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Exploratory Fishing and
Gear Research Base
Seattle, Washington
June 17, 1960

MASTER

A PRELIMINARY REPORT
ON MARINE INVESTIGATIONS
OF THE CHUKCHI SEA - AUGUST 1959

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INTRODUCTION

As a part of the U. S. Atomic Energy Commission Plowshare Program for developing peaceful uses of nuclear energy, a study (Project Chariot) is being made to determine the feasibility of utilizing nuclear explosives for carrying out large excavation projects, e.g., harbors, canals, etc. To provide a better understanding of the results that could be expected from nuclear explosions used for excavation, it has been proposed that an experimental harbor be created in an area remote from human population centers. A project site for such an experiment was therefore selected at the mouth of Ogotoruk Creek between Cape Thompson and Cape Seppings on the northwest coast of Alaska. If detonation of nuclear devices is actually programmed, the experiment is expected to result in the first full-scale planned excavation resulting from a simultaneous detonation of nuclear explosives.

Five nuclear devices having the explosive energy of 460 kilotons of TNT are planned for use in the experiment. The blast is expected to produce a harbor 550 by 950 yards, having an entrance channel 250 yards wide and 500 yards in length. The average depth of the harbor is expected to be about 30 feet.

A facet of the preblast studies conducted by the U. S. Atomic Energy Commission was an environmental program to determine (1) the biological effect (or cost) of a nuclear explosion, and (2) the optimum time for scheduling a blast so that minimum damage to the plant and animal populations of the region would occur. The Bureau of Commercial Fisheries

and the University of Washington Department of Oceanography were requested by the Commission to participate in the preblast marine ecological investigations of the area. The Bureau's discipline (within the framework of the environmental study) was to undertake an investigation of the distribution and the abundance of marine fauna inhabiting the eastern Chukchi Sea region. Studies were to include explorations of the benthic, demersal, and pelagic invertebrate and fish forms, as well as observations on the bird and the mammal life. A study of physical, chemical, and geological oceanography of the area, along with investigations of the distribution and abundance of phyto-and zoo-plankton, was to be carried out by the University of Washington Oceanography Department.

As the marine phase of the environmental program was similar in many respects to the investigations normally conducted by the Bureau's Branch of Exploratory Fishing, it was felt that the studies would be of mutual benefit to the Bureau and the Atomic Energy Commission.

An ecological study of the region would provide the opportunity to assess the economic potential of marine resources concurrent with a systematic evaluation of distribution and abundance of the marine biota-- a requisite of the Commission. Thus, the Bureau maintained an independent interest in the explorations of the region, and costs of the project were shared by the U. S. Bureau of Commercial Fisheries and the U. S. Atomic Energy Commission.

Field investigations were conducted aboard the Bureau's exploratory fishing vessel John N. Cobb during the period August 5 through August 31, 1959. This report concerns general results of qualitative and quantitative

distribution of marine life observed and information on meteorological and hydrographic observations. Detailed assessment of the biological cost which theoretically could occur following detonation of nuclear devices will be subsequently considered and reported on by scientists of the Atomic Energy Commission.

PREVIOUS HYDROBIOLOGICAL EXPLORATION OF THE AREA

The first expedition of the post-Bering era to penetrate beyond the Bering Straits was the third round-the-world cruise of Captain James Cook. In 1778 in the Resolution and the Discovery, Cook penetrated the Chukchi Sea as far as Icy Cape on the Alaskan shore and westward to North Cape on the Siberian Coast. Both of these landmarks and also Cape Lisburne were named during this voyage. The natural history material obtained by the expedition was described by Pennant (1784-87) in his "Arctic Zoology." However, there is evidence that no fish were obtained in Alaskan Arctic waters as expressed in the following statement (Pennant 1784: CLIX): "Whales abound in this sea. Fish, the food of seals and particularly of polar bears, must be here, notwithstanding they escaped the notice of the navigators."

Most of the voyages undertaken during this period did not reach Arctic waters; but during the summer of 1816, Captain Otto Von Kotzebue (1821-23), in the Russian Navy brig Rurik entered northern waters and explored the Sound which bears his name. The German poet-naturalist Chamisso and the surgeon Eschscholtz made scientific observations during the voyage. In addition to their own reports, the famous Baron Cuvier has described some of the ethnic finds.

In 1819 several vessels under Bellingshausen, Vasileff, Shishmareff, and Lazereff were outfitted for a voyage around the world. By 1820 the Good Intent under Shishmareff reached as far north as Icy Cape. As the reports on this voyage have been unavailable for examination, the extent of their natural history work is unknown to us.

By this time, interest in Arctic exploration, as such, initiated investigations of the North Pacific approach to the polar region and "Northwest Passage." In 1826 Captain F. W. Beechey in H.M.S. Blossom reached Icy Cape. Lay and Collie were naturalists on the Blossom and their natural history report contained a description of a new species of fish from Kotzebue Sound. It was during this expedition that Cape Thompson was first named. Beechey describes it as "a high cape, which I named after Mr. Deas Thomson, one of the commissioners of the Navy." In his text, Beechey (1831) spells the locality as Thomson, but the map shows it as Thompson, and this latter spelling is the one currently accepted. Parenthetically, it may be noted that Cape Thompson, which is also accepted for a locality in the Shumagin Islands, was not named until 1880 by Dall.

Although there were other voyages to the lower Chukchi Sea region during the 1830's, as far as can be ascertained none of them added to the biological knowledge of the area. The Russian American Company provided facilities for Elia Vossnessensky of the Russian Academy of Sciences to collect in Alaskan waters. He reached Kotzebue Sound in 1842. The results of his collections were included in reports of Brandt, Grube, and Middendorf (see Middendorf, 1874-75).

During the summer of 1848, the first whaler (under the command of Captain Royce in the bark Superior) passed through Bering Straits.

His success was such that in the next 3 years over 250 whalers followed. Considerable invertebrate material (particularly shells) was obtained by this group of pioneers, and their collections formed the basis of some of Dall's reports on the mollusks of the area.

In 1850 McClure (1856) on the Investigator passed through Bering Straits in search for the missing explorer Franklin. As opportunity permitted, the surgeon, Alexander Armstrong, who was a trained naturalist, obtained collections by means of a dredge. These were briefly described in his narrative (Armstrong, 1857). Unfortunately, the entire biological collection was left on board the Investigator when she was abandoned at Mercy Bay, Banks Island.

W. H. Dall reports that in 1865 M. Gustave Lambert, a French hydrographer, passed through Bering Straits on a whaler, but we have been unable to find any other reference to Lambert's voyage.

In 1879 the circumnavigation of Asia by the Vega was completed. Nordenskiöld's (1882-87) narrative contains a considerable amount of material on the marine fauna and several collections were made in the Chukchi Sea. The Vega fish material was reported upon in Smitt's (1893-95) "Scandinavian fishes" and much later reworked by Rendahl (1931). The invertebrate collections were studied by Stuxberg (1880, 1882) whose report on the "Invertebrates of the Siberian Shelf" is still a fundamental contribution to our knowledge of the area.

In 1880 under a broad program of the 10th Census, Tarleton H. Bean, as a representative of the Smithsonian Institution, investigated the fishery resources of Alaskan waters. Bean traveled with Dall on the steamer

Yukon as far north as Point Belcher. His collecting point nearest Cape Thompson was at Cape Lisburne. Bean's (1887) results appeared as a section of the monumental "Fisheries Industries of the U. S." In addition, more academic data were presented in the "Proceedings of the U. S. National Museum." (1882)

Ivan Petroff (1884) in conducting the enumeration of the 10th Census also traveled north of Bering Straits, but unfortunately his information on the biota is less accurate than that presented for the Yukon area. In part, perhaps, the antagonism of the natives was to blame.

Although several later expeditions passed through the area, the next work appropriate to our review was that of Cantwell and McLenengan on the Kobuk River and Kotzebue Sound. The results of this exploration are contained in Captain Healy's 1884 Corwin report (1889). In 1885 the Corwin again carried on explorations in the north, and some biological material was obtained from the Noatak River (Healy, 1887).

It was not until 1924 that investigators again stopped in the Cape Thompson area. R. A. Bartlett went as far as Kotzebue Sound officially to locate sites for air fields but he did carry on some collecting. His specimens are in the American Museum of Natural History. Both in 1932 and 1933 the Pacific Scientific Institute of Ichthyology (TINRO) of the Soviet Union sponsored extensive voyages in the Bering and Chukchi Seas. The trawlers Dalnevostotchnik and Krasnoarmeietz both occupied stations in the vicinity of Point Hope and Cape Thompson (Kireev, 1936).

World War II interrupted other work in the area and it was not until 1947 that additional collections were made in the region. Investigation by the U.S.S. Mereus and U.S.S. Burton Island obtained several fish and invertebrates in the lower Chukchi Sea. Of the aforementioned investigations, only the 1932-33 Russian work was on a magnitude corresponding to the Chariot studies.

AREA OF INVESTIGATION

The Chukchi Sea, which lies north of Bering Strait, is bordered on the west by Siberia and on the east by northwestern Alaska. To the north, it is delineated by the Arctic ice pack. It is generally considered to extend eastward along the Alaskan coast to Point Barrow. The greater part of the sea lies north of the Arctic Circle.

Marine explorations (figure 1) in the region were conducted from Bering Strait ($65^{\circ}20'N.$) to north of Cape Lisburne ($69^{\circ}17.2'N.$) and from Kotzebue Sound ($163^{\circ}48'W.$) west to the United States-Soviet convention line of 1867. The region investigated comprises an area in excess of 22,000 square miles. The topography features of the northwestern Alaskan coast are described in the United States Coast Pilot. "From Cape Krusenstern to Cape Seppings the coast is a low, single beach, back of which is a series of lagoons which discharge through small shallow openings. The highlands of Cape Krusenstern extend along the coast from a distance inland terminating in the Mulgrove Hills about 30 miles northward. After passing Mulgrove Hills the land is an extensive plain until the vicinity of Cape Seppings. . . . Cape Seppings and Cape Thompson are not distinct, and it is difficult to determine the points to which the names should be applied. . . . In the vicinity of Cape Thompson, for a distance of 6 miles, the mountains break off directly to the water in a series of abrupt cliffs about 500 feet high. The coast is generally straight without distinct promontories. From Cape Thompson the mountains continue northward to Cape Lisburne, while the coast curves northwestward and westward to Point Hope."

FIG. 1 - TRACK LINE - M. V. JOHN N. COBB - CHUKCHI SEA EXPLORATIONS - 1959

At Cape Lisburne the coast turns to the east. The bottom topography of the investigated area is monotonously flat and few abrupt irregularities occur in slope gradients. The bottom composition close inshore consists of small rock and gravel which changes to mud and sand and eventually to grey mud and sand in the deeper offshore regions.

Tides in the region are small, averaging less than one foot, and the general current flow, about one knot, moves to the north toward the Arctic Basin. Surface seawater temperatures during the summer months may exceed 50°Fahrenheit.

During the late fall, winter, and spring the region is covered by ice. Ice breakup generally occurs during late June and July, and during the latter part of August and September the ice has receded to its northern limit. Re-formation of ice generally commences during the latter part of September, and vessels are warned to be clear of Kotzebue Sound by September 15.

During the month of August much of the seas are covered by heavy fog. The shallow seas build up quickly with heavy winds; however, they abate quickly. There are few radio navigational aids in the region. The lack of modern navigational aids, coupled with the continued fog and poorly defined coastal promontories, made precise navigation fixes in the region difficult.

SAMPLING GEAR

Explorations were conducted aboard the 93-foot Bureau of Commercial Fisheries research vessel John N. Cobb. (A full description of the vessel is given in Fisheries Leaflet 385 (Ellson 1952)).

Echo-sounding devices aboard the vessel included: (1) A model D.R. 6A, CN00 7 Bendix dry paper recorder; (2 ranges: 0-400 feet, and 0-400 fathoms); (2) a model 1B Minneapolis-Honeywell sea scanner^{2/} (7 ranges 0-400 feet through 0-1600 feet); and (3) a model 510-5 SIMRAD special wet or dry paper recorder (16 ranges: 0-70 through 0-1100 fathoms).

Benthic and demersal ichthyo and invertebrate fauna were investigated using a toothed biological dredge, otter trawl, and shrimp traps, while the pelagic marine fauna was sampled with a Canadian-type midwater trawl, gillnets, and a beach seine. Field determination of radio activity in substrate and animal tissues was made using a gamma spectrometer (a field 2-inch well-type scintillation crystal with scaling unit).

Otter Trawl

The otter trawl used was a standard 4½-inch stretch mesh eastern 400-mesh net similar to that operated in commercial fishing operations. Details of the net as given by Greenwood (1958) are shown in table 1. To insure retention of smaller animal forms a small mesh (1½" stretch measure) liner which was 100 meshes in circumference and 200 meshes in length was inserted into the cod-end portion of the trawl.

^{2/} This instrument used for vertical or horizontal scanning is equipped with a stabilized extendable transducer and both cathode-ray tube and recorder presentation.

Table 1.--Details of standard 400-mesh eastern-type otter trawl used to sample bottom fauna

<u>A</u>	
Wings, square, belly ----	48 thread, $4\frac{1}{2}$ " mesh cotton webbing
Intermediate -----	72 thread, $3\frac{1}{2}$ " mesh cotton webbing
Cod end -----	96 thread, $3\frac{1}{2}$ " mesh cotton webbing
<u>B</u>	
Wings, square, belly ----	60 thread, $4\frac{1}{2}$ " mesh cotton webbing
Intermediate -----	84 thread, $3\frac{1}{2}$ " mesh cotton webbing
Cod end -----	120 thread, $3\frac{1}{2}$ " mesh cotton webbing
Headrope -----	71 feet plus eyes, of $\frac{3}{8}$ " 6x19 galv. wire rope wrapped with 6-thread manila line.
Footrope -----	94 feet plus eyes, of $\frac{1}{2}$ " 6x24 galv. wire rope wrapped with 27-thread manila line.
Breast lines -----	7 feet including eyes, of $\frac{3}{8}$ " galv. wire rope wrapped with 6-thread manila line.
Rib lines -----	8 each, of 27-thread manila line, one along each seam and one along top and bottom center, and one from the corners at each bosom on top and bottom running diagonally to join side rib lines.
<u>Hanging of Both Nets</u>	
Headrope -----	Wings hung 4 bars to $7\frac{1}{2}$ " hangings. Bosom hung 4 meshes to $5\frac{1}{2}$ " hangings.
Footrope -----	Lower bosom: 4 meshes hung to $9\frac{1}{2}$ " on 21-thread manila hanging line. $9\frac{1}{2}$ " of the hanging line hung to 7" on footrope. Lower wing: 4 bars hung to $10\frac{1}{2}$ " on 21-thread hanging line. $10\frac{1}{2}$ " of hanging line hung to $7\frac{1}{2}$ " on the footrope.

Midwater Trawl

A midwater trawl similar in design and construction to the Canadian midwater herring trawl (see bulletin no. 104, Fisheries Research Board of Canada, 1956) was used to sample marine life. The all-nylon trawl had an approximate 70-foot-square^{3/} opening with mesh sizes ranging from 5 inches (stretched measure) in the wings to $1\frac{1}{2}$ inches in the cod end.

^{3/} Does not indicate fishing attitude. Effective fishing is normally less than 30 feet square.

Thirteen spherical aluminum trawl floats on the headrope and 3-ounce leads spaced 6 inches apart on the footrope provided the vertical opening. Special "V"-type aluminum trawl doors or "otter boards" measuring 3 by 6 feet were attached to the net with 20-fathom bridles to achieve horizontal spread.

While fishing, the depth of the net was determined using an electrical depth telemeter which uses a special trawl cable containing electrical conductors (McNeely 1958).

Biological Dredge

The biological dredge used during the exploration measured 2 by 4 feet at the mouth (figure 2), and was equipped with a series of teeth designed to dig into the sea floor. Sections of black iron steel pipe $1\frac{1}{2}$ inches in diameter were welded together to form the 2-by 4-foot net frame of the dredge, and a bridle was formed by welding 4-foot sections of the pipe from each corner of the frame to a flat steel junction plate centered ahead of the mouth opening. A 3-inch diameter ring was welded to the junction plate to allow shackling of the towing wire. To the lower cross-member of the mouth frame, 26 teeth 6 inches in length and three-fourths of an inch in diameter were welded. The teeth, made of mild steel, were attached at a rake angle of 35° (from the horizontal) and the tips given a clearance of 5° . The dredge bag or net was made from 120 thread $1\frac{1}{2}$ -inch stretch-measure nylon webbing. The bag (hung in 50 percent from the mouth frame) was 4 feet in length and the lower end equipped with a purse-puckering string which allowed release or spilling of the contents of the net.

Figure 2.--Biological Dredge

Figure 3.--Box-type Shrimp Trap

Gillnets

Six gillnets were used to sample the pelagic fishes. The nets, 50 fathoms in length, were made of nylon webbing hung in 50 percent on a 1/2-inch manila cork line and 47.5 percent on the 1/2-inch manila lead lines. Three mesh sizes were used: 6 inches, 4 inches, and 1½ inches (stretch measure between knots). The nets having 6-inch webbing were hung 75 meshes deep, and those of 4-inch webbing and 1½-inch webbing 112 and 300 meshes deep, respectively. Breast lines for all nets were made from 54-thread soft lay cotton twine, and the hangings used for the webbing were 40-thread soft lay for the cork line and 32-thread soft lay on the lead line.

Shrimp Traps

Box-type (measuring 2 feet along each side) shrimp traps with four entrance tunnels were used during explorations (figure 3). The top frame of each trap was 1/2-inch-diameter galvanized iron, and the bottom frame was 5/8-inch-diameter galvanized iron. Four 1/2-inch-diameter galvanized iron rods, welded at each end to the corners of the top and bottom frames, formed the sides. The lid frame, constructed of 3/8-inch-diameter galvanized iron, was attached to the top of a side frame by 14-gauge wire wound around both frames to form a hinge. The lid, when closed, was secured to the opposite side of the top frame with twine. Tunnel entrances were made using 3-inch galvanized iron rings located in the center of each vertical side and tunnel indentations formed by cross-tying the opposing rings with seine twine. Frames and tunnels were covered with 18-thread 1½-inch stretch-mesh cotton netting.

Screening Box

A screening box (figure 4) with a series of 3 trays having progressively smaller mesh sizes from top to bottom was used to sort catches into size groups. The 3 wire-mesh trays were constructed by welding 2-by 2-by 1/4-inch angle iron to form rectangular frames. The wire mesh was inserted into the frames and welded into position. The lower frame measured 24 by 36 inches while the middle and upper frames were 22½ by 34½ inches. Screen mesh sizes were 3 inches, 1 inch and 1/4 inch running from the top to bottom, respectively. Both the screens and frames were galvanized to prevent rusting. Legs or corner posts 24 inches in length were made by 2-by 2-by 1/4-inch angle iron. The bottom frame was bolted to the corner post so that the lower sorting tray would be supported by 18-inch legs. Pieces of 1-by 3/16-inch angle iron 28 inches in length were then secured between the lower screen frame and the legs so that the sorting table would be rigid. Permanent 3/4-inch plywood ends 22½ by 28 inches were bolted to the upper corner posts enclosing the area from the lower screen to the top of the corner posts. Wooden screen supports which provided 10-inch vertical separation between the sorting frames were nailed to the plywood ends. The smaller size of the upper screen frames allowed 3/4-inch plywood side sections to be dropped into place, completing the box. Thus, both the upper 2 screens and both sides of the sorting box could be removed so that the sorted animals were easily accessible.

Figure 4.--Screening Box

Beach Seine

A 92-fathom beach seine was used to sample fish populations near shore. It was of all-nylon construction and composed of four sections: a bag, a wedge, a short wing, and a long wing. The bag was of 3-inch stretched mesh, 250 meshes long by 100 meshes deep, and hung to 9 fathoms of corkline (hung in 15 percent). A wedge of 3-inch nylon, 50 meshes deep, was sewed to the bottom of the bag and tapered to each wing using a 2-mesh, 1-bar taper. The wings were both of 4-inch stretch-mesh nylon. The short wing was 145 meshes hung in 15 percent to 7 fathoms of corkline, and the long wing was 1610 meshes hung in 15 percent to 76 fathoms of corkline.

Flotation was accomplished using 485 seine corks (4 by 1½ inches), spaced 7 per fathom on the bag, 6 per fathom on the short wing, and

5 per fathom on the long wing. The net was weighted with 4-ounce seine leads spaced 4 per fathom on the wings and 6 per fathom on the untapered section of the wedge.

METHODS

A three-phase ecological investigation of the area was planned to provide maximum information on the abundance and the distribution of the marine fauna. Phase I of the program entailed a gross survey of the demersal and benthic forms of the region. Stations were made on a predetermined grid at intervals of about 20 miles, and stations were monitored at distances of approximately 80 miles to sea and 80 miles north and south of the Chariot site. During this phase of the study the biological dredge and otter trawl were fished and in a few instances shrimp traps and gillnets set.

Phase II of the study involved a more detailed sampling of the area adjacent to the blast site. Stations were interspaced between Phase I locations so that the monitored positions were not more than 10 miles apart. This work was carried out at distances approximately 40 miles offshore and 40 miles north and south of the Chariot site.

Phase III involved a study of the pelagic fauna of the region. Gillnets, midwater trawls, and beach seines were used to sample animal populations. In addition, a continuous search was made with recording sonic equipment to provide records of the indication and the distribution of schooling fish or invertebrates in the region. At each station occupied, the position was determined using celestial bearings, radio bearings, or radar fixes. At times weather conditions and radio reception precluded use of these navigational techniques and required positioning

by dead reckoning. After ascertaining the ship's position, basic meteorological and hydrographic data were recorded.

The otter trawl and midwater trawl were normally fished for a period of 30 minutes (after the gear was completely set). Both of these nets were hauled and set over the stern of the vessel.

The shrimp traps and the gillnets were normally set during the evening just before dark and picked up in the early morning. The shrimp traps rigged from one continuous ground line were set in a string with a canvas float marker designating the first and last traps.

The gillnets were also set over the stern of the vessel similar to the trawls. A buoy, radar reflector, and anchor were first attached to the end of the first shackle of gillnet. This was then thrown overboard, and the net paid out as the vessel moved ahead in a straight line. When the end of the gillnet set was reached, another float and anchor was attached and the gear turned loose. When hauling the gillnets the gear was approached upwind. The convenient float and anchor were then brought aboard and the net hauled over a roller on the bow of the vessel. The fish were removed from the net as it was hauled and then taken aft and readied for another fishing trial.

The beach seine was fished from the small 16-foot inboard boat carried aboard the Cobb. The net was stacked into the stern of the inboard and taken ashore to be fished. One end of the net was hauled ashore by several men and the net then played out in a semi-circle and brought back to the beach. Both ends of the net were then hauled until the center of the seine was brought ashore. Approximately 30 minutes were needed to set and haul the seine.

A continuous record of the bottom bathymetry was obtained using the Bendix sonic recorder, and searches for subsurface fish schools were maintained using the SIMRAD "white line" recorder and the Minneapolis-Honeywell Sea Scanar. Meteorological and oceanographic data recorded for each station included wind direction and speed, air temperature, barometric pressure, surface water temperatures, and bottom temperatures. A bathythermograph cast and mud grab were taken at stations where the biological dredge or the otter trawl were fished. The bathythermograph slide and mud samples obtained were subsequently turned over to the University of Washington Department of Oceanography, and will be analyzed with data collected by the oceanographic vessel Brown Bear.

Field identification of specimens was made following each fishing effort, and the number and the sizes of animals taken recorded. In many instances when invertebrate catches were large, estimates of the quantity taken were made. All fish catches were counted for numbers of each species, and length frequency data were recorded for more abundant forms. Otoliths and scales were also taken from several varieties of fish so that growth patterns could be studied. Specimens of both invertebrates and fish taken from each station were preserved in either alcohol or 4 percent formaldehyde for subsequent laboratory study. Smaller animals were placed in 1-pound enameled cans and sealed aboard ship. A station identification number was placed inside the can and similar data written on the outside with instant-drying waterproof ink. Larger fish and invertebrates were placed in 5-gallon wooden kegs or 50-gallon steel drums. Colored and black and white photographs (figure 5) were made from many of the specimens collected.

Figure 5.--Photography of collected specimen

RESULTS

During the survey the John N. Cobb cruised approximately 2,500 miles making a series of transects throughout the Chukchi Sea. A total of 74 stations was monitored during the period August 6 - August 30, 1959 (figure 6). The otter trawl was set at 59 stations and the biological dredge, at 34. The midwater trawl, gillnets, and traps were fished at 12, 4, and 4 stations respectively. In addition to offshore survey work conducted from aboard the Cobb, several beach seine sets were made in the Point Hope area. Trawl and dredge sets were made at depths ranging from 7.3 to 34 fathoms.

The general bathymetry as determined from echo recordings made with the Bendix recorder are shown in figure 7. Although no abrupt topographic

FIG. 6 - STATION PATTERN AND GEAR USED FOR SAMPLING - CHUKCHI SEA - 1959

FIG. 8 - BATHYMETRY CHART OF CHUKCHI SEA

changes were noted, there was a definite indication of a depression or valley offshore between Kivalina and the Chariot site. An indication of a protrusion or finger to this depression appeared west of Point Hope. The ice bath moving offshore at about 57°50' north indicated a somewhat steeper slope gradient along the north side of the depression.

Fish Fauna

During the Chariot Operation (1959), over 7,000 fish were captured in the marine and fresh-water environment. Of these, 2,500 were returned to the Laboratory for detailed examination.

Identification of the fishes collected in the Chariot Area has been substantially completed. One or two genera require additional systematic judgment, and the proper nomenclatorial designation for one or two others must be determined on the basis of priority. The fishes of the area comprise 52 species as shown by the following list:

Table 2.--List of marine and freshwater^{4/} fishes taken during
Chukchi Sea investigation

Marine Fishes

<i>Clupea harengus pallasii</i>	<i>Myoxocephalus axillaris</i>
<i>Oncorhynchus gorboscha</i>	<i>Myoxocephalus jaok</i>
<i>Oncorhynchus keta</i>	<i>Myoxocephalus stelleri</i>
<i>Salvelinus alpinus</i>	<i>Myoxocephalus quadricornis</i>
<i>Salvelinus malma</i>	<i>Microcottus sellaris</i>
<i>Osmerus dentex</i>	<i>Gymnocanthus tricuspidalis orientalis</i>
<i>Mallotus villosus</i>	<i>Enophrys lucasi</i>
<i>Eleginus gracilis</i>	<i>Nautichthys pribilovius</i>
<i>Boreogadus saida</i>	<i>Aspidophoroides olriki</i>
<i>Atheresthes stomias</i>	<i>Podothecus acipenserinus</i>
<i>Hippoglossoides robustus</i>	<i>Liparis herschelini</i>
<i>Limanda aspera</i>	<i>Liparis sp.</i>
<i>Pleuronectes quadrituberculatus</i>	<i>Ammodytes hexapterus</i>
<i>Liopsetta glacialis</i>	<i>Stichaeus punctatus</i>
<i>Platichthys stellatus</i>	<i>Eumesogrammus praecisus</i>
<i>Hexagrammos sp.</i>	<i>Lumpenus fabricii</i>
<i>Hemilepidotus sp.</i>	<i>Lumpenus medius</i>
<i>Icelus s. spatula</i>	<i>Lycodes palearcticus arcticus</i>
<i>Triglops pingeli</i>	<i>Lycodes raridens</i>
<i>Arctodiellus scaber beringianus</i>	<i>Lycodes sp.</i>
<i>Megalocottus platycephalus</i>	<i>Gymnelis viridis</i>
<i>Myoxocephalus scorpius</i>	

Freshwater Fishes

<i>Salvelinus malma</i>	<i>Thymallus arcticus signifer</i>
<i>Salvelinus alpinus</i>	<i>Cottus cognatus</i>
<i>Coregonus autumnalis</i>	<i>Gasterosteus aculeatus</i>
<i>Coregonus sardinella</i>	<i>Pungitius pungitius</i>
<i>Coregonus lavaretus pidschian</i>	

The majority of the forms are benthic or demersal types. The pelagic element of the biota is limited to about eight species, some of which (as polar cod and capelin) are important items of food for birds and other predacious animals.

^{4/}Freshwater fishes were collected by Dr. Norman Wilimovsky in lagoons and streams of the area.

The shallow depth of the portions of the Chukchi Sea studied by us does not permit a detailed analysis of bathymetric distribution of the fish; the species are all sublittoral or littoral inhabitants. Apparently the distribution of various species is more directly related to temperature and salinity. Some very definite preferences have been noted; for example, the saffron cod (Eleginus gracilis) is found only in the warmer waters of the area and is replaced in the cold water by the polar cod (Boreogadus saida). Salinity is a limiting factor in the distribution of other species; for example, the starry flounder (Platichthys stellatus) apparently is found more commonly in low salinity water, being replaced by a host of other forms in high salinity water. The same general relationship exists for the four-horned sculpin (Myoxocephalus quadricornis).

The species list, as might be expected, is dominated by far northern types. However, the Chariot collection is unique in that it contains at least a dozen forms which heretofore have not been known to occur north of Bering Straits. As parts of the Chukchi Sea were studied by Russian expeditions in 1932 and 1933, the presence of these forms may represent either a general warming of the area or a temporal extension of the range of Bering Sea fishes, owing to local oceanographic phenomena.

The field data give some order of abundance of the different species. Numerically, the 10 dominant marine forms within the area of our exploration of the Chukchi Sea are:

Boreogadus saida
Clupea harengus pallasii
Gymnocanthus tricuspis
Artediellus scaber
Mallotus villosus

Hippoglossoides robustus
Osmerus dentex
Myoxocephalus scorpius
Triglops pingeli
Eleginus gracilis

By frequency of occurrence within the station pattern, the 10 dominant marine forms are:

Boreogadus saida	Podothecus acipenserinus
Gymnocanthus tricuspis	Lumpenus fabricii
Hippoglossoides robustus	Artediellus scaber
Myoxocephalus scorpius	Osmerus dentex
Triglops pingeli	Lycodes sp.

No definite pattern of abundance is indicated within the marine area studied. However, several of the species show distinctive trends of association. These ecological relationships are being analyzed objectively through the use of mathematical tests of association.

Commercial Potential

Fishes encountered during marine explorations of the eastern Chukchi Sea commonly harvested in world fisheries included species of salmon (and char), flatfishes, herring, and smelt.

Demersal Fishes

Six species of Pleuronectes (Atheresthes stomias, Hippoglossoides robustus, Limanda aspera, Pleuronectes quadrituberculatus, Liopsetta glacialis, and Platichthys stellatus) were identified from the Chukchi Sea catches. The aggregate of all flounders taken during the survey was 283 individuals. The small catches indicated a low population density as compared with other areas in which commercial fisheries operate for flatfish.

Three of the flatfishes encountered (Limanda, Hippoglossoides, and Pleuronectes) are extensively fished by the Japanese and the Russian trawl fisheries operating in the eastern Bering Sea. A striking characteristic of the flatfishes taken in the Chukchi Sea was their relatively small size. Only one specimen (Platichthys stellatus) exceeded 30 cm. in length.

The length frequency distributions for the major common species encountered during the survey are shown in table 3, and numbers of individuals per station are tabulated in table 4. The average size of the two major species encountered, Hippoglossoides and Limanda, was less than 20 cm., and the maximum sizes of any individuals for these species was 21 cm. and 19 cm., respectively. The samples of both species contained a large percentage of mature adults.^{5/}

Both the average and maximum sizes of flatfish taken were below those accepted by U. S. fisheries markets. The average size of Limanda aspera taken by the John N. Cobb in the eastern Bering Sea during its northward journey was 32.5 cm. These fish were taken in the general area of the large Russian trawl fishery operating in the area. Ellson, et al. (1949) reported that commercial-size Hippoglossoides taken in the eastern Bering Sea ranged from 37 to 48.5 cm. with the average noted in several areas being in excess of 40 cm.

The extreme low density of individuals encountered in the Chukchi Sea and the small maximum sizes attained suggests the physical climate of this Arctic Ocean area is limiting the population size of flatfish to a low level and and depressing normal growth patterns.

^{5/} The ovaries of many females were distended. Preliminary age readings made from otoliths of Hippoglossoides revealed between 5 and 12 annuli.

Table 3.--Size distribution (cm,) of common species of fish taken in Chukchi Sea

Species	Length in centimeters																														Mean (cm.)	Range (cm.)	N
	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30									
<u>Boreogadus</u> <u>saida</u>			5	18	36	17	10	7	33	42	58	52	35	17	6	3	1	1					1		1				15.9	9-30	344		
<u>Hippoglossoides</u> <u>elassodon</u>								1	4	7	3	7	26	26	19	5	7	4	1	1									19.9	14-26	111		
<u>Limanda aspera</u>	1	1	1	2		2		1	6	1	1		2																13.5	7-19	18		
<u>Clupea</u> <u>harengus</u> <u>pallasi</u>												1	7	21	39	53	30	42	18	6		1							22.4	18-26	217		
<u>Osmerus dentex</u>				1	1	1	16	9	2		1																		13.4	10-17	31		

Table 4.--Number of designated species*taken per ocean station

Species	Station and number taken	
<u>Hippoglossoides robustus</u>	12(7), 13(3), 14(2), 16(5), 17(3), 18(1), 20(11), 21(8), 23(6), 27(8), 28(12), 29(29), 30(4), 31(11), 32(12), 33(1), 34(30), 35(9), 36(1), 41(4), 42(1), 44(4), 45(2), 46(1), 47(15), 48(11), 49(24), 50(10), 51(3), 52(1), 56(5), 57(4), 58(1), 61(1), 73(1), 74(1)	Total catch <u>252</u>
<u>Limanda aspera</u>	2(3), 9(1), 11(1), 22(1), 26(18), 58(3), 59(3), 60(1)	Total catch <u>31</u>
<u>Clupea harengus pallasi</u>	3(4), 7(1), 10(2), 14(1), 26(1), 33(1000)**, 39(7), 41(4), 42(14), 52(1), 54(30), 57(1)	Total catch <u>1062</u>
<u>Osmerus dentex</u>	2(10), 6(7), 10(5), 12(2), 17(1), 18(3), 19(2), 26(2), 31(1), 39(1), 42(2), 73(2)	Total catch <u>38</u>
<u>Mallotus villosus</u>	8(64), 13(2), 14(2), 21(5), 26(1), 27(62), 28(3), 33(3), 43(1), 47(1), 48(1), 57(3), 61(150), 70(113), 73(1)	Total catch <u>412</u>
<u>Boreogadus saida</u>	2(6), 14(2), 15(10), 16(1), 19(8), 20(8), 21(8), 22(13), 23(27), 25(15), 26(258), 27(80), 28(104), 29(95), 30(198), 31(131), 32(63), 33(38), 34(135), 35(21), 36(267), 37(21), 39(4), 40(1), 41(26), 42(2), 43(8), 44(2), 45(2), 46(13), 47(118), 48(59), 50(96), 51(3), 52(127), 56(54), 57(66), 58(52), 59(110), 61(1047), 73(42)	Total catch <u>3341</u>
<u>Oncorhynchus keta</u>	3(3), 38(7), 54(4)	Total catch <u>14</u>
<u>Oncorhynchus gorbuscha</u>	38(1)	Total catch <u>1</u>

* Bracketed figures indicate numbers taken, unbracketed figures are station number.

** Estimated

Two species of smelt (Mallotus villosus and Osmerus dentex) were frequently encountered during the survey.^{6/} Mallotus were taken from 15 stations, a maximum catch of 113 individuals being taken at station 70. Osmerus dentex were noted at 12 stations and a maximum catch of 10 was taken at station 2. Analysis of commercial potential of these species is difficult. Although quantitative catches were small, the species may at times concentrate in quantities, which could result in higher catch rates than those observed.

Several gadoids (Boreogadus saida and Eleginus gracilis) were encountered throughout the Chukchi Sea region. The Arctic cod (Boreogadus saida) was the most common species taken during the survey, and 1047 specimens were taken at station 61. The average size of specimens taken during the survey was 15.9 cm. and the maximum size observed was 30 cm.

Quantitatively the entire catch of demersal fishes taken in the Chukchi Sea region is estimated at less than 400 pounds, and the level of productivity for these species as compared with areas in which commercial trawling operates was extremely low. Aggregate catch records from the Washington trawl fishery which operates between Columbia River and southeastern Alaska is shown to be about 1,000 pounds per hour fishing.

Pelagic Fishes

Commonly encountered commercially important pelagic forms included herring, salmon, char, and smelt. An estimated catch of 1,000 Pacific herring (Clupea palasii) having an average size of 22.4 cm. was taken in

^{6/} We have included these species with the demersal fishes as they were most commonly taken with otter trawl gear. Neither species, however, may be considered as restricted in its habitat to those waters near the sea floor, and both at times taken in the midwater trawl.

a gillnet set at station 38 adjacent to the camp site. This catch, made with the two 1½-inch mesh gillnets, was the largest catch taken with this type of gear. No other significant herring catches were made during the survey, although this species was encountered at several stations (see table 4). Two species of salmon, Oncorhynchus gorbuscha and Oncorhynchus keta, were taken in either gillnet or beach seine sets, along with dolly varden (Salvalinus malma). The char (Salvalinus alpinus) was the most common catch taken with the beach seine in the Point Hope area. Numbers of salmonoids taken during the investigation were small.

In addition to gillnet and midwater trawl sets, echo ranging for indications of schooling subsurface fish was conducted throughout the entire cruise. No prominent traces were encountered indicating concentrations of schooling fish. In many instances, however, a continuous "scatter" was noted at depths generally below the thermocline. Midwater sets made in these waters resulted in small catches of juvenile smelt (Osmeridae), numerous small hydrozoan medusa, and jellyfish (Cyanea).

Invertebrate Fauna

As contrasted with fishes, a large number of benthic and pelagic invertebrates was collected during the Chukchi Sea operations.

Echinoderms were the most dominant animal form found in the fauna and this phylum formed a conspicuous segment of the benthic fauna encountered. The basket star (Gorgonocephalus) was numerically the most abundant invertebrate noted; however, brittle stars, sea cucumbers, and sea urchins were also common.

A relatively wide variety of crustaceans was also taken, in which Tanner crabs (Chionoecetes, Cragonid, Hippolytid, and Pandalid shrimps,

and Amphipods were abundant. A few isolated king crab (Paralithodes platypus) were taken. Other phyla of invertebrates which were well represented include the Coelenterates, Annelids, and Molluscs. A more complete report on the invertebrate species encountered and their distribution and abundance has been submitted independently by Dr. Sparks of the University of Washington College of Fisheries.

Commercial Potential

The only catch of invertebrates which may be considered of commercially economic importance was a dredge haul containing 760 clams (Macoma) taken at Station 45. This species was also relatively abundant at stations 22, 23, and 43.

Relatively good catches of Tanner crab (Chionoecetes opilio) were taken with the otter trawl in the offshore waters between the Chariot site and Cape Lisburns (Stations 29, 30, 31, 32, and 34). This type of crab is harvested to some extent by the Japanese fishermen in the Bering Sea.

Although shrimp (Pandalidae and Cragonidae) were taken in most otter trawl tows made throughout the Chukchi Sea area, quantitatively they represented only a small segment of the catch. The largest shrimp catch was made in the area northeast of Cape Lisburne (Station 59), in which about 15 pounds of mixed shrimp were taken.

Scallops (Chlamys iclandica) were relatively numerous in the waters adjacent to Point Hope, the catches ranging from 58 to 246 individuals at Stations 25, 33, and 36.

Although commercial quantities (relative to the fisheries industries operative in the United States) were not encountered, it would appear that the quantities of Tanner crab, scallops, and shrimp inhabiting the eastern Chukchi Sea could be utilized by natives inhabiting northwest Alaskan

coastal areas. The scallop beds lying close to Point Hope could be harvested with simple gear operated by small craft.

Bird and Mammal Observations

Arctic waters are popularly believed to teem with marine mammals, if not with birds. Our observations in the eastern Chukchi Sea, a southern extension of the Arctic Ocean, indicated the region was sparsely populated with marine mammals during summer.

The bowhead whale (Balaena mysticetus), walrus (Odobenus rosmarus), bearded seal (Erignathus barbatus), ringed seal (Pusa (Phoca) hispida), and the rare ribbon seal (Histiophoca fasciata) are ice-edge or ice forms that follow the ice northward, leaving more southern waters, such as the Chukchi Sea, relatively deserted.

The gray whale (Eschrichtius gibbosus) is apparently the most important mammal moving in to fill the habitat vacated by the ice inhabitants. Gray whales were observed during the cruise of the John N. Cobb on four occasions. On August 10 at 67°10'N. and 166°43'W., gray whales, estimated at over 100 in number, were feeding over several square miles of ocean 24 fathoms in depth. As they came to the surface to blow, a large muddy patch of water surrounded them. Presumably, gray whales scoop up quantities of mud when feeding on the bottom and have not completely expelled this when they rise to the surface. Bottom sampling suggested that large amphipods and several species of shrimp were likely food items. The characteristic light blotches of color and the knobs along the posterior part of the back make the gray whale easy to recognize.

On August 16 the vessel Brown Bear located about 100 gray whales at 67°25'N. and 167°12'W. On August 19 and 20, at 67°57'N. and 166°02'W., additional sightings of either the same group or separate groups were made. All of these groups were feeding.

Twenty or more gray whales were found late on August 29 at 67°18'N. and 166°32'W. widely scattered and apparently traveling. Part of the whales were moving in pairs.

By mid-December, gray whales appear off San Diego, California, on their migration to breeding grounds in bays and lagoons of Baja California. Their route to and from the Chukchi Sea is not thoroughly known.

Three dead gray whales had drifted ashore in the Cape Thompson area and a fairly fresh specimen was seen adrift off Kivalina.

During 23 days in the Chukchi Sea, harbor seals (Phoca vitulina) were seen only five times. By comparison with the part of Alaska from Bristol Bay southward, this number represents extreme scarcity.

A young walrus (born 1959) was accidentally trapped in a beach seine off Point Hope. Its mother was doubtless killed earlier by walrus hunters.

The thick-billed murre (Uria lomvia) was common throughout the cruise. A large proportion of all birds seen were of this species. Their numbers increase near cliffs, such as the great rookery at Cape Thompson. Another alcid, the horned puffin (Fratercula corniculata) was also abundant.

Least auklets (Aethea pusilla) were common but scattered. The Pacific kittiwake (Rissa tridactyla) was widespread and common. Less abundant were glaucous gulls (Larus hyperboreus) and Arctic terns (Sterna paradisea). Sabine's gulls (Xema sabina) could usually be seen near Point Hope.

All three of the North American jaegers (Stercorarius) were seen in small numbers.

Slender-billed shearwaters (Puffinus tenuirostris) increased throughout August. By the end of the month, groups of 200 to 300 were occasionally seen.

The first fulmar (Fulmarus glacialis) was seen on August 20. They were never common.

The northern phalarope (Lobipes lobatus), arctic tern, Pacific kittiwake, and slender-billed shearwater all collected near feeding gray whales, settling where the whales had come to the surface.

Summary

The investigation indicated a profuse and abundant invertebrate fauna existing in the Chukchi Sea area. Both the numbers and quantities of invertebrate animals taken were quite significant, in light of the apparent low density and small numbers of species of fish encountered. Although the investigation did not yield catches of fishes or shellfishes which were considered as having commercial potential, there undoubtedly are sufficient numbers of herring, salmon, char, Arctic cod, smelt, clams, scallops, and shrimp which are used or have potential use for food supplies for Eskimo groups inhabiting the northwest Alaskan Coast. The investigators are satisfied that the explorations were of sufficient intensity to delineate the general extent, relative abundance, and species of demersal fishes and benthic invertebrates within the waters investigated. The pelagic (nekton) fauna, however, because of time limitations, was not fully investigated, and the results obtained here may not reflect the abundance of these forms. Further gillnet studies are planned during the 1960 field investigations.^{7/}

^{7/} By the Atomic Energy Commission

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Appendix I

List of Scientific Personnel aboard John N. Cobb

Dayton L. Alverson, Base Director, Exploratory Fishing and Gear Research
Base, Bureau of Commercial Fisheries

Richard L. McNeely, Electronics Scientist, Exploratory Fishing and Gear
Research Base, Bureau of Commercial Fisheries

Ford Wilke, Supervisory Biologist, Branch of Marine Mammal Research,
U. S. Fish and Wildlife Service

Dr. Albert K. Sparks, University of Washington College of Fisheries

Dr. Allyn H. Seymour, University of Washington Laboratory of Radiation
Biology

Mr. Walter T. Pereyra, Research Assistant, University of Washington
College of Fisheries

Dr. Norman J. Wilimovsky, Ichthyologist, Bureau of Commercial Fisheries,
Juneau, Alaska

STATION LOG U.S.F.W.S. EXPLORATORY FISHING VESSEL JOHN N. COBB - CRUISE 43

STATION NO.	DATE	POSITION	BAR.	AIR TEMP. *	SURF TEMP. *	BOTTOM TEMP.*	DEPTH IN FATHOMS	SUBSTRATE	WIND DIR. & KNOTS	GEAR USED
1	8/6/59	65° 20'N 168° 09'W	29.98	59	53.5	39.5	27	gn.S.M.	Lt.airs	Otter trawl & Dredge
2	8/6/59	66° 16'N 167° 10'N	29.98	50	49.2	42.2	14	gy.M.S.	Lt.airs	Otter trawl & Dredge
3	8/7/59	67° 06'N 163° 48'W	29.98	56	55.0	43.5	7-1/3	bl.M.	ESE-5	Otter trawl, gill net & shrimp traps
4	8/8/59	66° 55.2'N. 164° 20.5'W	30.00	58	54.5	42.5	14	gy.M.	SSW-12	Otter trawl & Dredge
5	8/8/59	66° 44'N 165° 00'W	30.01	56	49.8	43.0	13	gy.M.	SW-7	Otter trawl & Dredge
6	8/8/59	66° 43.5'N 166° 14.5'W	30.01	50	48.0	47.2	10		S-25	Otter trawl
7	8/8/59	66° 58'N 165° 36'W	30.04	54	48.3	42.3	14	gy.M.	SSE-18	Otter trawl
8	8/9/59	67° 11.5'N 165° 00'W	30.14	54	47.8	41.5	16	gy.M.	SSW-16	Otter trawl
9	8/9/59	67° 24'N 164° 23'W	30.15	52	52.5	44.0	14	gy.M.	SW-18	Otter trawl
10	8/9/59	67° 33.5'N 165° 02'W	31.04	50	46.8	42.5	19	gy.M.	S-28	Otter trawl
11	8/9/59	67° 43'N 164° 44'W.	30.14	52	49.0	44.5	13	gy.S.gy.M.	SSE-18	Otter trawl
12	8/10/59	67° 27'N 165° 72.5'W	30.13	48	43.5	41.0	23	gy.M.	SW-18	Otter trawl & Dredge
13	8/10/59	67° 13.5'N 166° 23'W	30.15	50	47.1	40.2	24	gy.M.	S-18	Otter trawl & Dredge
14	8/10/59	67° 13'N 167° 30'W	30.14	46	45.2	39.0	24	gy.M.	S-16	Otter trawl & Dredge
15	8/10/59	67° 30'N 166° 47'W	30.14	50	47.5	39.0	25	gn.M.	S-20	Otter trawl
16	8/10/59	67° 46'N 166° 08'W	30.14	48	44.0	41.5	24	gy.M.	S-16	Otter trawl

STATION LOG U.S.F.W.S. EXPLORATORY FISHING VESSEL JOHN N. COBB - CRUISE 43

STATION NO.	DATE	POSITION	BAR.	AIR TEMP.*	SURF TEMP.*	BOTTOM TEMP.*	DEPTH IN FATHOMS	SUBSTRATE	WIND DIR. & KNOTS	GEAR USED
17	8/11/59	67° 52'N 165° 34.5'W	30.09	48	46.8	45.2	23	G.gn.M	S-12	Otter trawl and dredge
18	8/11/59	68° 00'N 165° 32'W	30.08	50	51.5	46.5	10	G.	SSW-8	Otter trawl and dredge
19	8/12/59	68° 03'N 166° 18'W	29.95	58	50.5	45.5	14	G.	NW-14	Otter trawl and dredge
20	8/12/59	67° 50'N 166° 55'W	29.89	58	45.5	38.5	30	gn.M.	N-13	Otter trawl and dredge
21	8/12/59	67° 37'N 167° 35'W	29.89	51	43.2	37.8	27	gn.M.Sh.	NNE-16	Otter trawl and dredge
22	8/12/59	67° 37'N 168° 50'W	29.87	46	45.0	37.0	28	gn.M.Sh.	N-15	Otter trawl and dredge
23	8/13/59	67° 52'N 168° 12'W	29.82	45	45.5	39.0	31	gn.M.Sh.	N-14	Otter trawl and dredge
24	8/13/59	68° 03.5'N 167° 34'W	29.86	48	47.0	41.7	26	gn.M.Sh.G.	NW-15	Otter trawl and dredge
25	8/13/59	68° 18'N 166° 55'W	29.89	49	53.0	46.8	20	gn.M.Sh.S.G.	NNW-17	Otter trawl and dredge
26	8/13/59	68° 31.5'N 166° 54'W	29.81	49	49.0	46.7	14	gn.M.	NNW-24	Otter trawl
27	8/13/59	68° 47.5'N 166° 54'W	29.82	50	49.8	42.5	20	gn.M.	NNW-17	Otter trawl
28	8/14/59	68° 32.5'N 167° 32.5'W	29.79	47	46.0	41.2	28	gn.M.G.	NNW-18	Otter trawl
29	8/14/59	68° 18'N 168° 15'W	29.83	49	44.8	39.0	27		NW-16	Otter trawl
30	8/14/59	68° 03.5'N 168° 52'W	29.83	50	45.0	37.5	31	gn.M.Sh.	NNW-17	Otter trawl
31	8/14/59	68° 32'N 168° 52.5'W	29.83	51	45.0	38.0	28	gn.M.	N-14	Otter trawl
32	8/14/59	68° 47.5'N 168° 11'W	29.79	49	45.0	39.2	26	gn.M.	N-16	Otter trawl

* Degrees Fahrenheit

STATION LOG U.S.F.W.S. EXPLORATORY FISHING VESSEL JOHN N. COBB - CRUISE 43

STATION NO.	DATE	POSITION	BAR.	AIR TEMP.*	SURF TEMP.*	BOTTOM TEMP.*	DEPTH IN FATHOMS	SUBSTRATE	WIND DIR. & KNOTS	GEAR USED
33	8/16/59	68° 25'N 167° 12'W	29.98	46	51.0	42.5	22	bl.M.Cl.	WSW-8	Otter trawl and dredge
34	8/16/59	68° 25'N 167° 55'W	29.99	50	48.5	41.0	29	gn.M.S.	SSW-8	Otter trawl
35	8/16/59	68° 10.7'N 167° 55'W	30.01	50	48.2	40.5	28	gn.M.bl.S.	S-18	Otter trawl and dredge
36	8/16/59	68° 11'N 167° 12'W	30.03	51	49.5	42.5	22	gn.M.S.G.	SE-8	Otter trawl and dredge
37	8/16/59	68° 10.8'N 166° 35'W	30.06	49	51.0	45.0	12	S.G.	SE-10	Otter trawl and dredge
38	8/16/59	68° 03.5'N 165° 48.2'W	30.09	50	53.0	--	5½	--	S-8	Gill net & shrimp traps
39	8/17/59	67° 57'N 165° 57'W	30.02	52	52.0	43.8	23	gn.M.S.G.	SE-7	Otter trawl and dredge
40	8/17/59	67° 44'N 165° 23'W	29.99	48	52.5	44.0	21	gn.M.S.G.	NNW-8	Otter trawl and dredge
41	8/19/59	67° 31.5'N 165° 55'W	29.77	48	47.0	40.5	24	gn.M.	Calm	Otter trawl and dredge
42	8/19/59	67° 44'N 165° 56.2'W	29.77	58	51.9	41.8	29	gn.M.bk.S.	Calm	Otter trawl and dredge
43	8/19/59	67° 43.8'N 166° 35'W	29.82	63	47.8	37.2	28	gn.M.bk.S.	Calm	Otter trawl and dredge
44	8/19/59	67° 31'N 166° 35'W	29.82	56	48.0	37.0	24	gn.M.	Calm	Otter trawl and dredge
45	8/19/59	67° 31'N 167° 12'W	29.80	54	47.0	38.0	27	gn.M.	N-11	Otter trawl and dredge
46	8/19/59	67° 43.5'N 167° 12'W	29.81	48	46.5	37.0	34	gn.M.Sh.S.G.	W-11	Otter trawl and dredge
47	8/19/59	67° 43.8'N 167° 55'W	29.84	48	46.2	38.0	24	gn.M.S.Sh.	NW-11	Otter trawl
48	8/20/59	68° 10.8'N 168° 34'W	29.83	45	46.0	36.5	32	gn.M.S.Sh.	NE-20	Otter trawl
49	8/20/59	67° 57'N 168° 34'W	29.83	44	45.0	38.2	32	gn.M.	NNE-22	Otter trawl

* Degrees Fahrenheit

STATION LOG U.S.F.W.S. EXPLORATORY FISHING VESSEL JOHN W. COBB - CRUISE 43

STATION NO.	DATE	POSITION	BAR.	AIR TEMP.*	SURF TEMP.*	BOTTOM TEMP.*	DEPTH IN FATHOMS	SUBSTRATE	WIND DIR. & KNOTS	GEAR USED
50	8/20/59	67° 57'N 168° 02'W	29.87	47	46.2	37.9	30	gn.M.	NNE-15	Otter trawl
51	8/20/59	67° 55.6'N 167° 22'W	29.83	48	46.8	37.0	34	gn.M	NW-18	Otter trawl and dredge
52	8/20/59	67° 55.3'N 166° 42'W	29.84	52	48.0	40.0	32	gn.M.S.G.	N-17	Otter trawl
53	8/22/59	68° 07.5'N 166° 34'W	29.80	52	51.0	49.0	--	--	NNE-28	Midwater trawl
54	8/22/59	67° 56'N 165° 32.5'W	29.65	48	51.0	--	--	--	NNE-10	Gill nets
55	8/23/59	67° 46.5'N 164° 55'W	29.83	46	53.5	48.0	--	--	N-16	Midwater trawl
56	8/24/59	69° 03'N 167° 30'W	30.06	41	46.5	46.7	26	gy.M.	NW-14	Otter trawl and dredge
57	8/24/59	69° 17.2'N 166° 53'W	30.08	40	48.0	47.2	21	gy.M.	NW-10	Otter trawl and dredge
58	8/24/59	69° 04'N 166° 12'W	30.10	40	47.0	46.0	11	gy.M.	NW-8	Otter trawl and dredge
59	8/24/59	69° 16'N 165° 36'W	30.14	38	47.2	45.2	15	gy.M.	NW-5	Otter trawl and dredge
60	8/25/59	69° 03'N 164° 52'W	30.10	37	42.0	42.2	8	G.	NW-3	Otter trawl and dredge
61	8/25/59	69° 16'N 164° 22'W	30.19	39	43.5	41.0	12	rky.	NW-5	Otter trawl and dredge
62	8/25/59	68° 16'N 166° 40'W	30.14	48	51.0	--	--	--	SW-10	Gill nets
63	8/28/59	69° 02'N 167° 02'W	29.55	40	44.8	42.6	--	--	SSE-12	Midwater trawl
64	8/28/59	67° 52'N 167° 02'W	29.55	44	42.2	39.0	--	--	E-16	Midwater trawl
65	8/28/59	67° 58'N 166° 41'W	29.60	44	44.5	43.0	--	--	E-18	Midwater trawl
66	8/28/59	68° 03'N 166° 17'W	29.61	44	50.5	49.0	--	--	SE-10	Midwater trawl

* Depth Temperature

STATION LOG U.S.F.W.S. EXPLORATORY FISHING VESSEL JOHN N. COBB - CRUISE 43

STATION NO.	DATE	POSITION	BAR.	AIR TEMP.*	SURF TEMP.*	BOTTOM TEMP.*	DEPTH IN FATHOMS	SUBSTRATE	WIND DIR. & KNOTS	GEAR USED
67	8/29/59	68° 58'N 166° 04'W	29.71	44	49.8	46.5	--	--	E-8	Midwater trawl
68	8/29/59	67° 51'N 166° 25'W	29.72	47	44.5	41.0	--	--	WSW-6	Midwater trawl
69	8/29/59	67° 44'N 166° 43'W	29.72	46	42.2	36.0	--	--	E-10	Midwater trawl
70	8/29/59	67° 37'N 166° 26'W	29.73	47	44.2	39.0	--	--	E-10	Midwater trawl
71	8/29/59	67° 43'N 166° 05'W	29.72	46	45.0	42.0	--	--	E-10	Midwater trawl
72	8/29/59	67° 24'N 166° 24'W	29.68	42	43.5	39.0	--	--	SE-10	Midwater trawl
73	8/29/59	66° 43'N 166° 22'W	29.70	42	40.2	39.0	22	gy.M.	SE-10	Otter trawl and dredge
74	8/30/59	65° 44'N 168° 38'W	29.68	42	47.5	36.0	28	G. M.	WSW-12	Otter trawl

* Degrees Fahrenheit