distribution and abundance of the snail, *Neptunea lyrata*, from the northeastern Gulf of Alaska (NEGOA) trawl survey, summer 1975.

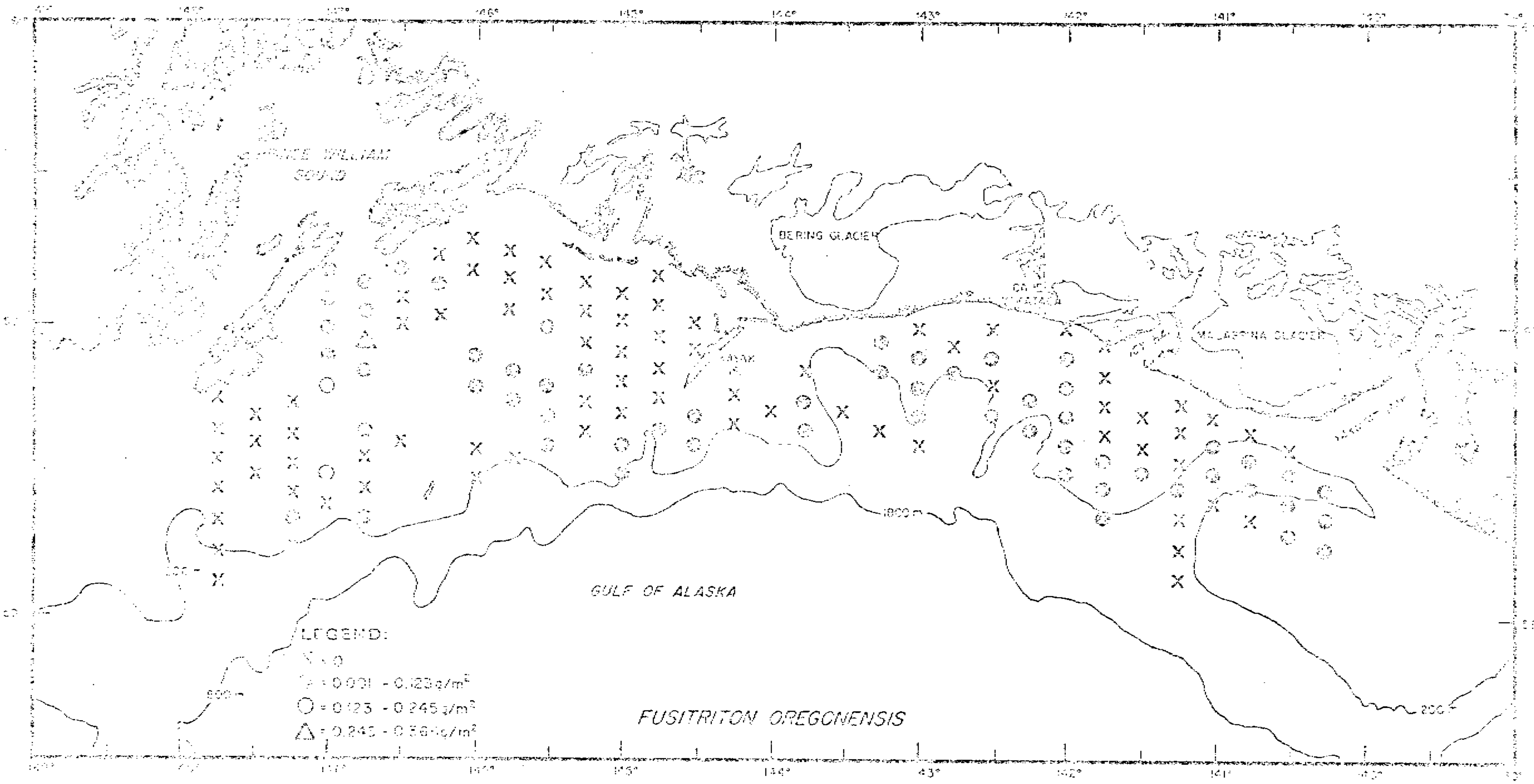


Figure 12. Distribution and abundance of the Oregon triton, *Fusitriton oregonensis*, from the northeastern Gulf of Alaska (NEGOA) trawl survey, summer 1975.

CHAPTER IV

DISCUSSION

4.1 Station Coverage

The trawl program permitted wide coverage of the Northeast Gulf of Alaska and made it possible to collect the more motile, as well as the larger, epifaunal species. The integrated trawl program (demersal fish, benthic invertebrates, fish stomach analysis, meristic analysis of fish species, trace metal, and hydrocarbon programs) represents a significant supplement to the data collected early in the first year by way of grab samples only, and should broaden the data base ultimately to be used to understand the shelf ecosystem.

It is impossible to return all invertebrates to the laboratory for verification, therefore, it is difficult to get total numbers and weights of every species found especially those species that are very similar. However, by careful development of conversion factors in the laboratory, it has been possible to make total numbers and weights available for all stations occupied.

The intensity of the demersal fish program, the necessary on-board lower priority given to invertebrate weighing and counting activities, and the multiple role occupied by the benthic biologist on the vessel (i.e. identify, count, weigh as many invertebrates as possible per station, collect -- in cooperation with the biologists of the demersal fish program -- many species of fishes for stomach and meristic analyses, sample specific species for both the hydrocarbon and trace metal programs) made it difficult for him to do much more than collect species distribution and density data. Weight data were obtained, but this was initially spotty and only accomplished on a time-available basis (Appendix Table

VIII in Feder and Mueller, 1975). Little effort (in fact, little time was available) was devoted to collection of sizable invertebrate samples for recruitment, growth age and feeding studies. It should be emphasized that support of a demersal fish trawling program is essential if a total, integrated understanding of the trophic-dynamics of the benthos is to be gained. Lack of additional trawl time will distinctly narrow the scope of the overall benthic program, and will hamper the development of an offshore monitoring plan.

4.2 Species Composition and Diversity

In addition to being the most abundant invertebrate and supporting an extensive commercial fishery, *Chionoecetes bairdi* also appears to be one of the main food items of the Pacific cod, *Gadus macrocephalus* (Feder, *et al.*, 1975). Feeding information of *C. bairdi* is not available. However, Yasuda (1967) examined the stomach contents of *C. opilio elongatus* collected in Japanese waters and reported that the bulk of the stomach contents was composed of Echinodermata (especially Ophiuroidea), Protobranchia (clams) and Decapod Crustacea (especially *C. opilio elongatus*). It is probable that *C. bairdi* in the northeastern Gulf of Alaska also feed on similar organisms.

Table 2 reveals that nine species accounted for 82.6% by weight of all invertebrate species. Sizable biomasses of echinoderms and molluscs were typical of most of the trawl station samples, and many of the species were sufficiently abundant to represent suitable organisms for in-depth investigations of their biology. Availability of sufficient numbers of echinoderm and mollusc organisms are a preliminary requirement for development of satisfactory monitoring schemes and acquisition of suitable predictive capabilities for stressed benthic systems.

Another echinoderm species of considerable interest is the large sea cucumber *Molpadia* sp. This species is a non-selective deposit feeder, and passes large amounts of unsorted bottom material through their digestive tracts. This species is continually reworking and ingesting the sediments deeper. This species is probably important in their particular areas in terms of recycling nutrients and petroleum hydrocarbons that might otherwise be trapped in the sediments. The more common sea cucumber, family Cucumaridae is a suspension feeder, constantly waving its arms in an attempt to catch suspended food particles in the water column.

Little is known about Ophiuroid feeding habits. Feeding behavior ranges from suspension feeding by hook-covered arm tendrils in *Gorgonocephalus cary* to filter feeding to browsing and detritus feeding to predator feeding by arm hook and tube feet capture (see Kyte, 1969 for synopsis of feeding types). Gentleman (1964) reports that *Ophiura sarsi* feeds primarily by the latter method.

Other echinoderms which contributed significantly to the total biomass were the heart urchin, *Brisaster townsendi*, the sea star, *Pycnopodia helianthoides* and the basket star, *Gorgonocephalus caryi*.

In a bottom trawling survey of the northeast Gulf of Alaska, Hitz and Rathjen (1965) reports that the deposit-feeding heart urchin *Brisaster townsendi* accounted for about 50 percent of the invertebrate catch, i.e. as high as 534 kg (1177 pounds) per hour (average 171 pounds per hour). *Brisaster townsendi* that were collected by the M/V *North Pacific* was also found in the same areas as reported by Hitz and Rathjen (1965), i.e. in Kayak Canyon, Icy Canyon and in particular Yakutat Canyon. Again the average catch of *Brisaster* on the North Pacific was 27 kg (61 pounds) per hour. The difference in average catches in mainly due to Hitz and Rathjen's large catches of this urchin in Alsek Canyon, an area southeast of our sampling grid. As a canyon dweller they can take fullest advantage of deposit feeding by living in an area where food particles are more readily carried and deposited by prevailing currents.

Feeding information of *Pycnopodia helianthoides* obtained in this study depicted this large sea star as preying entirely on molluscs and echinoderms. Paul and Feder (1975), found that most prey species of *Pycnopodia*, obtained from a Prince William Sound intertidal region, were small epifaunal of shallow-epifaunal organisms, primarily bivalve molluscs. *Pycnopodia* is capable of excavating for large clams (Mauzey *et al*; 1968). In addition to being the most abundant echinoderms, *Ctenodiscus crispatus* and *Ophiura sarsi* were the dominant food items of *Pycnopodia* in this study. Seventy-eight percent (78%) of the stations which contained *Pycnopodia* also contained *C. crispatus* and/or *O. sarsi*.

Hitz and Rathjen (1965) reported that approximately 20% of the total invertebrate catch was composed of sea stars, yet, only 6.7% of the NEGOA invertebrate catch were sea stars.

Caution must be taken when comparing densities of individual species or groups of invertebrates from Hitz and Rathjen (1965) and NEGOA since Hitz and Rathjen sampled an area farther east and west of the NEGOA station grid and densities of certain invertebrates may either increase or decrease between sampling periods of 13 years.

Some preliminary information on feeding habits of fishes was obtained in the trawl survey on the M/V *North Pacific* at several stations. Stations 94-A and 94-B (Fig. 1) were noteworthy for their large abundance of two species of fishes and the near-absence of invertebrates; this was especially true for the latter station. The starry flounder, *Platichthys stellatus*, dominated these two stations with 94-B yielding 3549 kg (7842 pounds) of these fishes per hour (average weights 2 kg). Preliminary examination of stomach contents in *P. stellatus* revealed that lamellibranchs, *Yoldia seminuda, Siliqua sloati* and *Macoma* sp. were the only food items found in the 35 stomachs examined. All stomachs were full. There appears to be a definite seasonal trend in feeding intensity for *Platichtyhs stellatus* (Miller, MS, 1965). Around January (month of the lowest bottom temperature) feeding stops and does not begin again until about June. The fullness of the stomachs of the starry flounder on 3 June in the Gulf of Alaska may be evidence of a recently terminated fasting period. It appears that the abundant clam populations in the study area might play a vital role in the trophic dynamics of *P. stellatus*.

A second species of interest was the large catch of juvenile walleye pollock, *Theragra chalcogramma* (approximately 10 cm long). Station 94-B yielded approximately 544 kg (1199 pounds) per hour. Thus, this area may be ecologically important in terms of supporting another potentially commercial species or as a developmental area for a species which is known to be an important trophic link in the North Pacific (Chang, 1974; Kamba, 1974; Takahashi and Yamaguchi, 1972).

The data from station 74-C is also of considerable interest. At this station was wide diversity of invertebrates and a high abundance of Pacific Halibut, *Hippoglossus stenolepis*. Of the 47 species of invertebrates that were found, 85% of the species were Crustaceans (14 species), echinoderms (13 species) and Molluscs (13 species). The biomass of the ascidian, *Halocynthia helgendorfi igaboja* was 4.521 g/m^2 or 419.8 kg (925 pounds) per hour. The halibut occurred at the rate of 1398.8 kg (3084 pounds) per hour. Each fish averaged 18.5 kg or 41 pounds. Regrettably, stomachs were not obtained at this station so it is not known what organism(s) they are feeding on.

The high frequency occurrence of pollutants within the surveyed area may give some indication of the amount of pollution that may occur throughout the North Pacific.

CHAPTER V

CONCLUSIONS

The joint National Marine Fisheries Service and Institute of Marine Science trawl charter for investigation of demersal fishes and epifaunal benthos was effective and maximum spatial coverage was achieved. Integration of this information with the infaunal benthic data (Feder *et al.*, 1975) will enhance our understanding of the shelf ecosystem.

To date this study represents the first intensive taxonomic study of epibenthic invertebrates in the Gulf of Alaska. Although this is not the only data base for epifaunal invertebrates of the Gulf (Hitz and Rathjen, 1965), our work does result in more thorough and more complete numerical and weight determinations.

Preliminary analysis of the data indicates that the commercially important crab, *Chionoecetes bairdi* clearly dominates the invertebrate biomass. Further, stomach analysis of the Pacific cod *Gadus macrocephalus* on the Kodiak shelf area, reveals that *C. bairdi* is a dominant food item (Feder, *et al.*, 1976). Here, we find a non-commercial species which has potential commercial importance, preying intensively on a species of great commercial significance.

In conclusion, it can be stated that sampling by means of grabs, trawls and/or dredges as well as stomach analysis of demersal fishes is necessary in order to fully comprehend trophic interactions in the benthic environment in the North Pacific.

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OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: September 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 20 R.U. NUMBER: 281

PRINCIPAL INVESTIGATOR: Dr. H. M. Feder

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates From	Collection Dates To	Estimated Submission Dates[1] Batch 1	2
Silas Bent Leg I #811	8/31/75	9/14/75	10/30/76	None
Discoverer Leg IV #812	10/8/75	10/16/75	9/30/76[a]	None
North Pacific	4/25/75	8/7/75	None	submitted
Discoverer #816	11/23/75	12/2/75	(b)	None
Contract #03-5-022-34	Last	Year	submitted	
Moana Wave	3/30/76	4/15/76	submitted	
Discoverer 001	3/17/76	3/27/76	(b)	

Note: [1] Data Management Plan and Data Formats have been approved and are considered contractual.

(a) Only samples for Kodiak area were processed. These data will be submitted with L.C.I. data from Moana Wave cruise.

(b) Selected samples will be processed in FY '77 pending continuation and funding for this project.

Quarterly Report

Contract #03-5-022-56
Research Unit #282/301
Reporting Period 7/1 - 9/30/76
Number of Pages 2

SUMMARIZATION OF EXISTING LITERATURE AND UNPUBLISHED DATA ON THE DISTRIBUTION, ABUNDANCE AND PRODUCTIVITY OF BENTHIC ORGANISMS OF THE GULF OF ALASKA AND BERING SEA

Dr. Howard M. Feder
Professor of Marine Science
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

October 1, 1976

Quarterly Report

I. Task Objectives

A. A summary of existing data, published and unpublished, for the Gulf of Alaska and the Bering Sea.

B. Access to and loan of archived material from both of the above areas.

C. Workup of archived data and material.

II. Field and Laboratory Activities

Methods

1. Literature survey using standard library search techniques has been undertaken. Plans are underway to utilize literature searching organizations: some correspondence will be initiated.

2. Correspondence will be initiated to locate archived data and material.

III. Results

The literature survey has been completed, including the Chukchi Sea literature. The majority of citations have been keypunched. One half of the key words have been keypunched. A test run to check the key word indexing program was successful.

IV. Preliminary Interpretations

Not applicable.

V. Problems Encountered

Not applicable.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: September 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 10 R.U. NUMBER: 282/301

PRINCIPAL INVESTIGATOR: Dr. H. M. Feder

Progress on this study has indicated that there is little data in a form suitable for submission using available EDS Format (Benthic Organisms). It is suggested that the following information products be accepted; (1) key word bibliography (2) distribution maps, which would be available as they are produced; however, the total applicable information available could not be converted into this media prior to December 1976.

The bibliography will be ready for submission on or about October 31, 1976. The distribution maps will be started as soon as the proper base maps are received from OCSEAP.

The delay on the bibliography is due to the addition of information for the Chukchi Sea, and a backlog in keypunching information due to the loss of one operator. We await approval of a funding request for this additional work.

Quarterly Report

Contract #03-5-022-56
Research Unit #284
Reporting Period 7/1 - 9/30/76
Number of Pages 6

FOOD AND FEEDING RELATIONSHIPS IN THE BENTHIC AND DEMERSAL FISHES OF THE GULF OF ALASKA AND BERING SEA

Dr. Ronald L. Smith
Associate Professor of Zoology
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

October 1, 1976

Quarterly Report

I. Task Objectives

Objectives for this quarter included a continuation of very limited archival procedures on recently acquired Bering Sea samples, completion of preliminary sorts on our five target species for the year and devising a computer program for analysis of data to be submitted in the immediate future.

II. Field and Laboratory Activities

No field activities were performed this quarter. Laboratory activities were centered around completing our gut analyses for the three Gulf of Alaska species (*Theragra chalcogrammus, Atheresthes stomias* and *Glyptocephalus zachirus*) and the two Bering Sea species (*Theragra chalcogrammus* and *Reinhardtius hippoglossoides*). The Gulf species have been completed with examinations of 290, 590, and 375 stomachs respectively. Bering sea material is virtually complete with examination of 140 and 120 individuals, respectively, of these species.

III. Results

The computer program for data analysis is almost complete. We have submitted data for the Gulf species and it should be keypunched in the appropriate format now. Data submission to NOAA will occur within two weeks of the date of this quarterly report. I hope to forward a copy of the data analysis with the data submission for each species. This data analysis will include the information indicated in the attached memorandum on documentation procedures. Data for the remaining two species will be forwarded to the OCS office in Fairbanks for keypunch within the next two weeks. Data submission and analysis will be forwarded to NOAA within the month, barring any unforeseen difficulties with our analyses.

IV. Problems Encountered

The lack of any firm committment from NOAA for the continuation of this project through the next fiscal year is generating problems with respect to continuity of personnel. It is difficult to retain trained and knowledgeable assistants when they have no real guarantee that they will be paid next month.

PROCEDURES AND QUALITY CONTROL

as used for

Contract 03-5-022-56
Task Order Number 21
30 June 1976

FOOD AND FEEDING RELATIONSHIPS IN THE BENTHIC AND DEMERSAL FISHES OF THE GULF OF ALASKA AND BERING SEA

Dr. Ronald L. Smith
Associate Professor of Zoology
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

OPERATING PROCEDURES

1. Collection
2. Curation
3. Sorting
4. Analysis
5. Data Submission

1. <u>Collection</u>

A. Methods (directly taken from information packet given to our collectors).

Fishes will be preserved whole rather than having stomachs removed on board. A sample of the catch for each trawl will (after slitting abdomens) be placed in a cloth bag with a waterproof label identifying the station number and haul number. No attempt to sort species into separate bags will be required. However, if the established routine includes sorting of fish species our work would be facilitated if some separation were possible. We will supply small cloth bags with drawstrings and also large burlap bags.

For each 55 gal drum add 5 gal formaldehyde and 15 gal seawater. Then add bags of fish but do not pack too tightly. Hopefully, that will provide enough liquid to surround the fish yet leave sufficient volume for fish. If this is insufficient fluid to cover the bags as the drum fills up, add some seawater but try to mix well.

A word about what fish we would like and how many: a maximum of 30 individuals per species per station (minimum of 10, if possible) unless a large number of fishes from a great range of sizes comes in a single trawl. In that case, we need a maximum of 30 of the largest, 30 of the smallest, and 30 from an in-between size class. Attached is a list of species we would like. They are listed in rank priority with a minimum number of individuals we need listed.

B. Sources of Specimens

<u>North Pacific</u> charter, Summer 1975, Gulf of Alaska

<u>Miller Freeman</u> Fall 1975, spring 1976, Bering Sea

<u>Surveyor</u> Spring 1976, Bering Sea

<u>Alpha Helix</u> 1970, 1971, 1972, Bering Sea

<u>Tordenskjold</u> 1976, Gulf of Alaska

C. Rationale for Collections

The original concept was to obtain a representative sampling of fish guts from a variety of bottom types, locations and times of the year. These collections were to be made simultaneously with benthic invert collections (trawls and grabs) so that the effects of invert abundance and fish selectivity could also be studied. Collections for this project have always been of the lowest priority on those cruises from which we have obtained specimens and often collections had to be made by personnel whose primary interests have been elsewhere. This has to some extent affected the quality and quantity of samples obtained. We had planned to continue the accumulation of fish samples in approximately the same way with a higher priority than previously. However, budgeting restrictions prohibit additional collection of curation activities. We have suitable collections, however, of about 12 species from the Bering Sea and about 8 species from the Gulf of Alaska.

2. Curation

Upon receipt of collections in Fairbanks, specimens were separated by species and station and repacked in 10% formalin (per total volume of water and fish) buffered with 20 grams of hexamethylenetetramine per liter of 10% solution. As a species is to be examined, specimens are measured for standard length to the nearest millimeter, sex and maturity are determined, and the alimentary system is placed in labeled vials of buffered formalin for subsequent analysis.

Fish species were identified to species by use of Wilimovsky's provisional keys to the fishes of Alaska, Hart's (1973) Pacific Fishes of Canada, Evermann and Goldsborough (1907) Fishes of Alaska, Jorden and Evermann's (1896) The Fishes of North and Middle America. In every case, fish identifications were verified by all three investigators in this project.

3. Sorting

Guts are opened with scissors and examined by eye under a dissecting scope. Counts and volumes (measured by water displacement to the nearest 0.1 ml) are made for each taxon. Food items are identified to the lowest level possible, consistent with the state of preservation (digestion). Stomach fullness is also recorded. Taxonomic assistance is provided on a courtesy basis for identifications beyond our expertise by the Marine Sorting Center, Fairbanks. Our low level of funding precludes an intensive interfacing with the Sorting Center.

Invertebrate identifications were made using keys either recommended by or provided by Marine Sorting Center, University of Alaska. In some cases, use of a compound microscope was required for these identifications.

4. Analysis

If time and budgetary constraints will allow us to examine significant numbers of specimens from each fish species, we hope to provide analyses over and above those for which we are contractually obligated. If possible we would like to provide a computer analysis yielding the following information by taxon:

- F. frequency of occurrance (excludes empty stomachs)
- V. percentage of total volume of prey
- N. percentage of total number of prey
- IRI. index of relative importance

$$IRI = (N + V) F$$

mean count per predator
mean volume per predator
mean length of predator
mean fullness of predator
number of predators

Five size categories, each comprising 20% of the range of standard lengths for predator species will be generated. For each of these size categories, N, F. V, and IRI will be recalculated.

Data for a predator species initially will be examined by station and by geographic area. Selected comparisons will be tested for significance of difference. We hope to examine all individuals of each predator species since few were received in numbers exceeding 250 for a particular geographic area (e.g., Gulf of Alaska or Bering Sea). A detailed explanation of codes employed in our computer analysis will accompany our first data submission.

These analyses will allow us to develop a more complete picture of a few of the salient features regulating fish feeding habits in the Gulf of Alaska and Bering Sea.

5. Data Submission

Data in the form of coding sheets are presented to the O.C.S. Coordination Office. These data are reformated into E.D.S. format, keypunched and transferred to magnetic tape for submission. A full review of the procedures followed appear in the FY '77 proposal for R.U.# 350

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: September 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 21 R.U. NUMBER: 284

PRINCIPAL INVESTIGATOR: Dr. R. L. Smith

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]			
	From	To	Batch 1			
North Pacific	4/25/75	8/7/75	(a)			
Miller Freeman	8/16/75	10/20/75	(a)			
Miller Freeman	3/76	6/76	(a)			

Note: [1] Data Management Plan has been approved and made contractual.

(a) Selected species will be examined, it is unlikely that any data will be submitted prior to FY '77, data will the be submitted pending continuation and funding of this project in FY '77.

Quarterly Report

Contract #03-5-022-56
Research Unit # 285
Reporting Period 7/1 - 9/30/76
Number of Pages 2

PREPARATION OF ILLUSTRATED KEYS TO OTOLITHS OF FORAGE FISHES

Dr. James E. Morrow
Professor of Zoology
Division of Life Science
University of Alaska
Fairbanks, Alaska 99701

October 1, 1976

Quarterly Report

I. Task Objectives

To develop illustrated keys to otoliths of forage fishes of the Gulf of Alaska and Bering Sea.

II. Field and Laboratory Activities

The principal investigator travelled to Long Beach, California, and Seattle, Washington, in the latter part of June. In Long Beach, four days were spent with Dr. John E. Fitch, discussing the keys, learning new details about otolith structure, studying specimens in Dr. Fitch's collection, and generally taking advantage of his tremendous knowledge of the subject. Dr. Fitch kindly lent us specimens of 65 species. One day was spent in Seattle with National Marine Fisheries Service personnel. Specimens of 21 species were borrowed from Jack Lalanne and Hiro Kajimura.

III. Results

The keys, covering 141 species in 86 genera and 20 families, have been completed and have been sent to Dr. Fitch for final check. 76 illustrations have been completed.

IV. Problems Encountered

None.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: September 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 22 R.U. NUMBER: 285

PRINCIPAL INVESTIGATOR: Dr. J. E. Morrow

No environmental data are to be taken by this task order as indicated in the Data Management Plan. A schedule of submission is therefore not applicable[1].

NOTE: [1] Data Management Plan has been approved and made contractual.

Quarterly Report

Contract #03-5-022-56
Research Unit #318
Reporting Period 7/1 - 9/30/76
Number of Pages 2

PREPARATION OF ILLUSTRATED KEYS TO OTOLITHS OF FORAGE FISHES

Dr. James E. Morrow
Professor of Zoology
Division of Life Science
University of Alaska
Fairbanks, Alaska 99701

October 1, 1976

Quarterly Report

I. Task Objectives

To develop illustrated keys to otoliths of forage fishes of the Beaufort Sea.

II. Field and Laboratory Activities

The principal investigator travelled to Long Beach, California, and Seattle, Washington, in the latter part of June. In Long Beach, four days were spent with Dr. John E. Fitch, discussing the keys, learning new details about otolith structure, studying specimens in Dr. Fitch's collection, and generally taking advantage of his tremendous knowledge of the subject. Dr. Fitch kindly lent us specimens of 65 species. One day was spent in Seattle with National Marine Fisheries Service personnel. Specimens of 21 species were borrowed from Jack Lalanne and Hiro Kajimura.

III. Results

The keys, covering 141 species in 86 genera and 20 families, have been completed and sent to Dr. Fitch for final check. 76 illustrations have been completed.

IV. Problems Encountered

None.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: September 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 9 R.U. NUMBER: 318

PRINCIPAL INVESTIGATOR: Dr. J. E. Morrow

No environmental data are to be taken by this task order as indicated in the Data Management Plan. A schedule of submission is therefore not applicable[1].

NOTE: [1] Data Management Plan has been approved and made contractual.

Quarterly Report

Contract #03-5-022-56
Research Unit #348
Reporting Period 7/1 - 9/30/76
Number of Pages 2

LITERATURE SEARCH ON DENSITY DISTRIBUTION OF FISHES OF THE BEAUFORT SEA

Dr. James E. Morrow
Professor of Zoology
Division of Life Science
University of Alaska
Fairbanks, Alaska 99701

October 1, 1976

Quarterly Report

I. Task Objectives

To complete a literature search on the density and distribution of fishes of the Beaufort Sea.

II. Field and Laboratory Activities

Ms. Pfeiffer spent about a month searching the libraries of the National Marine Fisheries Service, Auke Bay, Alaska and the University of Washington, Seattle, Washington.

III. Results

More than 600 references have been located and annotated. Final check of the annotations is under way. As soon as this has been completed, the annotated list will be typed and submitted.

IV. Problems Encountered

None.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: September 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 16 R.U. NUMBER: 348

PRINCIPAL INVESTIGATOR: Dr. J. E. Morrow

No environmental data are to be taken by this task order as indicated in the Data Management Plan. A schedule of submission is therefore not applicable[1].

NOTE: [1] Data Management Plan has been approved and made contractual.

RU# 349

NO REPORT WAS RECEIVED

A final report is expected next quarter

Contract 03-5-022-81

Research Unit 356

July 1, to September 30, 1976

18 pages

QUARTERLY REPORT

Reconnaissance Characterization of Littoral Biota,

Beaufort and Chukchi Seas

September 30, 1976

I. Task Objectives

During the quarter, our task statements 1 (Planning), 2 (Aerial surveys of the Beaufort and Chukchi coasts), and 3 (Field sampling of littoral biota of the Beaufort and Chukchi seas), as proposed in our revised work statement of January 15, 1976, were virtually completed. We were unable to make a few planned samples in both the Beaufort and Chukchi seas due to equipment failure (R. V. Alumiac), ice (Beaufort Lagoon and Barter Island) and adverse weather (Cape Prince of Wales area), but these omissions in our data are relatively few. Task 4 (literature research), although a continuing concern, was completed earlier. Task 5 (analysis of samples; data processing) has not been completed. Our 1975 Beaufort Sea samples have been sorted, analyzed, identified and weighed. Laboratory work on the 1976 samples began in August when the first samples of the current field season were received in Bellingham. The last samples of the 1976 season, however, were collected on August 31. These were shipped to Bellingham on September 11 and received on September 24. They and most of the rest of the 1976 samples have not yet been sorted. We have encountered delays in data processing at least partially beyond our control and the data processing of those samples completely analyzed has not been completed. In April (see report dated June 30) we met with data management people from O.C.S.E.A.P. and N.O.D.C. to work out a data reporting format that we, R. U. 79, and others could use in common. Details of this format have occupied some time since but are substantially completed. We still lack a few species code numbers necessary to reporting our biological results. Task 6 (preparation of a final report), for reasons given above, has not been completed.

II. Field or Laboratory Activities:

A. Ship and field trip schedule:

1. July 6-12: Aerial reconnaissance of the Chukchi Sea Coast from Cape Prince of Wales to Barrow by private charter (Baker Aviation, Kotzebue) and NARL flights. Investigators: Broad, Mason.
2. July 16-August 30: Sampling littoral biota of Beaufort Sea Coast for verification of 1973 data: Nuvagapak Point (Beaufort Lagoon) to Barrow. Travel by private charter (Walt Audi, Kaktovik; ERA helicopters, Deadhorse) and NARL. Investigators: Winkler, Clayton, Serrano.
3. July 16-August 17: Sampling biota of lagoons of Beaufort Sea Coast: Beaufort Lagoon, Barter Island area, Prudhoe Bay, Simpson Lagoon, Elson Lagoon and Dease Inlet). Sampling from small boats or from R/V Natchik (August 16, 17). Travel by private charter (Walt Audi, Kaktovik; ERA helicopters, Deadhorse) and NARL. Investigators: Schneider, Stiefel, Broad.
4. July 15-August 29: Sampling littoral biota of Chukchi Sea Coast between Barrow and Cape Thompson. Travel by NARL flights. Investigators: Webber, Spawn, Maier.

5. July 15-August 20: Sampling littoral biota of the Chukchi Coast and Kotzebue Sound between Kivalina and Cape Espenberg. Travel by private charter (Baker Aviation, Kotzebue) or by small boat. Investigators: Duke, McMillan, Walters.
6. July 17-August 28: Sampling littoral biota of the Chukchi Coast between Cape Espenberg and Cape Prince of Wales. Travel by private charter (Baker Aviation, Kotzebue) or by small boat. Investigators: Schweitzer, Kiera, Lauren, Mason.
7. August 19-September 8: Sampling the Beaufort Sea near shore benthos at depths of less than 5 meters between Barrow and Barter Island. Cruise on R/V Alumiac. Investigators: Cordell, Canfield.
8. Supervision of activities in Arctic: Broad (July 5-August 19), Mason (July 5-August 31).

B. Scientific Party

1. Principal Investigator

   A. C. Broad, on salary, July 1 - September 15

2. Associate Investigators and Team Leaders

   Jeffrey R. Cordell, July 15 - September 15

   Maurice A. Dube, July 1 - August 31

   David T. Mason, July 1 - August 31

   David E. Schneider, July 1 - August 15

   Martin Schweitzer, July 1 - August 31

   Herbert H. Webber, July 1 - August 31

   Paul Winkler, July 1 - August 31

3. Marine technicians and field assistants

   Mark Canfield, July 15 - August 31

   Cheryl Clayton, July 15 - August 31

   Eileen Kiera, July 15 - August 31

   Darrel Lauren, July 15 - August 31

   Bob Maier, July 15 - August 31

   Russel McMillan, July 15 - August 31

   Louis M. Serrano, July 15 - August 31

   Mary Spawn, July 15 - August 31

   Raymond A. Stiefel, July 15 - August 31

   Garrett P. Walters, July 15 - August 31

4. Computer programmer

   Gregg Miles Petrie, hourly wages

5. Laboratory supervisor

   Helmut Koch, July 1 - September 30

6. Laboratory assistants

   Susan Broad, hourly wages

   Mark Childers, hourly wages

   David Cormany, hourly wages

   Patricia R. Jackson, hourly wages

C. Methods

1. Aerial reconnaissance of the coast of the Chukchi Sea was by low-level (under 500 ft.) overflight in fixed-wing aircraft with frequent landing to verify observations. Two observers recorded observations on voice tape and by

making notations on charts or topographic maps. These observations are integrated in the laboratory by the principal investigator.

2. Field sampling of littoral biota by teams of on-site investigators is based largely on beach transects which run from the point at which beach vegetation gives way to terrestrial vegetation to the maximum depth of water that can be reached by the investigators (usually wading depth). Each station visited is identified by a three-digit, alphanumeric designator. Sampling sites along the transect are identified by the distance from and elevation above or below mean lower low water. Landward of the reference level (MLLW = 0) plant communities are sampled for frequency, cover and, ideally, biomass, all samples being based on counts within a $0.25M^2$ quadrat. Seaward of the reference level and in the intertidal zone where such exists, infauna is sampled by Ekman grab screened to 0.5 mm. The larger stones are rejected in the field and the rest of the sample is preserved for laboratory analysis. Where the nature of the sediment makes use of the Ekman impractical, either the Myren Corer (which takes 1 liter of soft sediment) or a shovel (non-quantitative) is used instead. Epifauna is sampled by means of a sled net towed a measured distance at a depth of 0.5 m. A shallow water, non-quantitative plankton sample is taken at each station.

Other samples include substrate and general collections. Meteorological hydrographic (salinity, water temperature, turbidity, dissolved oxygen) and general ecological observations (wind, weather, sea state) are made and recorded.

3. Shallow water benthos in lagoons and the open sea is sampled by bottom grab (Ekram in lagoons, Smith-McIntrye in open sea). The samples are screened to 0.5 mm and preserved. In addition, sea-sled net and plankton net samples are taken as are hydrographic and meteorological observations. Each sampling site is identified by a 3 digit designator.

4. Laboratory analysis of benthos, plankton and sled net samples begins with sorting to separate organisms for substrate material. The entire samples are lightly dyed with rose bengal. Organisms in each sample are identified and sorted by species. Biomass data are based on net weight and the entire sample is preserved and retained. Plant biomass samples are dried and weighed. Sediment samples are dried and sieved through U.S. standard screens.

D and E.

Sample localities and number of samples collected are presented in Table 1.

E. Other samples analyzed. The 1975 sample analysis was completed and about 10 per cent of the 1976 samples were analyzed during the quarter.

Table 1. Summary of sampling of beaches in the Beaufort and Chukchi Seas during the 1976 field season by R. U. 356.

Station No.	North Latitude 0	North Latitude 1	West Longitude 0	West Longitude 1	Habitat Type	Samples: Biological	Samples: Sediment	Vegetation Transect data
B17	69	53	142	18	Mainland, lagoon beach	11	2	X
B18	69	53	142	19	Mainland, lagoon beach	14	2	
B1A	69	53	142	19	Lagoon, no beach	4	0	
B1B	69	53	142	19	Lagoon, no beach	4	0	
B1C	69	53	142	19	Lagoon, no beach	4	1	
B1D	69	53	142	18	Lagoon, no beach	3	1	
B1E	69	53	142	18	Lagoon, no beach	2	1	
B2A	69	53	142	19	Lagoon, no beach	3	0	
B2B	69	53	142	19	Lagoon, no beach	1	0	
C3G	70	07	143	32	Lagoon, no beach	3	1	
C3H	70	07	143	32	Lagoon, no beach	4	1	
C3A	70	07	143	34	Lagoon, no beach	2	0	
C3B	70	08	143	34	Lagoon, no beach	3	1	
C3C	70	08	143	34	Lagoon, no beach	4	1	
C3D	70	07	143	34	Lagoon, no beach	4	1	
C3E	70	07	143	35	Lagoon, no beach	3	1	
C3F	70	07	143	36	Lagoon, no beach	5	0	
C35	70	08	143	36	Marsh, lagoon beach	7	2	X
C36	70	06	143	37	River mouth, lagoon beach	9	2	

Table 1 (continued)

Station No.	North Latitude 0	North Latitude 1	West Longitude 0	West Longitude 1	Habitat Type	Samples Biological	Samples Sediment	Vegetation Transect data
C37	70	08	143	37	Marsh, lagoon beach	14	2	X
C38	70	06	143	38	Salt pond	12	2	X
C39	70	08	143	39	Mainland, sea beach	11	2	X
C4A	70	06	143	38	Lagoon, no beach	3	1	
C4B	70	06	143	38	Lagoon, no beach	6	1	
C4C	70	05	143	37	Lagoon, no beach	4	1	
C4D	70	04	143	37	Lagoon, no beach	3	1	
C4E	70	08	143	40	Ocean, no beach	2	1	
C4F	70	05	143	40	Ocean, no beach	4	1	
F59	70	12	145	59	Barrier island, lagoon beach	14	2	X
G3A	70	23	147	30	Ocean, no beach	4	1	
HO8	70	20	148	08	Delta, sea beach	11	2	X
HOA	70	22	148	07	Ocean, no beach	4	1	
HOB	70	43	148	06	Ocean, no beach	4	1	
H1A	70	20	148	15	Bay, no beach	3	1	
H1B	70	19	148	19	Bay, no beach	3	1	
H2E	70	21	148	20	Bay, no beach	5	1	
H2A	70	19	148	20	Bay, no beach	4	1	
H2B	70	21	148	21	Bay, no beach	3	1	
H2C	70	19	148	23	Bay, no beach	4	1	

Table 1 (continued)

Station No.	North Latitude 0	North Latitude 1	West Longitude 0	West Longitude 1	Habitat Type	Samples Biological	Samples Sediment	Vegetation Transect data
H2D	70	20	148	23	Bay, no beach	3	1	
H2F	70	19	148	25	Bay, no beach	5	1	
H28	70	18	148	28	Delta, river shore	12	2	X
H3A	70	23	148	32	Bay, no beach	4	1	
H3B	70	24	148	32	Bay, no beach	3	1	
H3C	70	24	148	32	Bay, no beach	5	1	
H3D	70	24	148	31	Bay, no beach	3	1	
H32	70	22	148	32	Mainland, sea beach	13	2	X
H3E	70	25	148	34	Ocean, no beach	4	1	
H3F	70	24	148	34	Ocean, no beach	4	1	
H40	70	24	148	40	Marsh, lagoon beach	12	2	X
I3A	70	33	149	30	Lagoon, no beach	3	0	
I3B	70	32	149	30	Lagoon, no beach	4	1	
I3C	70	32	149	30	Lagoon, no beach	4	1	
I3D	70	31	149	31	Lagoon, no beach	4	1	
I3E	70	33	149	32	Ocean, no beach	3	1	
I3F	70	33	149	32	Ocean, no beach	4	1	
I50	70	30	149	50	Mainland, lagoon beach	12	2	X
I5C	70	30	149	50	Bay, no beach	3	1	
I5A	70	30	149	50	Bay, no beach	4	1	
I5B	70	32	149	51	Bay, no beach	4	1	

Table 1 (continued)

Station No.	North Latitude 0	North Latitude 1	West Longitude 0	West Longitude 1	Habitat Type	Samples: Biological	Samples: Sediment	Vegetation Transect data
I5E	70	33	149	53	Bay, no beach	4	1	
I5F	70	33	149	52	Bay, no beach	3	1	
I5G	70	29	149	56	Bay, no beach	3	1	
I5H	70	29	149	56	Bay, no beach	4	1	
J0A	70	30	150	00	Bay, no beach	3	1	
J0B	70	30	150	01	Bay, no beach	3	1	
J06	70	26	150	06	River shore	14	2	X
J0C	70	30	150	09	Ocean, no beach	2	1	
J1A	70	33	150	14	Ocean, no beach	5	1	
J22	70	26	150	22	Delta, sea beach	12	2	
J24	70	29	150	24	Bay, open water			
M07	70	55	153	07	River shore	13	2	X
M1A	70	55	153	12	Ocean, no beach	4	1	
M1B	70	55	153	14	Ocean, no beach	4	1	
N1A	70	55	154	13	Ocean, no beach	4	1	
N1B	70	53	154	11	Ocean, no beach	4	1	
Ø1A	71	09	155	10	Lagoon, no beach	5	1	
Ø1B	71	08	155	16	Lagoon, no beach	5	1	
Ø2A	71	08	155	22	Lagoon, no beach	5	1	
Ø3A	71	07	155	30	Lagoon, no beach	5	1	
Ø39	71	14	155	39	Barrier island, sea beach	6	1	

Table 1 (continued)

Station No.	North Latitude 0	1	West Longitude 0	1	Habitat Type	Samples Biological	Sediment	Vegetation Transect data
Ø40	71	14	155	40	Barrier island, lagoon beach	12	2	X
Ø4A	71	15	155	47	Lagoon, no beach	5	1	
Ø4B	71	14	155	46	Lagoon, no beach	5	1	
Ø5A	71	13	155	51	Lagoon, no beach	5	1	
Ø5B	71	12	155	53	Lagoon, no beach	5	1	
P0A	71	15	156	04	Lagoon, no beach	5	1	
P0B	71	17	156	08	Lagoon, no beach	5	1	
P1A	71	21	156	13	Lagoon, no beach	5	1	
P1B	71	20	156	15	Lagoon, no beach	5	1	
P2A	71	21	156	21	Lagoon, no beach	6	1	
P2B	71	20	156	25	Lagoon, no beach	3	1	
P2C	71	20	156	27	Lagoon, no beach	4	1	
P2D	71	23	156	27	Ocean, no beach	3	1	
P2E	71	23	156	27	Ocean, no beach	4	1	
P28	71	23	156	27	Mainland, sea beach	9	2	
P30	71	22	156	30	Mainland, lagoon beach	9	2	X
P31	71	22	156	31	Mainland, sea beach	9	2	
P33	71	18	156	33	River mouth, lagoon beach	12	2	
P34	71	19	156	34	Mainland, lagoon beach	9	2	
P4A	71	19	156	40	Lagoon, no beach	5	1	
P52	71	45	156	52	Marsh	9	2	X

Table 1 (continued)

Station No.	North Latitude 0	North Latitude 1	West Longitude 0	West Longitude 1	Habitat Type	Samples: Biological	Samples: Sediment	Vegetation Transect data
R19	70	49	158	19	Mainland, sea beach	7	2	
R20	70	49	158	19	Máinland, Lagoon beach	9	2	
R28	70	48	158	28	Mainland, lagoon beach	11	2	X
R40	70	47	158	40	Mainland, lagoon beach	11	2	
S51	70	42	159	51	Mainland, sea beach	14	1	X
S56	70	41	159	56	Mainland, sea beach	13	2	
T11	70	54	160	11	Mainland, lagoon beach	11	2	X
T12	70	17	160	11	Mainland, sea beach	10	2	
U51	70	17	161	51	Salt pond	11	3	X
U55	70	17	161	55	Mainland, lagoon beach	14	3	X
U57	70	16	161	57	Mainland, lagoon beach	11	2	
Z09	68	52	166	09	Mainland, sea beach	10	2	
Z44	68	21	166	45	Barrier Island, lagoon beach	8	1	
Z45	68	21	166	45	Mainland, sea beach	8	2	
Z46	68	21	166	45	Mainland, lagoon beach	8	2	X
45Y	68	06	165	45	River shore			X
46Y	68	06	165	46	Mainland, sea beach	8	2	X
48Y	68	06	165	48	Mainland, sea beach	3	0	
33X	67	44	164	33	River mouth, lagoon beach	40	2	X
44W	67	09	163	44	Mainland, sea beach	4	1	X

Table 1 (continued)

Section No.	North Latitude 0	North Latitude 1	West Longitude 0	West Longitude 1	Habitat Type	Samples: Biological	Samples: Sediment	Vegetation Transect data
27V	66	56	162	27	Mainland, lagoon beach	18	2	
28V	66	57	162	28	Bay, no beach	3	0	
31T	66	34	160	31	Marsh, lagoon beach	9	2	
OU3	66	09	161	03	River mouth, river shore	10	2	X
2U1	66	15	161	21	Mainland, sea beach	11	2	X
5U1	66	13	161	51	Island, sea beach	8	0	
5U2	66	26	161	52	Mainland, sea beach	22	1	X
5U4	66	15	161	54	Bay, no beach	2	0	
2V5	66	44	162	25	Mainland, sea beach	5	0	X
2V6	66	44	162	26	Mainland, sea beach	10	1	
3V2	66	48	162	32	Mainland, sea beach	6	1	X
4V4	66	06	162	44	Mainland, sea beach	6	0	
4V5	66	05	162	45	Mainland, sea beach	10	0	X
IWO	66	03	163	10	Mainland, sea beach	10	2	X
IW2	66	03	163	12	Mainland, sea beach	9	1	
2WO	66	05	163	20	Mainland, sea beach	23	2	X
4W5	66	35	163	45	Mainland, sea beach	25	3	X
5W3	66	35	163	53	Marsh	8	1	X
4YO	66	02	165	40	River mouth, river shore	16	2	X
4Y1	66	06	165	41	River shore	23	3	X

Table 1 (continued)

Section No.	North Latitude		West Longitude		Habitat Type	Samples		Vegetation Transect data
	0	1	0	1		Biological	Sediment	
5Y2	66	07	165	52	Mainland, lagoon beach	22	2	
0Z4	66	15	166	04	Marsh	5	0	X
0Z7	66	14	166	07	Barrier island, lagoon beach	30	2	X
0Z8	66	14	166	07	Barrier island, sea beach	20	3	
750	65	45	167	50	Barrier island, sea beach	18	6	X
751	65	45	167	51	Barrier island, lagoon beach	24	3	X
801	65	37	168	01	Mainland, lagoon beach	18	6	X
802	65	37	168	02	Mainland, lagoon beach	12	0	
Other, miscellaneous						15		
					Totals	1,172	199	43

III. Results.

Reporting of definitive results, other than preliminary interpretations given below, is not possible at this time. See item 5, Problems encountered.

IV. Preliminary interpretation of results--and some speculations.

The shoreline of the Beaufort Sea is unconsolidated and is comprised largely of pebble or sand and pebble beaches. The sediments are finer in the river deltas. There are occasional concentrations of boulders (at Heald Point, Flaxman Island, Brownlow Point, Kangigivik Point, and Demarcation Bay), presumably not of local origin. These boulders, however, are bare of attached organisms. There is virtually no shoal water or intertidal attached macrobenthos, but there sometimes are large numbers of smaller, invertebrates (mainly annelid worms) in the bottom sediments, and there are nearly always very large numbers of amphipods present everywhere. At depths in excess of about 2 meters in the lagoons as well as in the sea bivalve molluscs are common (occur in half of our samples) and polychaete worms are virtually ubiquitous. Large isopods (Saduria sp.) are abundant anad priapulids are common. Our benthos samples, however, indicate that other organisms, including gastropod molluscs, are not abundant in the Beaufort Sea littoral. In addition to the amphipods and isopods, there are sometimes enormous numbers of mysiid shrimp. Our samples show uneven distribution of these. Euphausiids have been less abundant in our material. Plankton sampling shows sometimes great concentrations of copepods, barnacle larvae, and chaetognaths in 1975 that were not encountered in 1976.

We currently believe that the shallow-water benthos of the Beaufort Sea is poor in variety (especially if compared to Southeast Alaska or the Pacific Northwest) but rich in certain limited faunal elements. Amphipods are almost certainly central to energy flow in the Beaufort Sea ecosystem, and their function as grazers, scavengers and primary carnivores and as the principal food of Arctic fishes will be the subject of future investigation.

We also believe that the Arctic littoral ecosystem receives significant contributions from the essentially terrestrial vegetation of beaches and tundra banks and, hence, is inseparable from it. Periodic, wind-induced fluctuations in local sea level result in innundation of much of the low-lying land. The plant communities in these marshy areas, thus, are affected by the sea, and are also important in the feeding of geese. Erosion of shorelines occurs mainly at the time of wind-induced high water and contributes significant amounts of terrestrial vegetation (in the form of peat) which is at least a potential source of energy perhaps as significant as sunlight. The degree to which the Arctic littoral is a detritus-based ecosystem bears further study.

The Chukchi shore north of 69°N is generally similar (unconsolidated, lacks attached macrobenthos) to the Beaufort. South of 69°N, however, rock outcroppings are common and, at least in the region south of 67°N, attached organisms occur. Our Chukchi biological samples have not yet been analyzed, but our field experience is that a greater variety of organisms occurs here.

V. Problems encountered

1. Data reporting: Our use with other units concerned with littoral or intertidal areas of a common intertidal data format (030) has not been without local problems. One code (habitat) was changed after our teams were in the field; one (breaker height) is lacking. We have found species not covered by the species code, and there have been some delays in obtaining numbers for these. None of these problems is major but delays have resulted from all of them.

2. The R/V Alumiac was a major problem. The vessel was made available slightly later than promised and hardly in full operating condition. It experienced failure of almost all equipment other than the main propulsion machinery and the stern anchor winch. In spite of this, some of the work planned was actually completed. We feel that credit for the partial success of the cruise goes to the skipper, John Kelly, and his crew.

3. We encountered a problem of communication with the native people of the village of Point Lay as did others during the summer. Our planned sampling in that area was denied by the village corporation largely because we had not written the right letters beforehand. Better advance information on the territories and prerogatives of the village and regional corporations would have helped and should be sought in the future.

4. Other, minor problems were: ice in the Beaufort Sea, winds in the vicinity of Cape Lisburne and Cape Prince of Wales, and the unexpected delays in receiving specimens shipped by air and closing accounts.

VI. Funds Expended.

Contract 03-5-022-81 originally was to have expired on September 30. The funds covered by that contract have been completely committed, but some bills are yet to be received (for example, from Baker Aviation in Kotzebue for the last flights made in August). A complete accounting will be made in October.

The new contract (or renewal of 03-5-022-81) indicated in Dr. Weller's letter to me of August 2 and accepted in my letter of August 7 to Dr. Wolfe has not been received. Pending receipt of that contract, I do not know whether to render a final accounting of 03-5-022-81 or an interim report on an extended contract.

QUARTERLY REPORT

Contract #: 03-5-022-67-TA2 #4
Research Unit #: 359
Report Period: 1 Jul - 30 Sep 1976
Number of Pages: 25

BEAUFORT SEA PLANKTON STUDIES

T. Saunders English
Rita A. Horner
Department of Oceanography
University of Washington
Seattle, Washington 98195

1 October 1976

Departmental Concurrence

Francis A. Richards
Associate Chairman for Research

REF: A76-63

I. Task Objectives - *Glacier* cruise

The primary objectives of this project are to determine the seasonal density distribution and environmental requirements of principal species of phytoplankton, zooplankton and ichthyoplankton, and to determine seasonal indices of phytoplankton production. The secondary objective is to summarize existing literature, unpublished data, and archived samples.

II. Field and Laboratory Activities

A. Ship schedule

Icy Cape to Narwhal Island; 07 Aug - 04 Sep 1976
USCGC *Glacier* WAGB 4

B. Scientific party

Rita A. Horner, Associate Investigator, 07 Aug - 04 Sep
Thomas Kaperak, Student Helper, 07 Aug - 04 Sep

Department of Oceanography
University of Washington
Seattle, Washington 98195

C. Methods - Field and Laboratory

This cruise was aboard USCGC *Glacier* (WAGB 4). This ship is 310 ft long, with a 74 ft beam and 28.5 ft draft. Displacement is 8449 tons. Top speed is 17 kt and the cruising range is 25,000 miles. *Glacier* has limitations as an oceanographic vessel because of her round bottom which causes her to roll in the slightest seas. In addition, the height and expanse of the superstructure make it difficult to maintain position in high winds.

Glacier has three oceanographic winches which are controlled from instrument consoles on the main deck. The STD and hydrographic winches are Northern Line Model 1210-A COHW oceanographic winches that operate in conjunction with a Northern Line Model 3102-LLC level luffing crane located on the port side. The crane, which rotates as well as luffs, accommodates a hoist line from each of the two winches by means of a double sheave arrangement. The lines lead from the winches, located below deck, through the crane king post. Effective luffing distance is about 110 cm and training range is 125°.

The oceanographic platform, 1.3 x 1.7 m, is located on the port side of the fantail, adjacent to the port crane and control console. The platform is approximately 5 m above the water.

Zooplankton and ichthyoplankton were sampled with a bongo net and 0.75-m ring net. The bongo net consists of a double-mouthed frame each mouth with an inside diameter of 60 cm and an area of 0.2827 m^2. Nets with a mesh size of 505 µm (8:1 OAR) and 333 µm (8:1 OAR) were attached to the frame. A TSK flow meter was mounted in the mouth of each net to determine the amount of water filtered, and a bathykymograph (BKG) was attached at the center of the frame to determine tow depth. Three 25-lb cannonball weights were also attached to the frame. Tows were double oblique with deployment at approximately 50 m/min, a 30 sec soaking time, and retrieval at 20 m/min. Sampling depth varied because of the shallow water, but the net was placed as close to the bottom as possible without endangering the net. Because of adverse ice conditions, only 10 bongo tows were made (Table 1).

The ring net consists of a net with a mesh size of 308 µm (2:1 OAR) mounted on a 0.75-m ring. This net was lowered to a predetermined depth, allowed to soak for 10 sec, and retrieved at 20 m/min. Depending on the water depth, usually 2 or more tows were made at a station, with 51 tows being done during the cruise (Table 2).

The zooplankton samples were concentrated by gently swirling the sample in a net collection bucket to remove excess water. The samples were then placed in 250 or 500 ml jars and preserved with 100% formalin and saturated sodium borate solution. The amount of formalin and buffer depended on the jar size. A label containing collection data was put in the jar, seawater was added, if necessary, to fill the jar, and the jar was tightly capped for storage.

Acoustic surveys were conducted using a Ross 200A Fine Line Echosounder system operating with a frequency of 105 kHz. A 10° transducer mounted in a 2 ft V-fin depressor was lowered to the water surface when the ship was stopped on station. The incoming signal was recorded on a paper chart marked with the station number, date, time (LDT), and other pertinent information. When ice and time allowed, the incoming signal was also recorded on magnetic tape for later analysis (Table 3). Most of the recording was done in the 0-50 fm range because of the shallowness of the water.

Phytoplankton samples were collected with 5-ℓ Niskin bottles. Subsamples were taken for salinity, standing stock, primary productivity, and chlorophyll *a* determinations. Salinity was measured on board using a Bisset Berman Hytech salinometer Model 6220 (USCG #4691M). Standing stock samples were preserved with approximately 10 ml of 4% formalin buffered with sodium acetate. These will be analyzed later using an inverted microscope.

Water for chlorophyll *a* determinations was filtered through 47 mm HA (0.45 µm) Millipore filters. A few drops of a saturated $MgCO_3$ solution were added and the filter tower was rinsed with filtered seawater. The filters were folded into quarters, placed in labelled coin envelopes, and frozen. These samples will be analyzed using either a fluorometer or spectrophotometer.

Table 1. UW Haul Summary Sheet, *Glacier* 1976

Bongo Tows

Date (1976) (GMT)	Time (GMT)	Station	Haul	Latitude (N)	Longitude (W)	Depth (m)	Volume Filtered (m^3)	Mesh Size (μm) 505	333
11 Aug	0024	4	1	70° 51'	162° 09'	32	72	1	1
11 Aug	1415	5	1	70° 47'	162° 14'	35	73	1	1
11 Aug	2212	6	1	70° 39'	162° 16'	34	85	1	1
12 Aug	1422	7	1	70° 28'	163° 26'	29	73	1	1
14 Aug	2341	9	1	71° 03'	159° 17'	50	139	1	1
15 Aug	2308	10	1	71° 16'	157° 43'	50	90	1	1
16 Aug	1637	11	1	71° 25.5'	156° 54.8'	100	216	1	1
17 Aug	1455	12	1	71° 31.5'	156° 09'	120	230	1	1
28 Aug	2254	20	1	71° 08'	151° 19'	20	45	1	1
1 Sep	1556	25	1	71° 08'	152° 57'	20	18	1	1

Table 2. UW Haul Summary Sheet, *Glacier* 1976

0.75-m Ring Net

Date (1976) (GMT)	Time (GMT)	Station	Haul	Latitude (N)	Longitude (W)	Depth (m)	Volume Filtered (m^3)	Mesh Size (μm)
10 Aug	1848	4	1	70° 54'	160° 04'	20-0	8.8	303
	1855		2			10-0	4.4	
11 Aug	1533	5	1	70° 47'	162° 14'	20-0	8.8	
	1542		2			10-0	4.4	
11 Aug	2337	6	1	70° 39'	162° 16'	20-0	8.8	
	2344		2			10-0	4.4	
12 Aug	1948	7	1	70° 28'	163° 26'	20-0	8.8	
	1955		2			10-0	4.4	
14 Aug	1905	9	1	71° 03'	159° 17'	50-0	22.1	
	1915		2			20-0	8.8	
	1920		3			10-0	4.4	
15 Aug	1911	10	1	71° 16'	157° 43'	50-0	22.1	
	1919		2			20-0	8.8	
	1925		3			10-0	4.4	
16 Aug	1602	11	1	71° 25.5'	156° 54.8'	100-0	44.2	
	1612		2			50-0	22.1	
	1617		3			20-0	8.8	
	1622		4			10-0	4.4	

Table 2. (continued)

Date (1976) (GMT)	Time (GMT)	Station	Haul	Latitude (N)	Longitude (W)	Depth (m)	Volume Filtered (m^3)	Mesh Size (μm)
17 Aug	1752	12	1	71° 31.5'	156° 09'	160-0	70.7	303
	1804		2			100-0	44.2	
	1817		3			50-0	22.1	
	1825		4			20-0	8.8	
	1831		5			10-0	4.4	
18 Aug	1519	13	1	71° 31'	155° 05'	20-0	8.8	
	1524		2			10-0	4.4	
21 Aug	0112	14	1	71° 11'	153° 09'	20-0	8.8	
	0118		2			10-0	4.4	
24 Aug	0118	15	1	70° 36'	148° 12'	10-0	4.4	
26 Aug	0534	17	1	70° 32'	147° 33'	20-0	8.8	
	0538		2			10-0	4.4	
26 Aug	1826	18	1	70° 39'	147° 37'	20-0	8.8	
	1837		2			11-0	4.9	
28 Aug	0920	19B	1	70° 57'	149° 33'	20-0	8.8	
	0926		2			10-0	4.4	
28 Aug	2348	20	1	71° 08'	151° 19'	20-0	8.8	
	2352		2			10-0	4.4	

Table 2. (continued)

Date (1976) (GMT)	Time (GMT)	Station	Haul	Latitude (N)	Longitude (W)	Depth (m)	Volume Filtered (m^3)	Mesh Size (μm)
30 Aug	0050	21	1	71° 43'	151° 47'	200-0	88.4	303
	0107		2			100-0	44.2	
	0120		3			50-0	22.1	
	0128		4			20-0	8.8	
	0132		5			10-0	4.4	
31 Aug	0148	23	1	71° 22'	152° 20'	50-0	22.1	
	0203		2			20-0	8.8	
	0207		3			10-0	4.4	
31 Aug	1757	24	1	71° 19'	152° 32'	50-0	22.1	
	1805		2			20-0	8.8	
	1812		3			10-0	4.4	
1 Sep	1635	25	1	71° 08'	152° 57'	20-0	8.8	
	1640		2			10-0	4.4	
2 Sep	1430	26	1	71° 23'	154° 21'	20-0	8.8	
	1435		2			10-0	4.4	

Table 3. UW Acoustic Survey Summary

Date (1976) (GMT)	Time (GMT)	Station	Magnetic Recording Time (min)	Comments
26 Aug	0600	17	3	Sonic return; ambient noise
30 Aug	0633	21	5	Layer of discrete targets at 20 m; ambient noise
31 Aug	1738	24	6	Several layers of organisms? ambient noise
1 Sep	1646	25	5	Layers seen earlier, suddenly vanished; ambient noise
2 Sep	1445	26	6	Two layers visible; ambient noise
2 Sep	2008	27	6	Few scattered targets

Primary productivity measurements were made in 60 ml reagent bottles. Two light bottles and one dark bottle were used for each depth. Two ml of $NaH^{14}CO_3$ solution were added to each bottle, an aluminum foil cap was placed over the top and sides of the dark bottle, and the samples were incubated in a sink incubator in the laboratory. A bank of cool white fluorescent lights was set up over the incubator. Light levels were measured at the beginning and end of the incubation period with a Gossen Super Pilot photographic light meter. Low temperature in the sink was maintained by running seawater and was measured at the beginning and end of the incubation period. The incubation period was 3-4 hr. The samples were filtered onto 25 mm HA (0.45 μm) Millipore filters, rinsed with approximately 5 ml filtered seawater and 5 ml 0.01 N HCl, and placed in liquid scintillation vials. Radioactive uptake will be measured using a Packard Tri-Carb Liquid Scintillation Spectrometer with Aquasol (New England Nuclear) as the scintillation cocktail.

D. The cruise track is given in Fig. 1. Station locations are given in Table 4.

E. Data collected and analyzed

Type	Number Collected	Number Analyzed
Phytoplankton standing stock	172	0
Chlorophyll *a*	172	0
Primary productivity	172	0
Temperature	172	87
Salinity	172	172
Zooplankton net tows		
Bongo net	10	0
Ring net	51	0
Echosounder records	10	0

III. Results

No results from this cruise are available at this time.

IV. Preliminary Interpretation of Results

No interpretation of results is possible at this time.

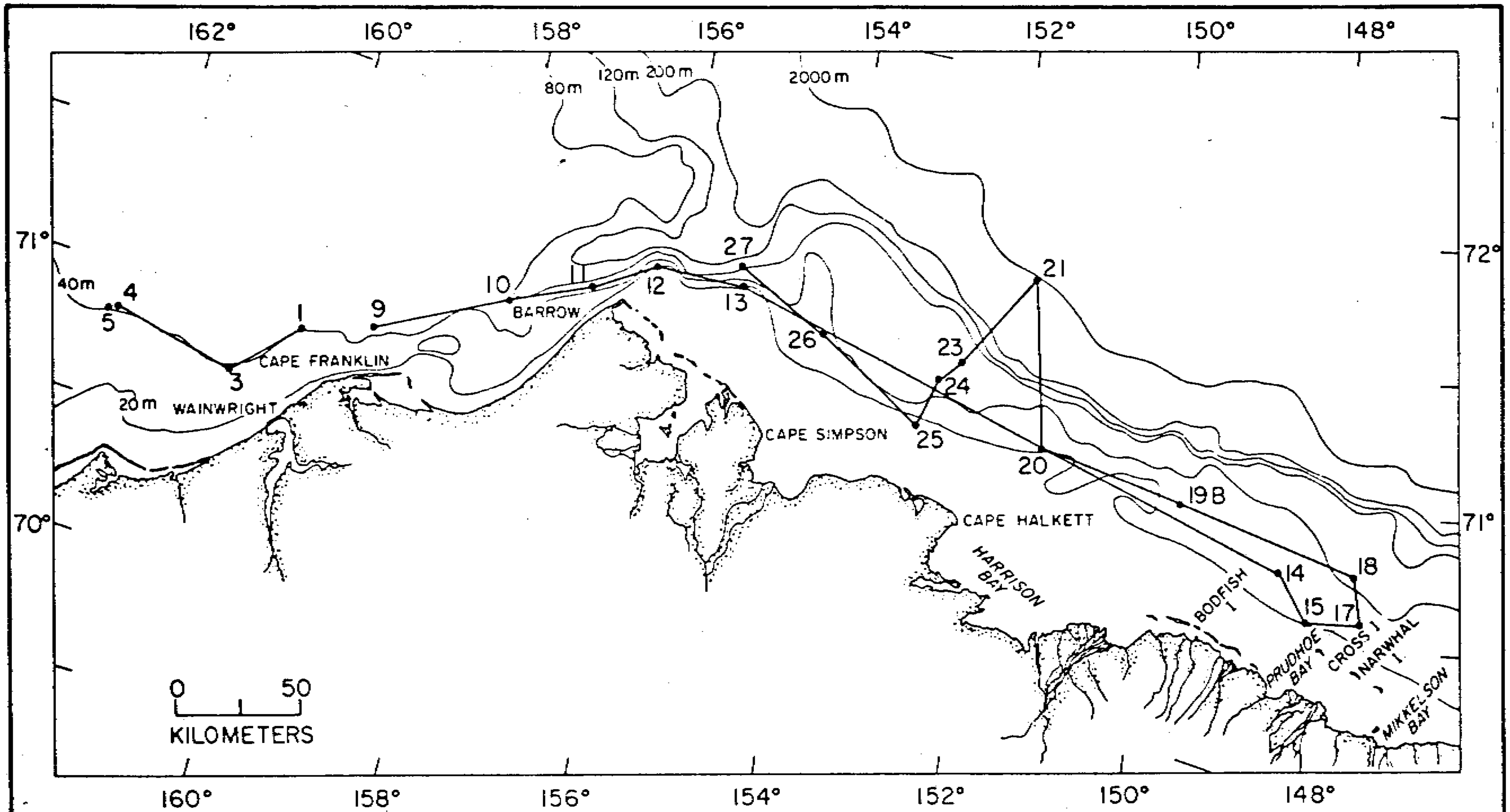

Fig. 1. Cruise track and station locations, USCGC *Glacier*, 7 Aug - 4 Sep 1976. Stations 6, 7, and 8 are off the chart to the west and are not given. Stations 2, 16, and 22 were not taken by us.

Table 4. Station locations, USCGC *Glacier*, 7 Aug - 4 Sep 1976

Station	Latitude (N)	Longitude (W)	Chart Depth (m)	Location
1	70° 54'	160° 04'	54	Chukchi Sea
3	70° 43'	160° 40'	20	Chukchi Sea
4	70° 50'	162° 09'	40	Chukchi Sea
5	70° 47'	162° 14'	36	Chukchi Sea
6	70° 39'	162° 16'	36	Chukchi Sea
7	70° 28'	163° 26'	40	Chukchi Sea
8	70° 34'	162° 50'	27	Chukchi Sea
9	71° 03'	159° 17'	61	Chukchi Sea
10	71° 16'	157° 43'	70	Chukchi Sea
11	71° 25.5'	156° 54.8'	106	Chukchi Sea
12	71° 31.5'	156° 09'	139	Chukchi Sea
13	71° 31'	155° 05'	13	Beaufort Sea
14	71° 11'	153° 09'	25	Beaufort Sea
15	70° 36'	148° 12'	16	Beaufort Sea
17	70° 32'	147° 33'	25	Beaufort Sea
18	70° 39'	147° 37'	25	Beaufort Sea
19B	70° 57'	149° [illegible]3'	30	Beaufort Sea
20	71° 08'	151° 1[illegible]'	34	Beaufort Sea
21	71° 43'	151° 47'	1700	Beaufort Sea
23	71° 22'	152° 20'	74	Beaufort Sea
24	71° 19'	152° 32'	52	Beaufort Sea
25	71° 08'	152° 57'	40	Beaufort Sea
26	71° 23'	154° 21'	22	Beaufort Sea
27	71° 36'	155° 32'	171	Beaufort Sea

V. Task Objectives - AIDJEX

The basic objective of the Beaufort Plankton Project at the AIDJEX camp in 1975 was to collect information on standing stocks and seasonal changes in the environment under the pack ice, including primary production and response of herbivores to production.

VI. Laboratory Activities

Analyses of the zooplankton samples from this cruise are continuing and will be reported in the December quarterly report.

VII. Literature Review: Zooplankton and Phytoplankton

The Arctic phytoplankton references have been put on computer cards and the first listings run (pp. 12-25). This is to be considered a preliminary list because corrections and additions have not been completed.

Some of the zooplankton references have been put on computer cards, but no listing has been done.

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QUARTERLY REPORT

Contract No. : None
Research Unit No.: RU-380
Reporting Period : July 1-September 30,1976
Number of Pages : 3

ICHTHYOPLANKTON OF THE EASTERN BERING SEA

Dr. Felix Favorite and Mr. Kenneth D. Waldron
National Marine Fisheries Service
Northwest Fisheries Center

24 September 1976

I. Task Objective: Collect and analyze ichthyoplankton samples from a portion of the eastern Bering Sea during the spring of 1976.

II. Field or Laboratory Activities:

A. Ship Schedule: No field activity.

B. Scientific Party

1. Laboratory personnel:

Kenneth D. Waldron	NMFS	Co-principal investigator
Beverly Vinter	NMFS	Ichthyoplankton specialist
Donald M. Fisk	NMFS	Technician

C. Methods:

Plankton samples collected during the previous quarter was sorted under contract and fish larvae identified at the Northwest Fisheries Center.

D. Sample Localities: See attached chart

E. Data Collected

1. No field collections
2. Number and type of analyses: Preliminary sorting completed on 56 samples each of neuston net and 505 bongo net. Volume and composition determined for 36 out of a total of 56 333 bongo net samples.
3. Miles of trackline: Not applicable

III. Results:

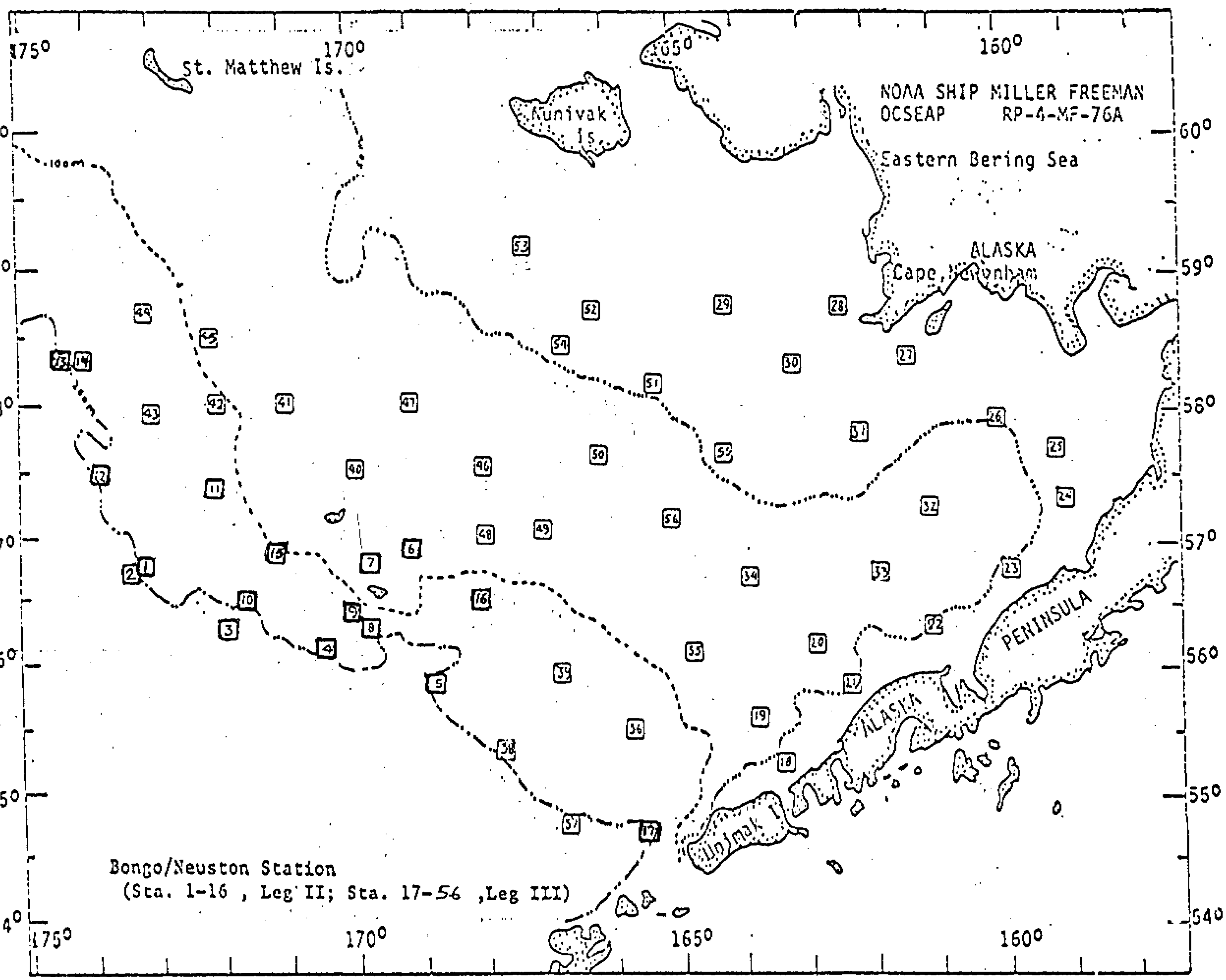
Although contract requirements were provided NASO prior to vessel departure (mid-April), final acceptance of bids for processing plankton samples was not made by the NASO contracting officer until July 22, 1976. Upon receipt of shipping containers from the contractor (Texas Instruments, Inc.) plankton samples were shipped and received in Dallas on August 5. Ichthyoplankton from the 505 bongo and the neuston samples were received at the Northwest Fisheries Center during the first week of September and identification of the specimens was begun.

Samples from the continental slope west of the Pribilof Islands and from one station near Unimak Pass have been examined (Sta's. 1-17). The predominant species from these stations has been walleye pollock (*Theragra chalcogramma*) . Larvae of other fish of commercial importance found in these samples include those of Greenland turbot (*Reinhardtius hippoglossoides*), arrowtooth flounder (*Atheresthes stomias*), and Pacific halibut (*Hippoglossus stenolepis*). Capture of halibut larvae is of interest because they have been reported infrequently from the eastern Bering Sea. Halibut larvae were found in samples collected at stations 3, 13 and 17, all near the 200 meter isobath. Other larvae found in the samples belong to the families Agonidae, Ammodytidae, Bathylagidae, Cottidae, Cyclopteridae, Hexagrammidae, Myctophidae, Scorpaenidae and Stichaeidae.

IV. Preliminary Interpretation of Results
No interpretations can be made at this time.

V. Problems Encountered/Recommended Changes
Delays by NASO in awarding the sorting contract caused us to fall behind our time schedule by about one month.

VI. Estimate of Funds Expended
As of 30 September 1976 an estimated $47,000 will have been expended for RU-380.



NOAA SHIP MILLER FREEMAN
OCSEAP RP-4-MF-76A
Eastern Bering Sea
St. Matthew Is.
Nunivak Is.
ALASKA
Cape Newenham
ALASKA PENINSULA
Unimak I.
175°
170°
165°
160°
60°
59°
58°
57°
56°
55°
54°
100m
Bongo/Neuston Station
(Sta. 1-16 , Leg II; Sta. 17-56 ,Leg III)

FISHERIES RESEARCH INSTITUTE
College of Fisheries
University of Washington
Seattle, Washington 98195

ASSESSMENT OF PELAGIC AND NEARSHORE FISH IN THREE BAYS ON SOUTHEAST KODIAK ISLAND

QUARTERLY PROGRESS REPORT

July 15 - September 30, 1976

by

Colin K. Harris
Project Leader

Allan C. Hartt
Principal Investigator

A contribution to biological information needed by OCSEAP in making decisions with respect to offshore oil leases. Work performed under proposal RU 485-76 RFP Tasks A-7, A-8, A-9, A-11.

Date: 30 September 1976

Approved:

Robert L. Burgner, Director
Fisheries Research Institute

I. Task Objectives

This quarterly progress report covers the last two sampling sessions of our pelagic and nearshore fish survey of Ugak, Kaiugnak, and Alitak bays on southeast Kodiak Island, Alaska. The objectives of this survey are to determine: (1) the species composition of the pelagic and nearshore ichthyofauna, (2) relative abundance by species, (3) age composition of abundant species by means of length frequency analysis, (4) food habits of abundant or otherwise major species, and (5) seasonal and diel migrations and changes in distribution. The resultant data will be analyzed and interpreted in a final report with inputs from the Alaska Department of Fish and Game's OCSEAP sponsored research on demersal fish in the same area.

II. Field and Laboratory Activities

Cruises 3 and 4 were in the periods of July 15 to August 5 and August 26 to September 16, respectively. Both cruises were on the M/V _Commando_, a 20.4 m fisheries research vessel maintained by the College of Fisheries, University of Washington. Personnel consisted of three permanent crewmen of the _Commando_ and four biologists including the senior author as Project Leader.

Five types of gear were employed in both cruises according to a predetermined sampling strategy. These gear were:

1. A 5 x 6 x 27 m Marinovitch midwater herring trawl with 2.1 x 1.5 m steel V-doors, and 5 cm body and 1.2 cm stretch cod end mesh.
2. A standard 6.1 x 3.1 x 15 m surface tow net with 7.6 cm outside, 1.9 - 3.8 cm body, and .6 cm stretch cod end mesh.

3. A 3.0 x 0.8 x 6 m try net (small otter trawl) with 3.3 cm stretch mesh in the body, 0.5 cm stretch mesh in the cod end, a cod end liner and tickler chain.
4. Two 46 x 2m trammel nets with 51 cm stretch mesh in the two outer panels and 5 cm stretch mesh in the inner panel.
5. A 47 x 3 m beach seine with 3.2 cm wing, 1 cm body, and 0.2 cm stretch inner mesh.

In addition, two 46 x 4 m variable mesh (one panel each of 13.3, 6.4, and 2.5 cm stretch mesh) gill nets were set once in the third cruise. Time constraints made us discontinue use of the gill nets in preference of thorough and repeated sampling with the trammel nets which were more productive in both numbers of fish and assortment of species.

The midwater trawl was usually fished in the deeper midwater zone (5 - 27 m from the bottom), although several repeated shallower hauls were made in each bay as well. The bathypelagic zone was emphasized as it consistently yielded larger and more diverse catches than did shallower waters. Ten minute tows, covering about 1.3 km, were standard, but three 20 minute tows were also made in Alitak Bay.

Townetting was done by towing the net on the surface between the Commando and a diesel-powered purse seine skiff so as to keep the net away from both propeller washes. The net was attached to two 3.7 m steel poles which kept it open, and these poles were in turn attached to the 9 m bridles. At the end of a ten minute tow, covering about .74 km, the entire net was hoisted on board the Commando for emptying. To allow valid comparison of our results with past FRI tow net data from these three bays, we duplicated past methods closely.

This included using many of the transects and stations of past projects, and sampling exclusively at night in Ugak and Kaiugnak bays and in daytime in Alitak Bay. In the fourth cruise, a few nighttime tows were made around Cape Hepburn in Alitak where juvenile pink salmon have consistently been abundant.

Trynetting was done from the diesel-powered purse seine skiff with help from a model 8274 12-v Warn winch. Try net sites were chosen in the second cruise on the basis of smooth and workable substrate, habitat type, and position in the bays. Trawl depths of 4, 9, and 13 m were maintained by a portable echo sounder or a sounding line. Tows were ten minutes long and covered about .46 km depending on the force and direction of wind and current. Catches were bagged and labelled for processing on board the Commando.

The trammel nets and beach seine were set from a 4.6 m Delta Marine fiberglass skiff. The trammel nets were set off rocky points and bluffs and in kelp beds to sample littoral areas unworkable by the try net. The two nets were set together, one attached to and perpendicular to shore, and the second continuing from the first but parallel to shore. This arrangement seemed to form a crude trap for fish moving along shore. The sets were 2.5 or 5 hours long, and catches from the perpendicular and parallel nets were processed separately to allow inference about littoral movements. The beach seine was set by anchoring one end to shore and laying the net out from the skiff to form a semicircle. As the arc was closed, the seine was pulled to shore manually, and catches were bagged and/or preserved for processing later.

Figures 1 - 3 show sampling transects and stations for all gear types. We attempted to sample exactly the same trammel net, beach seine, and try net sites during various cruises. However, adverse sea and/or weather conditions sometimes precluded replication at a site or necessitated replicate effort at a different but proximate and similar site.

Our pelagic sampling and beach seining frequently yielded large catches of small, usually juvenile fish. If one or more species were abundant in the catch, a single random subsample was chosen to make a volume of 200, 500, or 1000 ml, depending on the size of fish. This subsample was enumerated by species and usually retained for length measurements. The volume of the total catch was then found by water displacement, and thereby catch in numbers of each species could be estimated proportionately. Species represented in small numbers were first separated and counted directly. This volumetric estimation procedure was also employed when fish were so mixed with large quantities of jellyfish or shrimp that separation and direct counting would have been impractical.

A considerable amount of material was preserved in the field and shipped to Seattle for later laboratory examination. In every case specimens of questionable identity were saved. Samples of every species were routinely taken for the College of Fisheries fish collection, and specimens of especially abundant species were preserved for food studies.

With very few exceptions, length measurements were recorded for all fish or a subsample of fish from every haul. A total of 3456 individual measurements were recorded during the third cruise, and a commensurate albeit presently uncounted sample is available from the fourth cruise.

During the third cruise, 204 collections or hauls were made (Table 1A). Seven days were spent sampling Ugak Bay, three days were in Kaiugnak Bay, and seven days were spent in Alitak Bay. The fourth cruise resulted in 230 hauls

(Table 1B), and consisted of six, three, and eight days in Ugak, Kaiugnak, and Alitak bays, respectively.

III. Results

Data from the third cruise has only recently been keypunched, and no formal analysis of it has been made to date. Some general interpretations can be made, however, from preliminary tabulations compiled from a listing of the species catch cards. Data from the recent fourth cruise have not yet been keypunched, and only a few major results from that cruise will be mentioned in this report. A detailed analysis of data from all four cruises will constitute the final narrative report.

Throughout the rest of this Results section, species lists are in order of decreasing abundance.

The pelagic midwater habitat of Ugak Bay hosts considerably large populations of capelin (*Mallotus villosus*) and Pacific sandfish (*Trichodon trichodon*) (Table 2). The snake prickleback (*Lumpenus sagitta*), sandlance (*Ammodytes hexapterus*), and flathead sole (*Hippoglossoides elassodon*) were also very common, although in much less abundance. Expectedly, all of these species are represented overwhelmingly more by larvae and juveniles than by adults. Discretionally dividing the bay into three roughly equal thirds elucidates some possible distributional trends (Table 2). For instance, the Pacific sandfish was only found in the outer two-thirds of the bay, while the capelin and sandlance were most abundant in the middle sector. The night-time hauls yielded more incidental catches of typically benthic species such as sculpins and flatfish than did daytime hauls, although a firm statement must await a close examination of trawling depths in the two periods. Notable incidental species in herring trawl catches were *Hemilepidotus jordani*, *Gilbertidia sigalutes*, *Theragra chalcogramma*, *Oncorhynchus kisutch*, *Lepidopsetta* bilineata, and Blepsias cirrhosus.

The surface layer of Ugak Bay included large numbers of capelin, Pacific sandfish, and pink salmon (Oncorhynchus gorbuscha) (Table 3). Juveniles made up most or all of every species encountered in the surface zone. The capelin, pink salmon, and several incidental species were notably most abundant in the middle third of the bay, while the sandfish was by far most abundant in the outer third (Table 3).

Sampling in the nearshore zone produced a much higher species diversity than in the pelagic areas, as expected. Beach seining produced large numbers of juvenile and adult pink salmon, chum salmon (Oncorhynchus keta), sandlance, snake pricklebacks, and capelin. Except capelin, which were caught only in the outer bay, these species were most abundant in the middle third of the bay. Much less abundant but still common in the beach seine were the great sculpin (Myoxocephalus polyacanthocephalus), rock sole (Lepidopsetta bilineata), white-spotted greenling (Hexagrammos stelleri), tubesnout poacher (Pallasina barbata), and crescent gunnel (Pholis laeta). The presence of juvenile pink and chum salmon in beach seine catches as well as in tow net catches suggests that they might have been in a period of transition from nearshore to pelagic habitats. In one seine haul in Eagle Harbor on the south central shore of the bay an estimated 10,000 pink salmon and 500 chum salmon juveniles were caught and released. The same site also produced large juvenile salmon catches in past cruises, and may be an aggregation point for fish from several natal streams around the bay. Trynetting, usually done just offshore from the beach seine sites (Figures 1-3), yielded many species also seen in seine catches, and several other species as well. Abundant species in try net catches were yellowfin sole (Limanda aspera), rock sole, snake pricklebacks, and Gymnocanthus spp. (all of which are archived and tentatively identified as G. galeatus or G. pistilliger). There were no marked distributional trends between inner, middle, and outer bay, but a more complete analysis will compare catches from specific trawling areas (e.g. head of bay, Saltery Cove, Pasagshak Bay and so on). Trynetting in Cruises 2 and 4 demonstrated an abundant population of the butter sole (Isopsetta isolepis) in outer Ugak Bay, particularly in Pasagshak Bay. No butter sole were caught in the third cruise, but this is surely due to the much lowered trynetting effort at that time. A mechanical failure permitted only two hauls in Pasagshak Bay instead of the usual six, and no hauls were made near Gull Point to avoid interfering with several commercial operations. Passive nearshore sampling yielded exclusively adults of the masked greenling (Hexagrammos octogrammos), rock greenling (Hexagrammos lagocephalus), rock sole, herring (Clupea harengus pallasi), sturgeon poacher (Agonus acipenserinus), whitespotted greenling, and incidentals also caught by other means. The herring was only caught in Pasagshak Bay. The average catch per gill net set was considerably smaller than that of a trammel set (18 fish/set vs. 70.7 fish/set) despite its greater surface area. Relative to the trammel nets, the gill nets were selective for pink and chum salmon adults and selective against greenlings.

Kaiugnak Bay is similar to Ugak Bay in that capelin and sandfish comprise most of the midwater and surface fish fauna (Table 4 A & B). Capelin was the only truly abundant species and was encountered only in the outer half of the bay in surface and midwater strata. Pelagic sandfish were caught only on the surface in the inner bay. Incidental midwater catches were walleye pollock (Theragra chalcogramma), Bering wolffish (Anarhichas orientalis), and bigmouth sculpin (Hemitripterus bolini). Twice as many species were caught by the nighttime tow net than by the diurnal midwater sampling, although it is presently difficult to infer whether this is a function of greater diversity on the surface or differences in selectivity of the two types of gear. Indeed, all of the fish caught by the tow net were juveniles or young adults which might easily pass through the herring trawl. Large amounts of krill and pink shrimp (Pandalus borealis) were caught consistently in the tow net in the outer transects of the bay.

The nearshore zone of Kaiugnak Bay was also divided into inner and outer halves for this overview. Sandfish and sandlance were by far the most abundant species as determined by beach seining, although both of these species were caught in only two (separate) hauls. The sandlance were seined only at the head of the bay and, surprisingly, 2205 sandfish, which are usually pelagic rather than nearshore residents, were seined on the north central shore. Juvenile pink salmon and sticklebacks (Gasterosteus aculeatus) were quite abundant in the lagoon off Kiavak Bay (at about 57°1'30" N, 153°37'W, Figure 2). The masked greenling was the most abundant hexagrammid species, especially in the Kiavak lagoon. More abundance and diversity of fish were found in the outer bay than inner bay by trynetting, although this is partly due to gear problems from the greater amounts of kelp at the inner bay sites. The snake prickleback, rock sole, silver-spotted sculpin (Blepsias cirrhosus), masked greenling, yellowfin sole, and rock greenling were the common species in try net catches. The trammel nets captured abundantly only masked and rock greenlings. Three specimens of the black rockfish (Sebastes melanops) were caught in the trammel net in the outer bay and were the only adult rockfish encountered in the entire study.

Alitak Bay is a large and complex environment featuring a fjord type of habitat (Deadman Bay), exposed rocky shores on the east side, relatively protected rocky inlets, channels, and islands on the west side, and an exposed, sandy, shallow-profile beach at the southwest corner (Tanner Head). The bay is deepest in Deadman Bay, and the bottom of the middle and outer bay is very irregular with numerous reefs and troughs.

Midwater trawl results are reviewed herein according to Deadman, middle, and outer bay regions. The only abundant species in all three regions was the capelin (Table 5A), which was caught more often in the deeper hauls than in shallow. As before, these were mostly juveniles. Considerable quantities of shrimp (Pandalus spp. and Pandalopsis dispar) were also caught in the deeper hauls, especially in the several troughs of the middle bay region. The pink salmon juveniles trawled (Table 5) were from a single haul at 10 fathoms and were possibly strained from the surface waters at the start or end of the tow. The Alaska eelpout (Bothrocara pusillum) was only found in Deadman Bay, although in other cruises it was encountered in other parts of Alitak. Relative to Ugak and Kaiugnak Bays, Alitak seems to host small numbers of sandfish.

Two additional regions of Alitak Bay are defined for the tow net sampling. Cape Hepburn (between the two north arms of the bay) has consistently hosted large populations of juvenile pink salmon, as shown by past FRI studies, and should receive special note herein. Also, the west side bays and channels were sampled by the tow net and are distinguished from the middle and outer transects. Pink salmon juveniles were by far the most abundant surface residents, although the vast majority of these were caught in south Deadman Bay and Cape Hepburn regions as predicted (Table 6). No pink salmon were caught in the expansive outer sections of the bay (although their presence there was verified by the midwater trawl) and very few were caught in the middle region, suggesting that they were still mostly associated with nearshore, as opposed to oceanic, areas. Greenling juveniles were fairly abundant in surface waters, and while the striking similarity of hexagrammid juveniles precluded identification of every individual caught, later laboratory examination of specimens indicated that these were mostly whitespotted greenling. Interestingly, only one capelin was caught in 29 diurnal tow net hauls. Because capelin were very abundant in nighttime tow net catches in the other two bays, there is good evidence that the young smelt move closer to the surface at night.

Littoral sampling of Alitak Bay was much hampered by the paucity of suitable trawling bottom (e.g., not a single workable shelf could be found in all of Deadman Bay) and by the enormous quantities of kelp that usually clogged the opening of the trawl. Rock sole comprised over half of the fish caught by the try net, and the majority of these was caught off Tanner Head where the bottom was most suitable for trawling. Besides rock sole, only the masked greenling was common in try net catches, especially on the east side of the bay.

Beach seining in Alitak Bay indicated large intertidal populations of sandlance in all areas but Tanner Head. Less abundant by a factor of at least ten were adult pink salmon (all caught in one haul near a creek mouth), whitespotted greenling, masked greenling, Dolly Varden (Salvelinus malma), rock sole, and great sculpins (M. polyacanthocephalus and M. scorpius). M. scorpius seemed to be more abundant in Alitak than in Ugak and Kaiugnak bays.

The masked greenling comprised over ninety percent of the cumulative trammel net catches,the remainder made up of rock greenling, whitespotted greenling, and incidentals.

As mentioned, data from the fourth cruise have not been keypunched. Some results can be noted by way of gross comparison with the third cruise, however. In Ugak and Kaiugnak bays the dominant pelagic forms were again capelin and sandfish, and in Alitak Bay the same pattern of many capelin and few sandfish was observed. Pink and chum salmon juveniles had grown considerably between the third and fourth cruises, and were only rarely caught in the tow net in all three bays. This relative scarcity of juvenile salmon in tow net catches has several possible explanations which will receive attention in later analysis:

1) they had largely left the bays for oceanic residence,
2) they reside deeper in the bays at this age (although none were caught in the midwater trawl),
3) they are not aggregated in schools as large as before, reflected in lower catches per unit of effort,
4) at a larger size they can better avoid the tow net.

Pink salmon juveniles were never caught in the beach seine during Cruise 4 (except for one stunted individual), indicating at least their departure from intertidal areas.

Greenlings continued to be the dominant littoral form, and juveniles were mostly in littoral areas, having changed from silvery to adult coloration, rather than in the pelagic zone as in Cruises 2 and 3. Cruise 3 was at or near the peak of greenling spawning season as indicated by color patterns and ripeness of gonadal products. By Cruise 4, only a few fish, males mostly, had spawning colors and these were obviously fading. Juvenile cottids (e.g., Myoxocephalus and Gymnocanthus spp.) and flatfish (e.g., rock sole and at Tanner Head halibut (Hippoglossus stenolepis)) seemed to be more abundant in the littoral zone in Cruise 4 than in Cruise 3.

IV. Interpretations Pertinent to Oil Exploration

Predicting the impact of oil exploration on fish populations is not an objective of this study. Nevertheless, as major features of the pelagic and nearshore ichthyofauna of southeast Kodiak Island are elucidated by this study, obviously pertinent findings and speculations should be mentioned.

One of the salient findings of our study is that while all three bays have numerous species in the pelagic zone, only a few are regularly abundant. Capelin, sandfish, and to a lesser extent sandlance and pink salmon comprise a major fraction of the pelagic fish community. Considering relative abundances along with numbers of species we can conclude that the pelagic zone of these bays does not support a great diversity of fish life. Without considerable food habit information and data on long-term population changes, it is impossible to say what bearing this low diversity has on food web complexity and community stability. However, there is some room for surmising that if one or more of the dominant pelagic species were affected by an environmental change or upset, much of the remaining community could be indirectly affected as well.

Almost all species in the pelagic zone were overwhelmingly represented by larval or juvenile stages. This seems to be true even for the capelin, as very few of the thousands of individuals caught had attained sexual maturity. This preponderance of juvenile fish suggests that the pelagic areas of the bays are nursery areas for fish which reside as adults in benthic, littoral, or oceanic habitats.

Species distributions greatly pertain to impact studies as small and localized environmental disturbances can have major effects on the community if they coincide with migratory routes, centers of abundance, nursery areas, and so on. We hesitate to make any firm statements regarding species distributions in the three bays covered by this survey until the entire data base is analyzed. However, there are indications of patchy or localized distributions within our study area. For instance, the butter sole was only abundant in outer Ugak Bay. Also, the last cruise demonstrated a somewhat localized abundance of juvenile Pacific halibut off Tanner Head in Alitak Bay.

The pink salmon especially, but also sockeye, chum, and coho salmon deserve special mention in this regard because of their immense economic importance to the Kodiak region. The pelagic area just south of Cape Hepburn in Alitak Bay consistently hosts large aggregations of juvenile pink salmon, presumably from several natal areas within the bay. One area in Eagle Harbor, Ugak Bay, was found to contain a large concentration of juvenile pink and chum salmon, perhaps from several natal streams in the bay. Also noteworthy, juvenile salmon seemingly have the most vertically restricted habitat of the abundant pelagic species. They are predominately epipelagic residents. Only a few times in Cruises 3 and 4 were salmon caught by the midwater trawl, and then they might have been strained from near the surface at the start or end of the hauls. The concentration of many returning adult salmon in bights, estuaries, and streams poses another important consideration in the location of exploratory structures and operations. For instance, Humpy Cove, a bight on the southeast shore of Alitak Bay, reportedly has summer concentrations of pink and chum salmon adults ultimately bound for various streams in the bay. Any major disturbance in that small area could conceivably have far-reaching consequences. Similarly, a localized and untimely disturbance near Olga Narrows could affect many migrant salmon concentrated there for entrance into Olga Bay.

V. Problems Encountered

The last two cruises presented few new problems. The weather was a hindrance especially in the fourth cruise, but essentially the entire sampling plan was completed in both cruises. Our reluctance to interfere or compete with commercial salmon fishermen in Cruise 3 prevented setting the trammel net at Saltery Cove and trynetting at Gull Point as was usually done, but this omission will not severely affect the reliability of our results.

VI. Estimate of Funds Expended

As of 31 August 1976 this project has spent $72,355.76 of the original contract allocation of $99,999. The balance is expected to be (almost) entirely spent in the last month of the project for boat charter, wages, travel, secretarial and data processing services, and indirect costs.

Table 1. Distribution of sampling by cruise, bay, and gear type.

A. Third Cruise

Bay	Gear type and number of hauls						Total
	Midwater trawl	Tow net	Beach seine	Gill net	Try net	Trammel net	
Ugak	23	20	14	2	15	4	78
Kaiugnak and Kiavak	7	10	7		8	4	36
Alitak	18	29	16		19	8	90
Total	48	59	37	2	42	16	204

B. Fourth Cruise

Bay	Gear type and number of hauls					Total
	Midwater trawl	Tow net	Beach seine	Try net	Trammel net	
Ugak	19	20	13	20	8	80
Kaiugnak and Kiavak	7	10	9	12	4	42
Alitak	18	36	21	21	12	108
Total	44	66	43	53	24	230

Table 2. Cumulative midwater trawl catches of common species from three regions of Ugak Bay, Cruise 3. Values in parentheses are mean catches per unit of effort (cumulative catch/number of hauls).

Species	Daytime: Upper third of bay, 3 hauls	Daytime: Middle third of bay, 10 hauls	Daytime: Outer third of bay, 6 hauls	Daytime total, 19 hauls	Nighttime, upper and middle thirds of bay, 4 hauls	Total
Capelin *Mallotus villosus*	97 (32.3)	933 (93.3)	160 (26.7)	1190 (62.6)	2316 (579.0)	3506
Pacific sandfish *Trichodon trichodon*	--	295 (29.5)	415 (69.2)	710 (37.4)	122 (30.5)	832
Snake prickleback *Lumpenus sagitta*	--	45 (4.5)	4 (0.7)	49 (2.6)	35 (8.7)	84
Sandlance *Ammodytes hexapterus*	--	32 (3.2)	--	32 (1.7)	2 (0.5)	34
Flathead sole *Hippoglossoides elassodon*	--	--	--	--	16 (4.0)	16

Table 3. Cumulative tow net catches of common species from three regions of Ugak Bay, Cruise 3. Values in parentheses are mean catches per unit of effort (cumulative catch/ number of hauls).

Species	Upper third of bay, 3 hauls	Middle third of bay, 11 hauls	Outer third of bay, 6 hauls	Total
Capelin *Mallotus villosus*	23 (7.7)	11775 (1070.5)	36 (6.0)	11834
Pacific sandfish *Trichodon trichodon*	--	475 (43.2)	1917 (319.5)	2392
Pink salmon *Oncorhynchus gorbuscha*	24 (8.0)	217 (19.7)	13 (2.2)	254
Snake prickleback *Lumpenus sagitta*	1 (0.3)	35 (3.2)	--	36
Coho salmon *Oncorhynchus kisutch*	2 (0.7)	31 (2.8)	--	33
Chum salmon *Oncorhynchus keta*	3 (1.0)	15 (1.4)	--	18

Table 4. Cumulative catches of common pelagic species from two regions of Kaiugnak and Kiavak bays (Kiavak included in the outer half of Kaiugnak), Cruise 3. Values in parentheses are mean catches per unit of effort (cumulative catch/number of hauls), and CPUE values are not intended for comparison between the two gear types.

Species	Upper half of bay	Outer half + Kiavak Bay	Total
A. Midwater trawl	3 hauls	4 hauls	
Capelin *Mallotus villosus*	--	421 (105.3)	421
Pacific sandfish *Trichodon trichodon*	2 (0.7)	5 (1.3)	7
Walleye pollock *Theragra chalcogramma*	1 (0.3)	3 (0.8)	4
Bering wolffish *Anarhichas orientalis*	--	2 (0.5)	2
Bigmouth sculpin *Hemitripterus bolini*	--	1 (0.3)	1
B. Tow net	4 hauls	6 hauls	
Capelin *Mallotus villosus*	--	4943 (823.8)	4943
Pacific sandfish *Trichodon trichodon*	291 (728.0)	25 (4.2)	316
Pink salmon *Oncorhynchus gorbuscha*	2 (0.5)	3 (0.5)	5
Sandlance *Ammodytes hexapterus*	--	4 (0.7)	4
Whitespotted greenling *Hexagrammos stelleri*	1 (0.3)	3 (0.5)	4

Table 5. Cumulative midwater trawl catches of common pelagic species from various regions of Alitak Bay, Cruise 3. Values in parentheses are mean catches per unit of effort (cumulative catch/number of hauls).

Species	Deadman Bay, 7 hauls	Middle bay, 6 hauls*	Outer bay, 5 hauls	Total
Capelin *Mallotus villosus*	948 (135.4)	26772 (2974.7)	2829 (565.8)	30549
Pink salmon *Oncorhynchus gorbuscha*	--	--	74 (14.8)	74
Alaska eelpout *Bothrocara pusillum*	53 (7.6)	--	--	53
Snake prickleback *Lumpenus sagitta*	8 (1.1)	--	--	8
Chum salmon *Oncorhynchus keta*	--	--	5 (1.0)	5
Sandfish *Trichodon trichodon*	--	2 (0.2)	1 (0.2)	3

*Three of these hauls were 20 minutes in duration, so an effective 9 hauls was used for calculation of CPUE values.

Table 6. Cumulative tow net catches of common pelagic species from various regions of Alitak Bay, Cruise 3. Values in parentheses are mean catches per unit of effort (cumulative catch/number of hauls).

Species	Deadman Bay 10 hauls	Cape Hepburn 5 hauls	West side 4 hauls	Middle bay 7 hauls	Outer bay 3 hauls	Total
Pink salmon *Oncorhynchus gorbuscha*	565 (56.5)	1304 (260.8)	58 (14.5)	10 (1.4)	--	1937
Whitespotted greenling *Hexagrammos stelleri*	1 (0.1)	2 (0.4)	54 (13.5)	--	--	57
Stickleback *Gasterosteus aculeatus*	--	--	24 (6.0)	--	--	24
Chum salmon *Oncorhynchus keta*	5 (0.5)	--	2 (0.5)	--	--	7

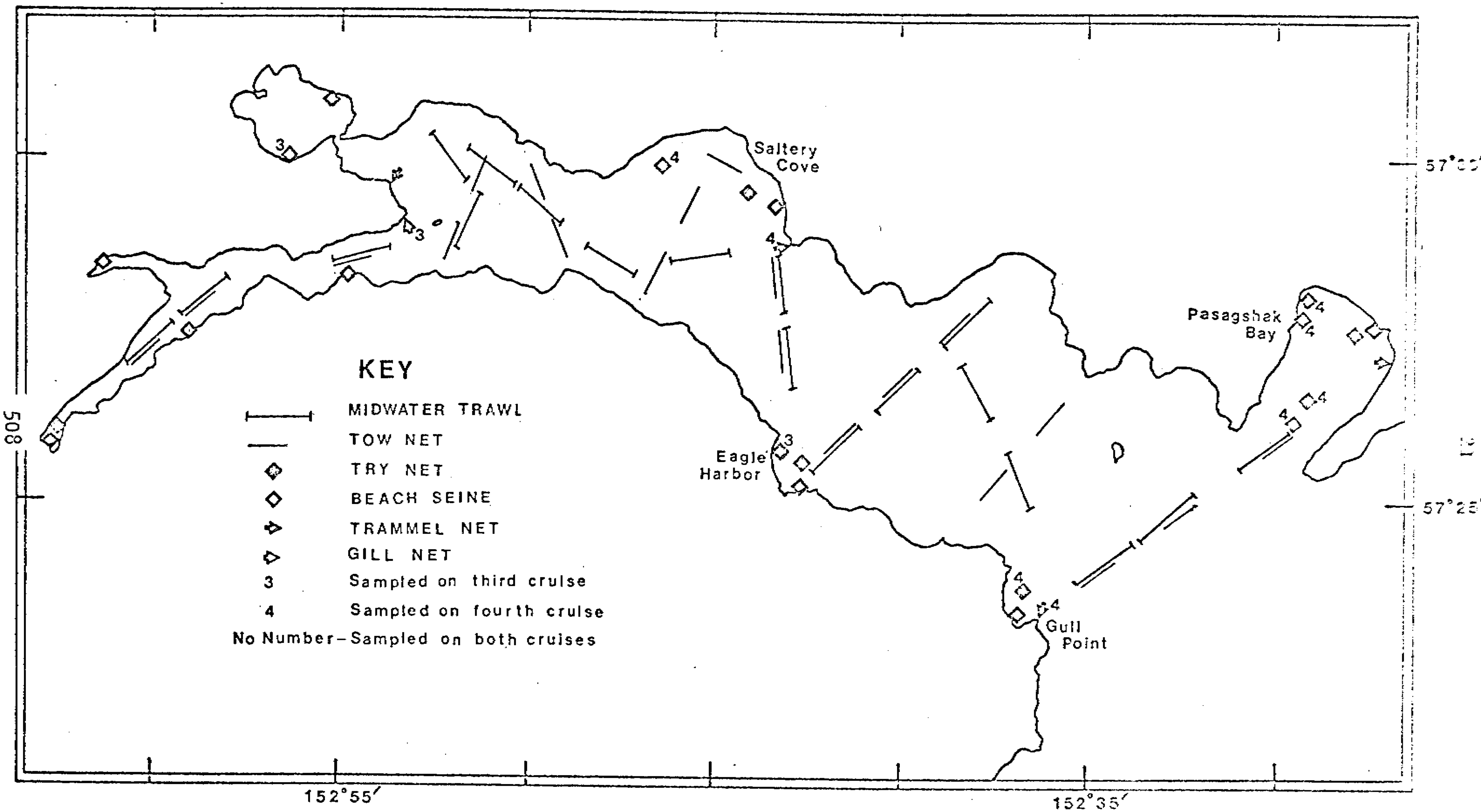


Figure 1. Sampling transects and stations in Ugak Bay, Cruises 3 and 4. One or more hauls were made at each station.

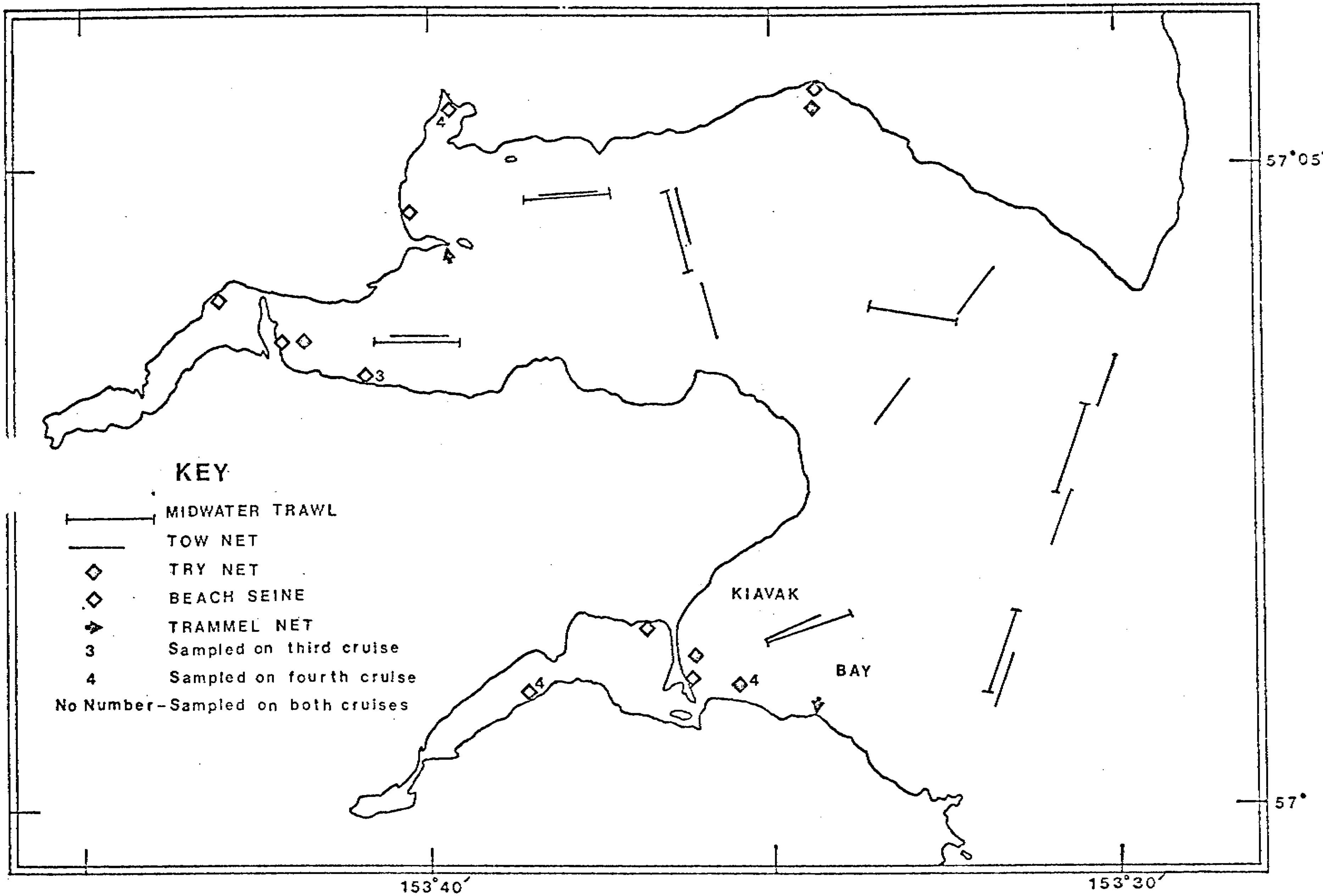


Figure 2. Sampling transects and stations in Kaiugnak and Kiavak bays, Cruises 3 and 4. One or more hauls were made at each station.

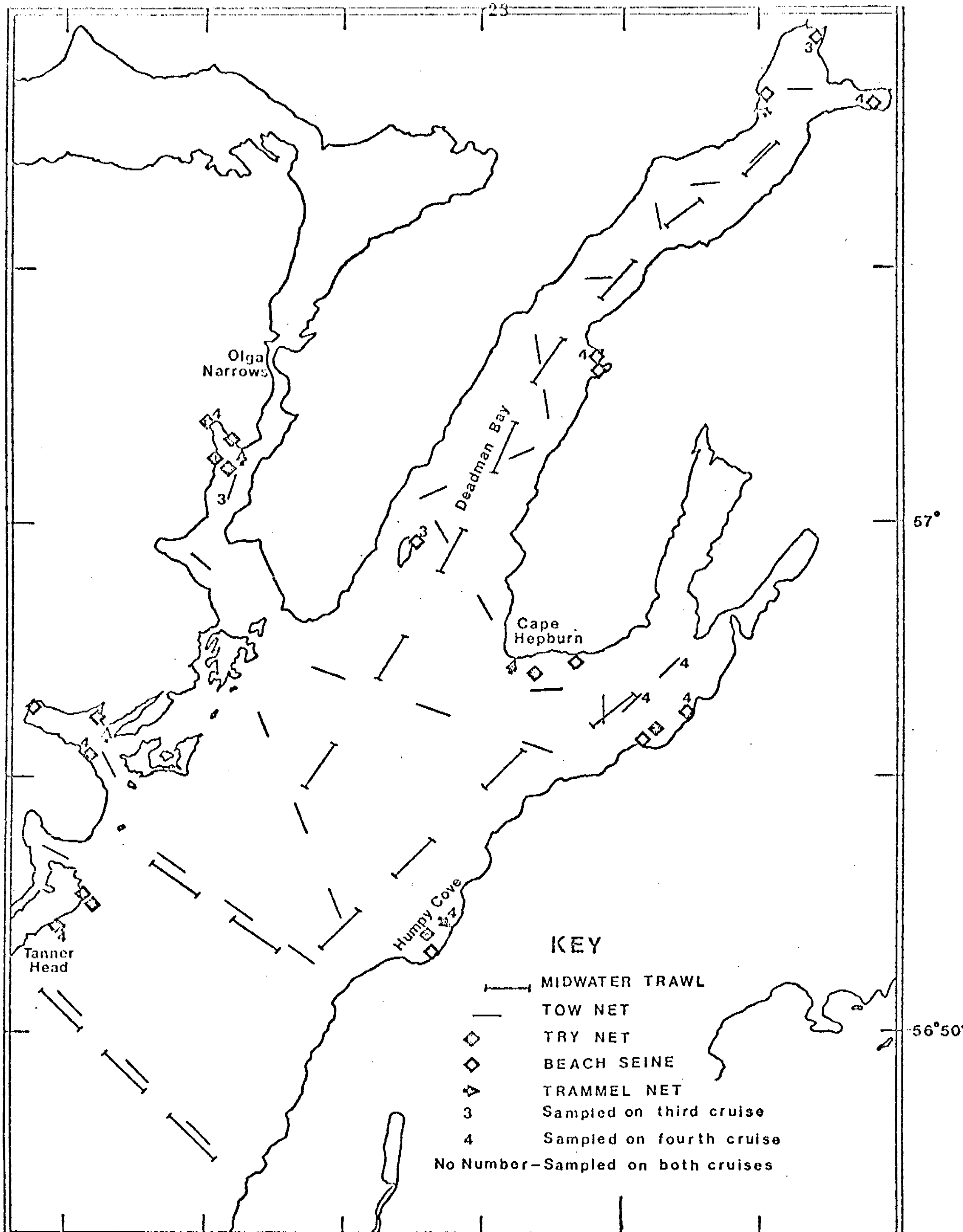


Figure 3. Sampling transects and stations in Alitak Bay, Cruises 3 and 4. One or more hauls were made at each station.

Research Unit # U 486-76

Demersal Fish and Shellfish Assessment in Selected Estuary Systems of Kodiak Island

Principal Investigator
JAMES E. BLACKBURN
Alaska Department of Fish and Game
P.O. Box 686
Kodiak, Alaska 99615

September, 1976

Completion Report for Period July 1 - September 30, 1976

Prepared for:

National Oceanic and Atmospheric Administration
Environmental Research Laboratories
Boulder, Colorado

Introduction

This report presents the activities and a preliminary statement of results obtained on Demersal Fish and Shellfish Assessment in Selected Estuary Systems of Kodiak Island, Research Unit U 486-76, from July 1 through September 30, 1976.

The study area for this project is inside of a line drawn between headlands and deeper than ten fathoms (18 M) in Ugak and Alitak bays on Kodiak Island (Figure 1).

Task Objectives

Task objectives of this project are listed below.

A. Determine the spatial and temporal (June-September) distribution, relative abundance and inter-relationships of the various demersal finfish and shellfish species in the study area.

B. Determine the growth rate and food habits of selected demersal fish species.

C. Conduct literature survey to obtain and summarize an ordinal level documentation of commercial catch, stock assessment data, distribution as well as species and age group composition of various shellfish species in the study area.

D. Obtain basic oceanographic and atmospheric data to determine any correlations between these factors and migrations and/or relative abundance of various demersal fish and shellfish species encountered.

Field or Laboratory Activities

The M/V BIG VALLEY was utilized during the last half of July, August and September 1976, to otter trawl in Ugak and Alitak bays on Kodiak Island (Figure 1). Aboard during the cruises were Alaska Department of Fish and Game personnel Al Carbary, staff member; Dan Wieczorek, staff member; and Max Hoberg of the University of Alaska project entitled "Distribution, Abundance and Diversity of Epifaunal Benthic Organisms in Two (Alitak and Ugak) Bays of Kodiak Island, Alaska".

A 400 mesh eastern otter trawl was used to make 20 minute hauls. In Ugak Bay 25 samples were taken in July and August and 22 in September. In Alitak Bay 28 samples were taken in July, 22 samples in August and 27 samples in September. Crab pots stored on the sampling station caused the variation in number of samples. All fish taxa sampled were identified, enumerated and weighed. Unknown species were preserved for later identification. All invertebrates were handled by the University of Alaska representative in July and August and they were handled by Alaska Department of Fish and Game personnel in September. A reference collection was made which includes virtually every species encountered.

Results

Catches in both Ugak and Alitak bays consisted almost entirely of crustaceans, flounders (*Pleuronectidae*) sculpins (*Cottidae*) and cod (*Gadidae*) (Table 1). All data on crustaceans during June, July and August was kindly provided by the

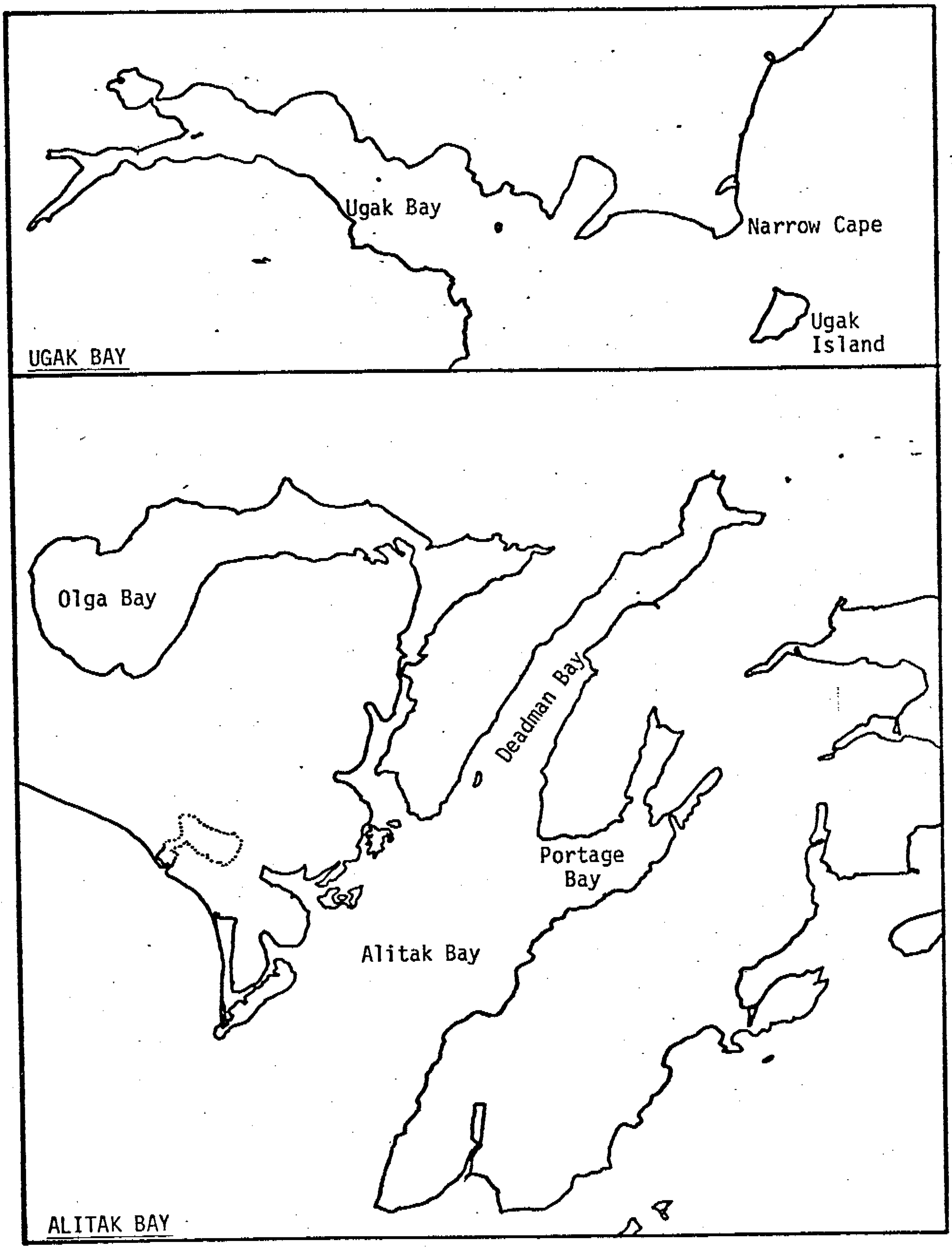


Figure 1. Diagram of the study areas, Ugak and Alitak bays on Kodiak Island.

Table 1. Preliminary tabulation of otter trawl catch in kilograms per 20 minute haul in Ugak and Alitak bays on Kodiak Island, June, July and August 1976.

	Ugak Bay			Alitak Bay		
	June	July	August	June	July	August
Crustaceans	50.7	84.4	78.3	95.6	132.4	69.2
Flounders	55.3	76.5	68.1	34.5	45.1	29.8
Sculpins	51.0	35.2	16.0	13.0	19.5	9.8
Cod	17.1	31.4	0.5	3.9	16.4	4.8
King crab	7.9	41.7	39.1	12.3	39.4	19.9
Tanner crab	35.4	36.9	18.5	71.1	61.0	28.0
Shrimp	7.4	5.4	21.1	12.2	31.7	21.2
Yellowfin sole	26.7	42.8	38.0	18.5	25.8	19.9
Irish Lord[1]	33.0	11.0	2.4	0.4	1.7	0.5
Flathead sole	22.5	17.7	12.9	2.3	4.3	2.9
Great sculpin	11.2	14.8	8.6	12.2	16.8	9.2
Halibut	7.3	3.5	5.0	7.5	9.2	4.0
Pacific cod	16.7	30.5	0.3	T[2]	1.8	0.4
Rock sole	2.6	7.5	2.7	1.6	2.8	0.7
Butter sole	2.5	0.5	1.7	0.1	0.2	T[2]
Starry flounder	0.4	0.2	0.7	2.9	1.2	1.8
Walleye pollock	0.2	0.6	0.1	3.9	14.6	4.0
Total Catch	186.5	252.0	183.1	151.3	219.5	118.5

[1]First identified as brown Irish Lord, now believed to be yellow Irish Lord
[2]Trace, less than 0.1 kilogram per 20 minute haul

University of Alaska (Catch data for September is not yet available for analysis.) Predominant taxa encountered were tanner crab (*Chionoecetes bairdi*), yellowfin sole (*Limanda aspera*), king crab (*Paralithodes camtschatica*), shrimp, great sculpin (*Myoxocephalus polyacanthocephalus*), flathead sole (*Hippoglossoides elassodon*), Pacific cod (*Gadus macrocephalus*) and Irish Lord (presumably yellow Irish Lord, *Hemelepidotus jordani*) (Table 1).

There were considerable differences in the catch between the bays. In Ugak Bay the mean total catch was greater in each month. The mean catch of the following taxa was greater in Ugak Bay each month: yellowfin sole, Irish Lord, flathead sole, rock sole (*Lepidopsetta bilineata*) and butter sole (*Isopsetta isolepis*). The mean catch of the following taxa was greater in Alitak Bay each month: tanner crab, shrimp, great sculpin, starry flounder (*Platichthys stellatus*) and walleye pollock (*Theragra chalcogramma*). Pacific cod catch was markedly greater in Ugak Bay in June and July and shrimp catch was lowest in Ugak Bay in June and July.

The catch of fish within both Ugak and Alitak Bays tended to be greatest near the mouth and decrease further within the bay (Figures 2 and 3). In Ugak Bay three stations between 7 and 9½ miles inside the bay had somewhat greater catches than other stations nearby (Figure 2).

The catch of crustaceans within each bay did not show a trend of abundance along the length of the bay (Figures 4 and 5). However, king crab were virtually never captured in Deadman Bay while they were taken at virtually every other station in Alitak Bay each month.

Total catches were greatest during July in both Ugak and Alitak bays. Mean catch of yellowfin sole and Irish Lord in Ugak Bay decreased each month. However, no other taxon either increased or decreased simply with time. Mean catches of most taxa were greatest in July (Table 1).

Preliminary interpretation of Results

Further interpretation of results is not warranted at this time.

Problems Encountered/Recommended Changes

Recommendations for the data format and coding system were discussed in the quarterly report for RU 19E, Pelagic and Demersal Fish Assessment in the Lower Cook Inlet Estuary System, July 1 - September 30, 1976.

The scientific crew was limited to two personnel by both bunk space and prior agreement with the boat owner. This limitation restricted the amount of information that could be gleaned from the catch. The scientific crew was fully occupied sorting and weighing the catch, thus length frequencies, collection of stomach samples and preservation of specimens was accomplished as time was available. Accommodations for two more scientific crew members would have been well rewarded with data.

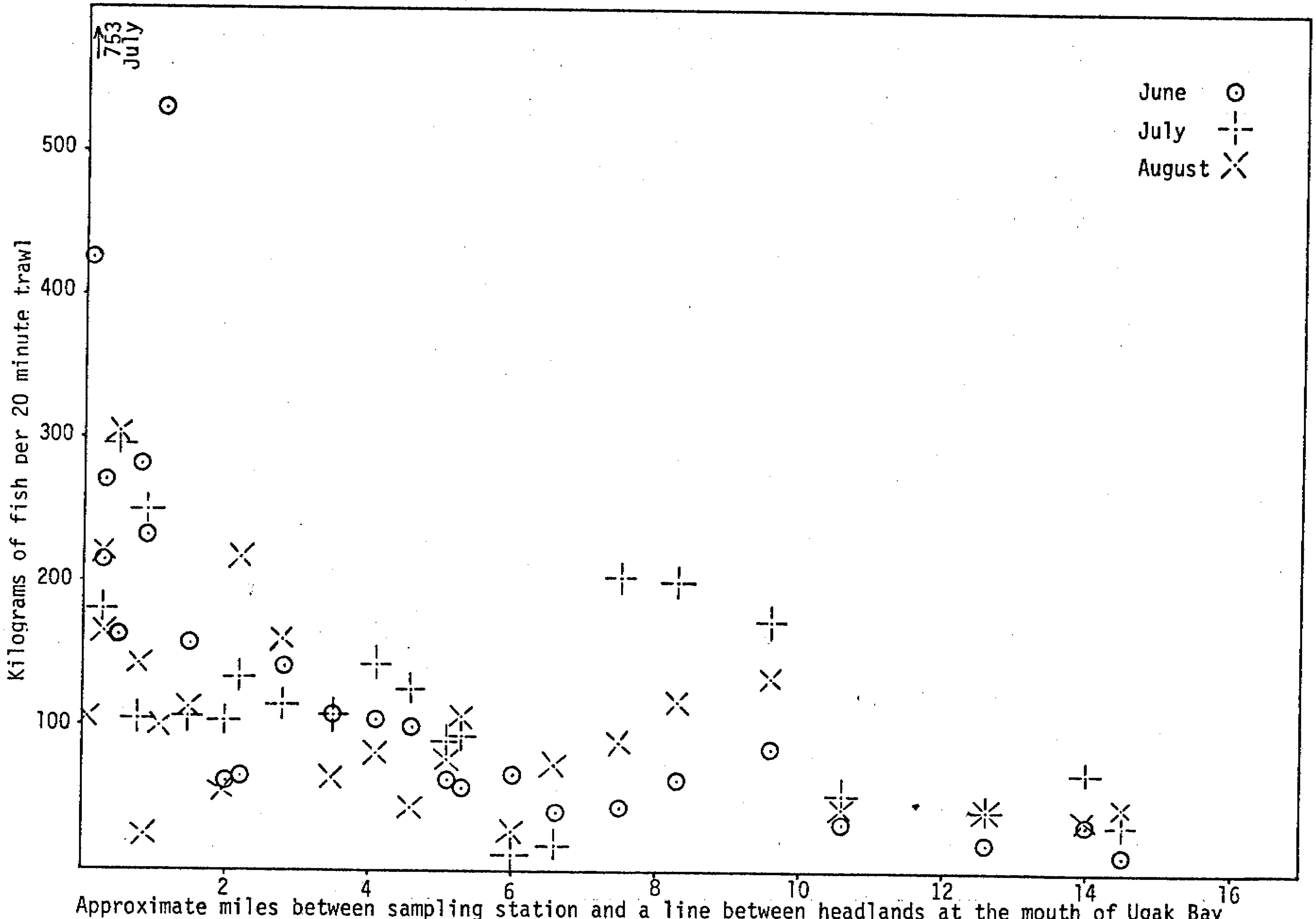


Figure 2. Otter trawl catch of fish in kilograms per 20 minute haul in Ugak Bay by approximate distance in miles between the area sampled and a line between the headlands of the bay.

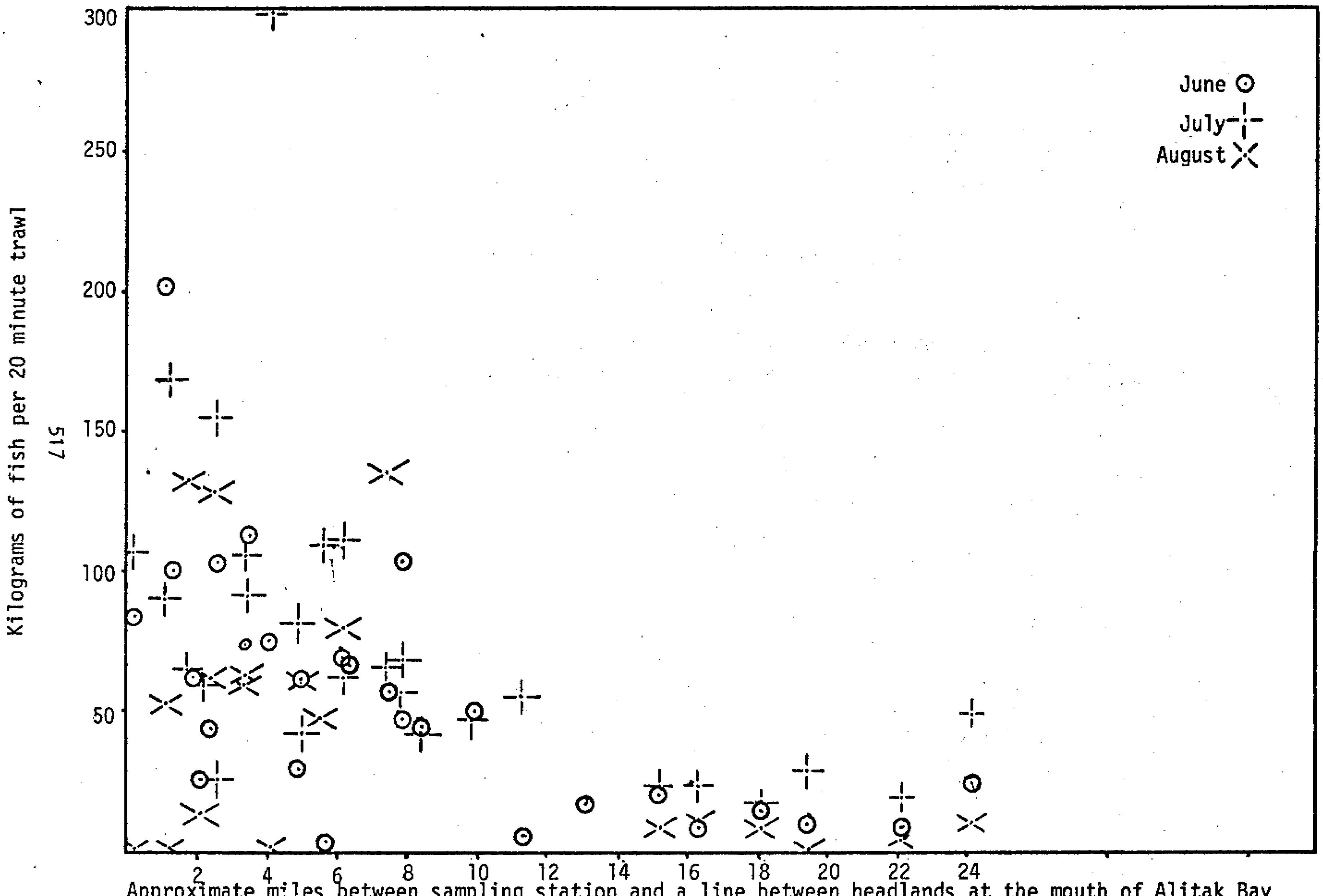


Figure 3. Otter trawl catch of fish in kilograms per 20 minute haul in Alitak Bay by approximate distance in miles between the area sampled and a line between the headlands of the bay.

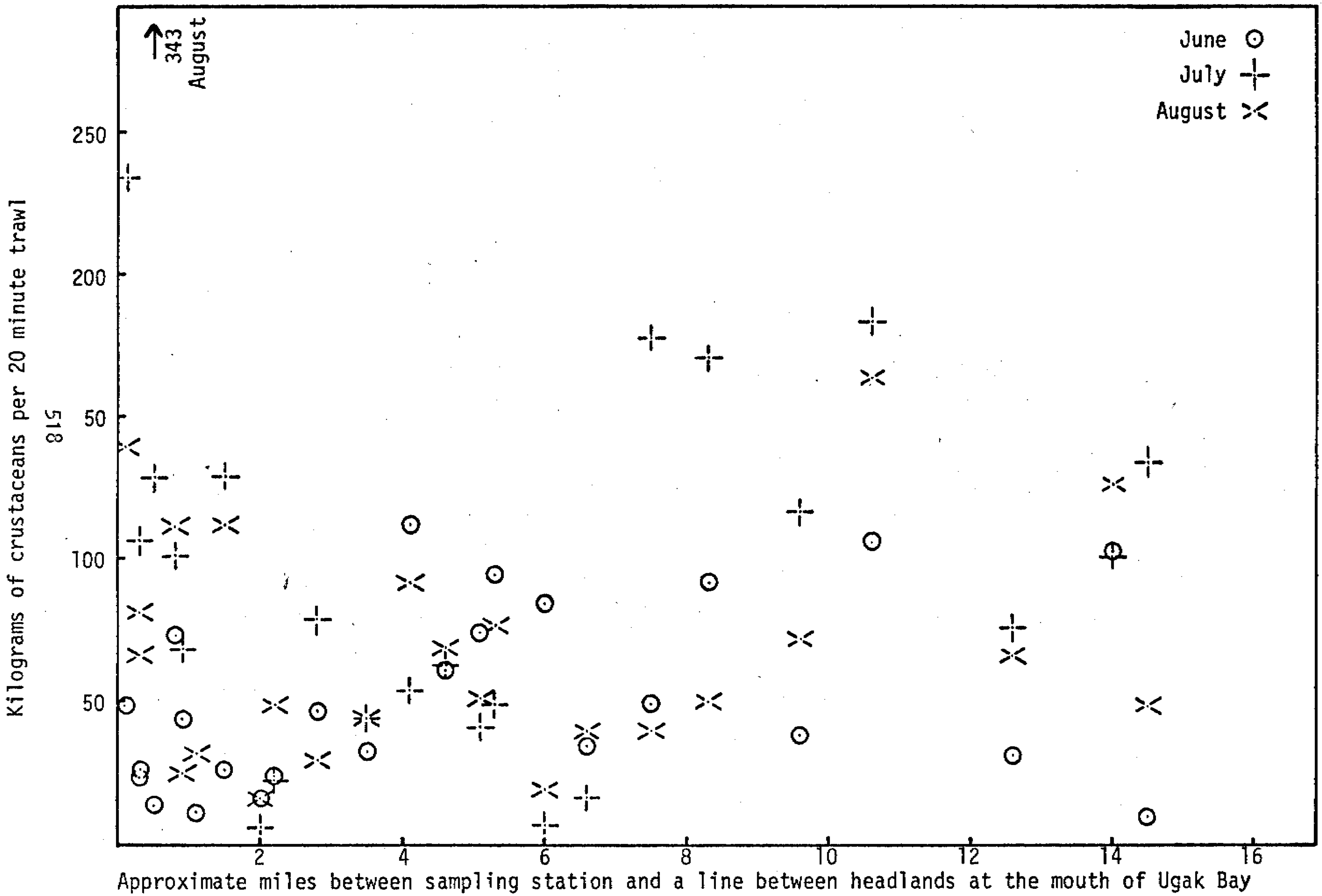


Figure 4. Otter trawl catch of crustaceans in kilograms per 20 minute haul in Ugak Bay by approximate distance in miles between the area sampled and a line between the headlands of the bay.

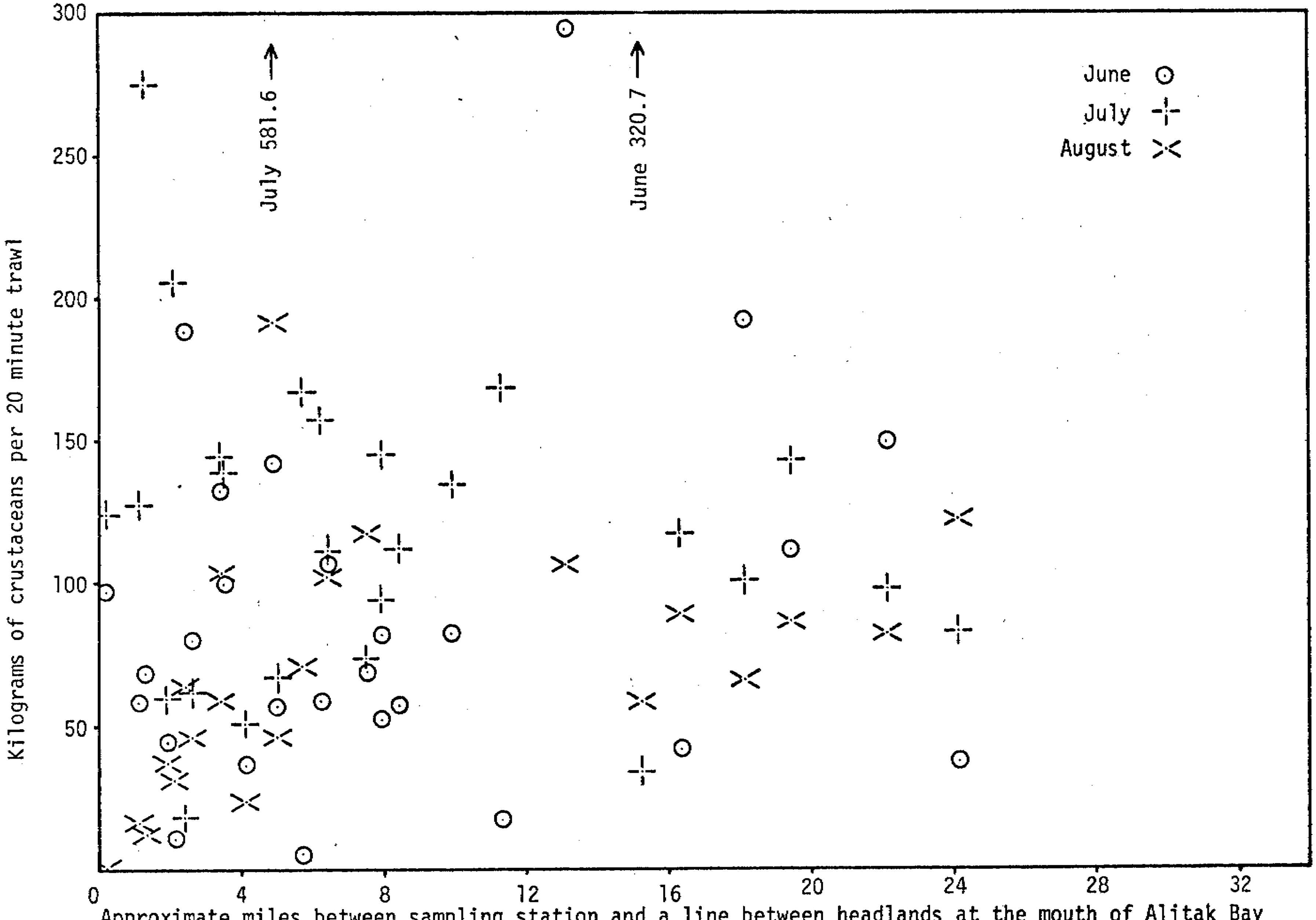


Figure 5. Otter trawl catch of crustaceans in kilograms per 20 minute haul in Alitak Bay by approximate distance in miles between the area sampled and a line between the headlands of the bay.

Preliminary Audit of Expenses to Date

A.	Personnel		9.8[1]
	Permanent	-	
	Temporary	9.8	
B.	Travel and Subsistence		1.3
C.	Contractual Services		35.2
D.	Commodities[2]		3.1
E.	Equipment		3.2
		Total	52.6
		10% Overhead	4.9
		GRAND TOTAL	57.5

[1]Includes benefits
[2]Encludes expendable fishing gear, i.e. trawls and seines

Quarterly Report

Contract #03-5-022-56
Research Unit #502
Reporting Period 7/1 - 9/30/76
Number of Pages 5

TECHNICAL TRAWL SURVEY OF THE BENTHIC EPIFAUNA OF THE CHUKCHI SEA AND NORTON SOUND

O.C.S. Coordination Office
University of Alaska
Fairbanks, Alaska 99701

October 1, 1976

Quarterly Report

I. Task Objectives

To conduct a survey of the benthic epifaunal invertebrates of the Chukchi Sea/Norton Sound areas.

II. Field Activities

A. The first leg of the trawl survey cruise aboard the *Miller Freeman* was completed. A summary of the activities of the invertebrate study party is enclosed.

The second leg of the cruise is under way.

B. Scientific Party

Leg I, *Miller Freeman* cruise

Mr. Steve Jewett, IMS, University of Alaska
Mr. Max Hoberg, IMS, University of Alaska

Leg II, *Miller Freeman* cruise

Mr. Max Hoberg, IMS, University of Alaska
Mr. John Hilsinger, IMS, University of Alaska

C. Methods

Details of the methodology used in invertebrate sampling by otter trawl have been submitted for R.U. #281 by this office.

D. Sample Localities

Exact cruise tracks are determined by Northwest Fisheries Service.

E. Data Collected

See cruise summary, Leg I, enclosed.

III. Results

See cruise summary, Leg I, enclosed

IV. Preliminary Interpretation of Results

None.

V. Problems Encountered

None.

CRUISE REPORT
NOAA SHIP MILLER FREEMAN FRS-21
RP-4-MF-76B Leg I
9/2/76 - 9/24/76
Epibenthic Invertebrates
Norton Sound - Chukchi Sea

Enumeration and gravimetric determination of the epibenthic invertebrates of Chukchi Sea and segments of Norton Sound was made on Leg I of MILLER FREEMAN cruise 76-B. Invertebrate data was obtained from 136 stations.

Although large concentrations of invertebrates were encountered, no economically important species were found in commercial quantities. The asteroids (sea stars) were the most conspicuous members of the invertebrate biomass with nine species encountered and four species dominating i.e. Asterias amurensis, Leptasterias polarias ascervata Evasterias echinosoma and Lethasterias nanimensis.

In addition to the qualitative and quantitative inventory census of benthic invertebrate epifaunal species, preliminary observations of biological interrelationships between selected segments of the benthic biota was made.

No major problems were encountered during the sampling period. A minor problem arose in sampling parasitized invertebrates. Our project instructions call for us to obtain selected biological data on parasitized epibenthic invertebrates. This is also one of the objectives of the scientists in charge of pathology sampling. Both parties were interested in the data as well as the samples. We shared! In the future duplication of effort should be eliminated.

Thirty-three 5-gallon buckets containing invertebrates will be stored in the formalin bin on port side of MILLER FREEMAN. Also three 5-gallon buckets are frozen in the walk-in freezer. All specimens are to remain on board until the end of Leg III, at which time they will be off-loaded in Seward.

Feeding Observations

Frequency of occurence inde
R - Rare (<5 observations)
C - Common (>5 observations

Predator	Prey
Asterias amurensis	Strongylocentrotus droebachiensis (urchin) -
	Echinarachnius parma (sand dollar) - R
Leptasterias polarias ascervata -	Cyclocardia crebricastata (clam) - C
	Boreotrophon pacifica (gastropod) - R
	Astarte borealis (clam) - C
	Chelyosoma orientale (tunicate) - C
	Boltenia echinata (tunicate)- C
	Macoma calcarea (clam) - C
	Natica sp. (gastropod) - C
	Pectinaria sp. (polychaete worm) - C
	Buccinum polare (gastropod) - R
	Nuculana fossa (clam) - R

	Evasterias echinosoma	-	Serripes groenlandicus (clam) - C Clinocardium ciliatum (clam) - C Mya truncata (clam) - R Astarte borealis (clam) - C Musculus niger (clam) - R
	Lethasterias nanimensis	-	Serripes groenlandicus (clam) - C Clinocardium ciliatum (clam) - C Clinocardium californiense (clam) - R
	Solaster endeca	-	Gorgonocephalus caryi (basket star) - R
	Ophiura sarsii	-	Crustacean remains - C
	Gorgonocephalus caryi	-	Crangonid shrimp - (Tube worms) - R
235	Platichthys stellatus	-	Brittle star - C Yoldia hyperborea (clam) - C Polychaeteous annilids - C Gymnocanthus sp. (sculpin) - R Echiurus echiurus (echiurid worm) - C Lumpenus fabricii (prickleback fish) - C Serripes groenlandiceus (clam) - C Clinocardium californiense (clam) - C Musculus niger (clam) - C Yoldia amygdalea (clam) - C Priapulus caudatus (priapulid worm) - C Saduria entomon (isopod) - R Hydrozoan - R Pectinaria sp. (polychaeteous annilid) - R
32	Paralithodes camtschatica	-	Shell fragments
1	Hippoglossus stenolepis 44.5 kg	-	13 Chionoecetes opilio - Average carapace width 55 mm; 8 octopus; 2 Gymnocanthus sp.

Parasitism

Leech egg cases on pleopods and eggs of the shrimp Sclerocrangon boreas.

Parasitic barnacles (Rhizocephala) attached to the abdomen of Pagurid crabs, specifically Pagurus capillatus.

Parasitic gastropods forming galls inside the sea stars Leptasterias polarias ascervata and Leptasterias sp.

Parasitic isopods under the carapace of the shrimp Argis lar.

Reproduction

The sea star Leptasterias sp. with brooding light orange eggs around oral area.

The sea stars Leptasterias polarias ascervata and Evasterias echinosoma brooding young. Young are attached to dead pelecypod or gastropod which are held by their tube feet.

Only five ovigerous Telmessus cheiragonus (crab) were observed. Most females were at the pre-ecdysis stage and orange eggs were present internally only

Most female Hyas coarctatus alutaceus (crab) were gravid with orange eggs.

Few ovigerous crabs of Paralithodes spp. and Chionoecetes spp. were observed. Those observed were very small.

Female crabs of Hyas coarctatus alutaceus and Chionoecetes opilio were preserved for fecundity studies.

Gravid Argis lar were nearly always encountered. Maximum percentage with eggs per station was 73%. Aqua-colored eggs were often observed internally developing.

The amphipod Stegocephalapsis ampulla was carrying light yellow eggs.

The anemone Stomphia coccinea with brooding young internal. Young look like small boiled onions.

Four species of Pagurid crabs were carrying eggs. The maximum percentage of ovigerous females of any one specie per station was never greater than 40%.

The shrimp Crangon dalli, which was mainly found in Norton Sound, had a maximum % ovigerous/station of 41%.

Pollutants

6.6% of invertebrate stations contained pollutants such as a leather boot, tin cans, plastics, bottles, aluminum foil and a dry cell battery.

Miscellaneous data collection

A collection of voucher specimens was obtained for the purpose of providing intercomparisons of taxonomic identifications.

Thirty-two King crabs, Paralithodes camtschatica, stomachs as well as several hundred brittle stars, Ophiura sarsii, were preserved for later examination in trophic relationships.

Several Greenland cockles, Serripes groenlandicus, were frozen for an age-growth study.

Nine-hundred-thirty-three sea urchins, Strongylocentrotus droebachiensis, were measured and weighed for area growth comparisons.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: September 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: R.U. NUMBER: 502

PRINCIPAL INVESTIGATOR: O.C.S. Coordination Office
University of Alaska

Data are currently being collected. At the end of the current cruise, pending successful contractual negotiations, a schedule of submission of data will be sent.

Quarterly Report

Contract #03-5-022-56
Research Unit #~~P29~~ 517
Reporting Period 7/1 - 9/30/76
Number of Pages 3

THE DISTRIBUTION, ABUNDANCE AND DIVERSITY OF THE EPIFAUNAL BENTHIC ORGANISMS IN TWO (ALITAK AND UGAK) BAYS OF KODIAK ISLAND, ALASKA

Dr. Howard M. Feder
Professor of Marine Science
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

October 1, 1976

QUARTERLY REPORT

I. Task Objectives

A. A qualitative inventory census of dominant benthic invertebrate epifaunal species within the study sites (Alitak and Ugak Bays).

B. A description of spatial distribution patterns of selected benthic invertebrate epifaunal species in the designated study sites.

C. Observations of biological interrelationships between segments of the benthic biota in the designated study areas.

II. Field and Laboratory Activities

A. Ship Schedules and Names of Vessels

7/18/76 - 7/28/76; *Big Valley*
8/19/76 - 8/29/76; *Big Valley*

B. Scientific Party

Max K. Hoberg - Legs II and III, Marine Technician, University of Alaska.

C. Methods

Data was obtained in conjunction with the trawling activities of the Alaska Department of Fish and Game during July and August. Stations were occupied with a 400-mesh eastern otter trawl for a distance of one nautical mile for 20 minutes. The invertebrates were separated, enumerated, and weighed according to methodology developed by Feder in his OCS investigations of the Gulf of Alaska and the Bering Sea. All invertebrates were sorted on shipboard, given tentative identifications, counted, weighed, and representative samples of individual species preserved and labeled for final identification at the Institute of Marine Science, University of Alaska in Fairbanks. All species will be assigned Taxon Code numbers after final identification.

Limited biological data (food studies and reproductive notes) were collected. Cluster analyses used with the trawl data from the Gulf of Alaska will be applied where appropriate to data collected. Assessment of the latter computer printouts will be made.

D. Sample Locations

1. Alitak Bay -- from 57° 12.3' lat. 153° 47.5' long. extending southwest to 56° 45' lat. 154° 0.95' long.

2. Ugak Bay -- from 57° 28.4' lat. 152° 55.2' long. extending southeast to 57° 25' lat. 152° 23.2' long.

E. Data Collected or Analyzed

1. Alitak Bay -- Leg II (July) - 28 stations occupied
Leg III (August) - 22 stations occupied.

2. Ugak Bay -- Leg II (July) - 25 stations occupied
Leg III (August) - 25 stations occupied.

III. Results

Invertebrates were identified to the lowest taxon with numbers and weights normally assigned to each taxon. Approximately 95 percent of the invertebrate biomass and species consisted of *Chionoecetes bairdi, Paralithodes camtschatica, Pandalus borealis* and *Pandalus hypsinotus*. Unidentified organisms were preserved for later identification. Some observations of biological interrelationships between segments of the benthic biota were made, i.e., feeding observations on commercial crab and demersal fishes. Also, reproductive conditions of selected crabs and shrimps were noted.

Pollutants were recorded in four stations.

A copy of the field notes was forwarded to the office of the Outer Continental Shelf Environmental Assessment Program at Alaska Department of Fish and Game in Kodiak.

IV. Preliminary Interpretation

During the July and August sampling periods diversity and number of organisms was lower than expected. The snow crab, *Chionoecetes bairdi*, dominated the catch with 100 percent frequency occurrence in the 100 stations. Highest catch of snow crab was 154 kg/km at the mouth of Deadman Bay in approximately 150 meters.

Records from the Alaska Department of Fish and Game (ADF&G) show Alitak Bay to be one of the more productive bays for the king crab, *Paralithodes camtschatica*. Seventy-eight percent (78%) of the Alitak Bay stations contained *P. camtschatica* with only a few legal males (<145 mm carapace length). Fifty-five percent (55%) adult males were found in July and 24 in August as compared to only 9 in June. During the past annual ADF&G king crab indexing study in July, mainly adult females and juveniles of both sexes have been found here. The current study yielded the same results. It is assumed that the legal males that normally are caught during the commercial season in August and September were not found in the sampling area in larger quantities for one or more reasons: (1) they were in shallower water; (2) they were in untrawlable areas; and/or (3) they were outside of the bay.

Ugak Bay, an area not fished as intensively as Alitak Bay, contained more king crab, specially legal males.

The catch of pink shrimp, *Pandalus borealis*, generally increased in both bays as the stations progressed seaward and the reciprical pattern was found for the coon-stripe shrimp, *Pandalus hypsinotus*.

V. Problems Encountered, Recommended Changes

During the August sampling period, seven stations in Alitak Bay were eliminated due to storage of crab gear. There is probably no solution to this kind of problem unless the sampling strategy is planned around the crab season.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: September 30, 1976

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 29

PRINCIPAL INVESTIGATOR: Dr. H. M. Feder

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]			
	From	To	Batch 1	2	3	4
Big Valley 001	6/17/76	6/23/76	2/28/77[a]			
Big Valley 002	7/18/76	7/28/76	2/28/77[a]			
Big Valley 003	8/19/76	8/29/76	2/28/77[a]			

NOTE: [1] Data Management Plan submitted August 16, 1976, we await formal approval.

[a] Data submission is dependent on approval and funding of proposed work statement for FY '77, and reflects the Milestone dates of said proposal.

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