MASTER

PROGRESS REPORT
OF
THE LABORATORY OF RADIATION BIOLOGY,
UNIVERSITY OF WASHINGTON

October 1, 1959

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Following is a report of the present status of the Laboratory's participation in Phase II of the Chariot Project.

The order in which the report is presented will be the same as the order in which the objectives of the Laboratory's program were given in the letter of July 7 to Mr. Campbell.

a. Coordination of the marine program

The overall objective of the program was to obtain an inventory and other ecological information about the marine organisms of the Chukchi Sea for comparison with similar observations after the Chariot event for the purpose of assessing the biological cost of the experiment; and, to obtain oceanographic information from which the distribution of radioactivity in the Chukchi Sea could be predicted.

The first step was to contact persons who had the people and facilities to carry on a field program in the Chukchi Sea in oceanography and in fisheries. The program was discussed with Dr. Fleming, executive officer, of the Department of Oceanography, University of Washington and Mr. Alverson, Chief, North Pacific Exploratory Fishing and Gear Research Branch of the Fish and Wildlife Service. When both expressed an interest in the program and submitted proposals that were accepted by the AEC, the strongest possible nucleus for a field program was formed.

The responsibility for the measurement of the radio-activity in the samples and for the research areas of the marine program that were not included in the work of the Department of Oceanography and the Fish and Wildlife Service rested with the Laboratory of Radiation Biology. The general program of the Department of Oceanography was to determine the water movements and of the Fish and Wildlife Service was to determine the fish populations in the eastern Chukchi Sea, but both programs were considerably more extensive. The Laboratory of Radiation Biology supplemented the work of these two programs by engaging the services of Dr. A. K. Sparks and Mr. W. Pereyra of the College of Fisheries, University of Washington, to identify and to prepare a list of the invertebrates; Dr. N. J. Wilimovsky of the Fish and Wildlife Service, Juneau, to identify and to prepare a list of the fishes, and Mr. H. D. Smith of the Fisheries Research Institute, University of Washington, to make an evaluation of the salmon resource.

To carry on the field program the "Brown Bear" of the Department of Oceanography and the "John N. Cobb" of the Fish and Wildlife Service were employed. The two vessels spent a month in the Chukchi Sea and another month enroute to and from the area.

The Department of Oceanography submitted their own proposal and also will submit their own reports. The Department's budget, the greatest single expense being for the

operation of the "Brown Bear", was \$100,000. For convenience and in order to make funds immediately available, the money was appropriated to the Laboratory of Radiation Biology's budget but was transferred in total within the University to the Department of Oceanography.

The cost of the operation of the "John Cobb", \$40,000, was shared equally by the Fish and Wildlife Service and the AEC. The North Pacific Exploratory Fishing and Gear Research Branch of the Fish and Wildlife Service was interested in determining the fisheries potential of the area, a program that complemented very well the AEC interest in obtaining an inventory of the marine organisms. The Fish and Wildlife Service, like the Department of Oceanography, submitted their own proposal and also will submit their own reports.

Because there was good communication between the Department of Oceanography, the Fish and Wildlife Service and the Laboratory of Radiation Biology, and there was a mutual understanding of needs and objectives, coordination of the program was a minor task.

- b. Radiological analyses of samples of marine organisms and sediments.

A shielded two-inch well-type scintillation crystal with scaling unit was installed aboard the "John Cobb" for gamma counting of samples in the field. The levels of radioactivity to be found in the samples were unknown, and although

expected to be low, offered a possible means of screening samples that were to be taken back to the home laboratory for more precise analyses. Of the samples counted aboard the "Cobb" the radioactivity of the biological samples only rarely exceeded the background count. The count of radioactivity in mud samples was low but generally greater than background.

Laboratory counting of the samples has begun and results to date of beta counting indicate that there is little contamination, if any, from weapons tests. In the biological samples the beta activity is about what would be expected from naturally occurring K^{40} . Gamma analyses of the mud samples indicate that naturally occurring radium, thorium and uranium, account for practically all of the radioactivity in the mud.

The beta counting of samples is mostly completed. Some work is yet to be done on the chemical separation of radioelements in the samples for the purpose of positively identifying the radioisotopes present. There appears to be no need for collecting other samples for radiological analyses until after the Chariot event.

c. Preparation of an inventory of the marine invertebrates.

Trawl and dredge catches made aboard the "John Cobb" provided large and rich collections of invertebrates. Catches were made at 74 stations. Gross identification and estimates

of abundance were made in the field and large numbers of specimens were preserved for later identification. This is undoubtedly the finest collection ever made in the area. Because of the large collections and scarcity of information on the invertebrates of this area, a gigantic task of identifying the specimens remains. As the area was well sampled, additional collections do not appear to be needed at this time, although "short-comings" may become apparent as the collection is worked up.

A preliminary report of the invertebrate collection has been prepared by Dr. Sparks and is attached as Appendix A.

d. Preparation of an inventory of the fishes, marine and freshwater.

Catches of fish were made at the same stations as the invertebrates but unlike the invertebrate catches, the fish were conspicuous by their absence and small size. With the type of gear used (an otter trawl) catches of several thousand pounds of fish per haul are not uncommon in many areas, but in all the hauls made in the Chukchi Sea the largest catch was less than twenty-five pounds. Also, the fish were small but this was expected. Using five gill nets just off the Chariot Site, 1000 herring, 8 salmon and 15 birds were caught in a night set but subsequent sets were much less productive. Details of the fish catches will be reported by the Fish and Wildlife Service.

Fish were also captured from the lagoons and streams in the vicinity of the Chariot Site. Compared to the invertebrates, the identification of the fishes will be a lesser task because the number of species of fish are fewer and because the person responsible for the identification is well acquainted with the fishes of the area. Although the collections of the summer stocks of fish are adequate, knowledge of the winter stocks and of the species utilized by the large bird population would be of interest. Further study of the Pt. Hope and Kivalina lagoons also may be warranted.

A report of the present status of the work on the identification of fishes has been prepared by Dr. Wilimovsky and is attached as Appendix B.

Because of the importance of the salmon fishery to the economy of Alaska, special attention was given to the evaluation of the salmon resource of the area even though it was realized before hand that the fishery was not being exploited. This part of the program was reserved from the start and up until July 16 for the Alaska Department of Fish and Game but when turned down by ADFG, assistance from the Fisheries Research Institute was obtained.

There are a few salmon in the area and of two species, chum (O. keta) and pink (O. gorbuscha). A few king salmon (O. tshawytscha) are reported in the Kotzebue area. The annual

catch by the natives has been estimated (Raleigh, 1957) to be 500 at Kivalina and 2500 at Pt. Hope. No salmon were observed in Ogotoruk Creek. The Kukpuk River at Point Hope and the Singoalik at Cape Seppings both produce pinks and some chums. About 5000 pink salmon were observed in the Kukpuk on August 12. There is also a small run to the Wulik River at Kivalina. From early to mid-August is the time that the adult salmon are in the rivers. Salmon contribute little to the economy of the region and there appears to be little interest by the natives in salmon. Although the salmon stocks are not large, more salmon than are being caught are readily available.

If more information about salmon is needed this is a program that definitely needs to be continued for several years because of their cyclic nature. Observations in 1960 would be on stocks totally unrelated to the stocks observed in 1959 and therefore should produce equally valuable information. A two-man team during the first three weeks in August with two or three aerial surveys and weasel support should accomplish the mission.

A report, essentially in its final form, on the salmon resource of the area has been prepared by Howard Smith and is attached as Appendix C.

Allyn H. Seymour
Laboratory of Radiation Biology
University of Washington

APPENDIX A

A Preliminary Progress Report of the Benthic Invertebrate

Studies in the Chukchi Sea, July - August, 1959

Albert K. Sparks
College of Fisheries
University of Washington
September 24, 1959

REPORT I

A Preliminary Progress Report of the Benthic Invertebrate Studies in the Chukchi Sea.

July - August, 1959.

TO: Dr. Allyn H. Seymour
Acting Director
Laboratory of Radiation Biology

FROM: Albert K. Sparks
Associate Professor
College of Fisheries

Introduction

Responsibility for the study of the marine benthic invertebrates of Operation Chariot was accepted by the Invertebrate Fisheries Section of the College of Fisheries. Plans were made for sampling the area in collaboration with Mr. Dayton L. Alverson, Chief, North Pacific Exploratory Fishing and Gear Research Unit, U.S. Fish and Wildlife Service, and Dr. Norman Wilimovsky, Ichthyologist, Bureau of Commercial Fisheries, Juneau, Alaska.

Objectives

1. To adequately sample, according to the station plan, the benthic invertebrates in the Chukchi Sea and in the intertidal zone and lagoons in the area adjacent to the project site.

2. To determine the approximate numbers of various invertebrates at each sampling location and to preserve for later identification in the laboratory, representative specimens of each species at each location.

3. To prepare, after more complete identification, a list of marine invertebrates of the Chukchi Sea.

Procedure

Mr. Walter T. Pereyra, A Research Assistant in Invertebrate Fisheries, arrived at Cape Thompson on July 28, 1959, where he worked with Dr. Norman Wilimovsky in sampling the beaches and lagoons and the area just off the beach. Mr. Pereyra preserved representative invertebrate forms for later study.

The Author flew to Nome, Alaska, on August 5, 1959 and joined the M. V. John N. Cobb. The John N. Cobb departed Nome on August 5 and, taking samples enroute, proceeded to Kotzebue, Alaska, where Dr. Wilimovsky and Mr. Pereyra joined the party.

At each of the stations listed in the cruise plan a 30-minute otter trawl was made. The invertebrates from each trawl were field identified, enumerated and representative specimens were preserved for transport back to the College of Fisheries for more detailed study. At each station, when the weather permitted, a bottom sample was obtained with a toothed biological dredge. The contents of each dredge were washed through a series of graded screens; those invertebrates left on each screen were field identified, enumerated and representatives of each species preserved.

During the cruise a total of 59 otter trawls and 35 dredge hauls were made over the eastern Chukchi Sea, from the Bering Straits to a line approximately 40 miles north of Cape Lisburne, with particular emphasis on the area in the immediate vicinity of the project site.

A Cruise Report (No. 43) of the M. V. John N. Cobb, showing the location of each sampling station, is attached.

The Author left the M. V. John N. Cobb on August 20, 1959; Mr. Pereyra remained on the vessel until the conclusion of the cruise and was responsible for the collection of the benthic invertebrates in the Author's absence.

Preliminary Findings

No commercial quantities of economically important invertebrates were found, though two fairly extensive concentrations of scallops were located. Some preliminary observations on the benthic animals collected are included.

Coelenterates. Two species of Anemones were fairly numerous throughout the area, soft corals were common and a jellyfish, Cyanea, was very abundant

Annelids. Large numbers of tubeworms of several different species were collected in all areas of soft bottom; polychaetes were numerous, and large scaleworms were abundant.

Molluscs. Scallops were found to be fairly abundant just off Cape Thompson and off Pt. Hope. Large whelks and several other species

of predaceous gastropods were very numerous over the entire sampling area. Chitons were present in limited numbers and those collected were all quite small. Nudibranchs were common and apparently represent several species. Clams, including Macoma sp., Yoldia (razor clam), bean clams and the Greenland cockle, were abundant at certain localities; but none are believed to be of commercial quantities. Of interest was the collection of two small octopods; no squids were collected by any of the collecting methods.

Crustaceans. Very few king crabs (Paralithodes) were taken; Pandalid shrimp, though common, were all small and not in sufficient numbers to be fished. Tanner crabs were numerous, but rather small. Large numbers of Hippolytid and Cragonid shrimp were taken, representing several species in both families. Amphipods were quite common and numerous species were collected. Of particular interest was the presence of large concentrations of amphipods in all samples in the localities where schools of whales were sighted. Isopods were not abundant, but one exceptionally large form was taken on several occasions. Hermit crabs were extremely numerous and a large number of species are apparently present in our collections.

Echinoderms. The basket star (Gorgonocephalus) is one of the dominant animals, from the standpoint of numbers, present in the Chukchi Sea. The phylum Echinodermata forms a conspicuous segment of the benthic fauna with numerous examples of several species of asteroids, large numbers of brittle stars, abundant Psolus and other Holothuroids (sea cucumbers), large populations of sea urchins, and, in at least one northern station, abundant sand dollars.

Minor Phyla. Many of the rare forms from other waters were found rather commonly in our collections. Some of these were Sepunculoids, Nemertines, Priapuloids and Echiuroids. These were not a conspicuous part of the fauna, but are of considerable interest zoologically.

Accomplishment of Mission

It is believed at the present time that the benthic invertebrates of the area in question were adequately sampled during the summer of 1959 and that a return to the Chukchi Sea in 1960 will not be essential. It is possible, however, that as identification of the animals collected proceeds, the need for further investigation will become apparent.

Albert K. Sparks
Associate Professor of
College of Fisheries

APPENDIX B

Preliminary Progress Letter - Narrative Report
of Studies Conducted to Date, Project Chariot

Norman J. Wilimovsky
U. S. Fish & Wildlife Service
Juneau, Alaska
September 24, 1959

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF COMMERCIAL FISHERIES

Box 2481
JUNEAU, ALASKA

September 24, 1959

To: Laboratory of Radiation Biology
Fisheries Center
University of Washington
Seattle 5, Washington
ATTEN: Dr. A. H. Seymour

From: Norman J. Wilimovsky
Chief, Marine Fisheries Investigations
Bureau of Commercial Fisheries
Juneau, Alaska

Subject: Preliminary progress letter--Narrative report of studies conducted to date, Project Chariot.

Task Order: To conduct field investigations and make collections necessary to prepare a list of marine and freshwater fishes in the Project Chariot area. (ltr. L. R. Donaldson, July 13, 1959)

Field efforts toward this objective were carried out from July 27 through August 20, 1959. The field work involved (1) collecting in river and lakes in the Cape Thompson region, (2) test fishing in all lagoons in the immediate Project Chariot area, and (3) obtaining samples of fishes collected by the John N. Cobb during its survey activities in the Chukchi Sea. More than 106 separate collecting stations were occupied, though the resulting coverage was not divided evenly among the three habitat categories.

Although only a portion of my time was spent on board the Cobb, samples were obtained by that vessel from throughout the entire Chariot area. These samples were received in the Juneau laboratory on September 7 and are currently being processed for examination (transferring to alcohol, sorting, etc.). Cruise data are to be ready by the last week in September. Preliminary examination suggests that the Cobb collections are adequately representative of the fish fauna in the Chukchi Sea area. Certain questions regarding the marine fauna however remain unanswered. Some of these are: (1) What are the fish used as food by the cliff birds at Cape Thompson and what is their source, and (2) what are the composition and distribution pattern of the fauna and the relative abundance of fishes during the winter periods? The Cobb collections are not adequate to answer these questions. Depending on the predicted duration and the extent of the fallout of the proposed shot, an additional question may be asked: (3) What are the general timing and duration of movement of salmon and sheefish populations that are utilized by the Kotzebue village residents? In the three areas studied,

assessment of marine fish fauna was the most complete, and it is doubtful whether additional marine work of the type conducted during the summer months will be necessary in the forthcoming season.

Fishing effort in the freshwater and brackish lagoons varied. However, all 10 of the lagoons from north of Cape Thompson to Cape Seppings were examined, and reasonably good knowledge of their fish fauna is available. The lagoons are generally closed to the sea during much of the open water period, and inlet streams are small. This limits extensive population of such areas by a varied fish fauna. For the purposes of the present program, additional work on these lagoons is probably not required because of their limited fauna and little utilization. Effort might be usefully devoted to the three lagoons near Tigara (Point Hope) and the two lagoons in the immediate vicinity of Kivalina. Of the two regions, utilization of the fish fauna appears to be greater in the Kivalina area. However, because of the proximity of Point Hope to the Chariot site, these northern lagoons should receive priority of study over the Kivalina area in spite of the reduced utilization. If further studies of these lagoons are determined to be necessary, it would be desirable to conduct these investigations in the spring, shortly after ice break-up and during late fall just prior to freeze-up. On the basis of local information, these times would appear best to assess the extent of utilization.

Of the three habitats examined, the least effort, and consequently smallest coverage, was given to the river systems. Our investigations covered in some detail all of the rivers and streams in the region from Cape Seppings to Point Hope. Some 30 stations were occupied. This survey included study of the Kukpuk River. Generally the rivers in this circumscribed area are of low productivity and do not support any fish runs of major size. Dolly Varden char, grayling, stickleback, and sculpin dominate the fish fauna. The primary reason for this reduced productivity is that summer storms close off the mouths of these slowly flowing streams, limiting movement of migrating fish. The only evidence of migrating forms was a small pink salmon run on the Kukpuk River. Outside of the immediate study area, salmon occurred in the Kivalina River. Salmon are also known to occur north of the Point Hope area. Further effort in stream survey work is probably desirable and dependent upon the pattern of predicted fallout. These surveys should be timed for August so as to assess the salmon runs during their peak.

There are few lakes in the region; the lakes in the immediate Chariot vicinity have been very carefully surveyed--usually with negative results.

The next phase of this Chariot study will be to identify all fish obtained. Further recommendations and conclusions will be possible upon completion of such determinations.

Collecting equipment has been distributed to several individuals and agencies in the Cape Thompson area, and it is expected that some data concerning the fish fauna will continue to be received throughout the coming months. These collections will serve to fill in details of our knowledge of distribution.

APPENDIX C

An Evaluation of Salmon Resources in the Region
of the United States Atomic Energy Commission's
Project Chariot at Cape Thompson, Alaska

Howard D. Smith
Fisheries Research Institute
College of Fisheries
University of Washington
September 21, 1959

AN EVALUATION OF SALMON RESOURCES IN THE REGION OF THE
UNITED STATES ATOMIC ENERGY COMMISSION'S PROJECT CHARIOT
AT CAPE THOMPSON, ALASKA

by

Howard D. Smith
Fisheries Research Institute
College of Fisheries
University of Washington

September 21, 1959

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AN EVALUATION OF SALMON RESOURCES IN THE
REGION OF THE UNITED STATES ATOMIC ENERGY COMMISSION'S
PROJECT CHARIOT AT CAPE THOMPSON, ALASKA

Introduction

A field trip was taken to the United States Atomic Energy Commission's project CHARIOT at Ogotoruk Creek, Cape Thompson, Alaska during the period August 5 - 20, 1959. (Fig. 1) This paper is an evaluation of the salmon resources of the Cape Thompson area as directed by the Laboratory of Radiation Biology, University of Washington. CHARIOT is one of the projects undertaken by the Commission under its PLOWSHARE program wherein the peaceful application of nuclear explosives is being studied. Project CHARIOT proposes to test the feasibility of moving a large volume of overburden from the earth's surface by the detonation of thermonuclear charges placed at considerable depth. If the proposal is carried through its final stages the planned excavation may prove useful as a harbour. However, before such a large scale operation can be approved it is necessary to determine the biological "costs" of the operation. A program of the magnitude planned for Cape Thompson cannot fail to destroy plant and animal life in the immediate vicinity. It is therefore imperative that precautions are taken to assure a minimum of loss to the susceptible forms. This loss whether instantaneous or accrued constitutes the biological cost.

In order to determine what forms of animal and plant life are present in the project area, and to determine their numbers and seasonal distributions an environmental study program has been initiated. The conclusions of the investigators assigned to the environmental program will be evaluated, and the decision to excavate must pend those results. The findings will also

assist in the determination of the most favorable season and the optimum meteorological conditions to prevail at the time of the blast.

METHODS OF EVALUATION

It is not possible to provide a comprehensive evaluation of the salmon resources of an area on the basis of one short period of study. Four of the five species of Pacific salmon manifest inconsistent ages at maturity and pink salmon (the 5th species) may appear in odd years to the virtual exclusion of the even - or vice versa - and the cyclic nature of the salmon production curves in areas long under study warn against conclusions based upon a single year's data.

It is possible to assess the 1959 production by reference to several available sources of information, including "on the site" observations. For purposes of this paper the Cape Thompson study area is that region which lies between Kivalina and Point Hope and extends inland to encompass the lower part of the Kukpuk River drainage. Thus all waters within 30 miles of the project base at Ogotoruk Creek are under consideration here. (Fig. 1)

A. Reference to Available Literature.

A detailed review of the literature pertaining to the anadromous fishes in the vicinity of the project has not yet been concluded. However, the following have been found to contain helpful information:

Raleigh, Robert F., 1957

Reconnaissance of Salmon Fisheries between Cape Newenham and Point Hope, Alaska, 1957. Department of the Interior U.S.F.W.S., Bureau of Commercial Fisheries, Alaska Region.

Townsend, C. H., 1885

"Notes on the Natural History of Northern Alaska" (in Report of Revenue Steamer Corwin in the Arctic Ocean, 1885.) Gov. Printing Office, Washington, D.C., 1887.

Wilimovsky, Norman J., 1956

The Utilization of Fishery Resources by The Arctic Eskimo.
Presented to the 3rd Alaska Science Conference, Sept. 1952.
- Occasional Papers of the Natural History Museum, Stanford
University. No. 2, June 1956.

B. Interrogation

Salmon production may be evaluated in general terms from talks with native fishermen and informed residents. However, there is a likelihood of reaching erroneous conclusions as to abundance and distribution when one relies upon this source of information alone. The local names for salmon, and the failure of many of the natives to differentiate between salmon, trout, whitefish and other species pose special problems when reports are interpreted in the light of local terminology. Nevertheless some talks have been valuable:

At Kotzebue on August 8, native fishermen were found cleaning fish for drying. Several men, including one who has fished for red salmon in Bristol Bay, were interrogated.

At Cape Thompson and southward, occasional hunting parties were encountered. Members of these parties, generally from the village of Kivalina, were questioned as to the occurrence of salmon in the coastal streams between Kivalina and Point Hope.

At the village of Tigara at Point Hope, native residents including the keeper of the native store, several beach fishermen, and a group of hunters were asked about the local salmon runs and their utilization of them.

Discussions with two native workmen - one from Kotzebue, the other from Tigara - at Cape Thompson were useful in tying together scraps of information picked up elsewhere.

C. Aerial Survey

The project contractors arranged two charter flights in a Wien Alaska Airlines Cessna 180 on wheels.

Witnesses remain in the area.

The witness, confidential informant, was interviewed in a room in the
C. V. Smith Building.

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On August 12, Mr. John Crosse piloted an aerial survey of the streams in the project area. During a one hour flight the streams from Ogotoruk Creek to, and including the Kukpuk River were observed. (Fig. 2) The Kukpuk was flown eastward from its mouth to the confluence of the Ipewik, and then southward for a distance of 10 to 15 miles east of the Ogotoruk Creek drainage. Ogotoruk Creek was flown on the return from that trip.

On August 17, the Kukpuk was resurveyed from the forks to a point about 2/3 of the way to the mouth, and the Ipewik was surveyed for an estimated 10 miles upstream.

D. Ground Reconnaissance

Evaluation of local streams was facilitated by transportation in U.S. Army type "weasels."

On August 11, a weasel was driven about 5 miles up Ogotoruk Creek and afforded a close look at the stream and its salmon spawning facilities.

Coastwise trips along the beach were possible only in a southeasterly direction, for northwest of Ogotoruk Creek there are several miles of cliffs which rise almost vertically from the sea and preclude land travel at the base.

Six weasel trips and "on foot" inspection of streams southeast of the project site as far as Cape Seppings were made during the period of August 10 to 18. Inspections of smaller streams were limited to their mouths for they generally discharged into lagoons which in turn seeped into the sea through gravel bars. On August 13 and 18, surveys included the Singoalik River, largest stream between Cape Seppings and Point Hope. On the later visit a weasel was run four miles up the stream which was surveyed enroute.

E. Water Reconnaissance

On August 15, Drs. Martin Johnson and Norman Wilimovsky and the writer traveled from Ogotoruk Creek to the village of Tigara at Point Hope. The southernmost of three principal lagoons along that section of coast were visited at that time.

On August 17, Dr. Wilimovsky and the writer flew to the Kukpuk River and landed on a gravel bar about half way between the mouth and the confluence of the Ipewik. A rubber raft was floated downstream three miles and the nature of the stream and its spawning facilities were determined at first hand.

RESULTS OF EVALUATIONS

The several means of evaluating salmon production in the Cape Thompson area produced the following information:

A. From reference to available literature

Raleigh (1957) (page 11, Table 1) estimates the average salmon catches from the villages of Kivalina and Tigara:

Village	Estimated Recent Annual Salmon Catch		
	Chums	Pink	Total
Kivalina	500	None	500
Point Hope	2520	70	2590
Combined	3020	70	3090

Raleigh lists as "low" the dependency of these two villages on the salmon resources of the area.

Townsend (1887) (page 95) states that on his trip up the Kobuk River about 100 miles southeast of Cape Thompson during July and August 1885, only a few pink salmon were seen but that great numbers of dog salmon were dried by the people.

Wilimovsky (1952) () states that the people of the region from Point Hope to Point Barrow only utilize the sea fisheries slightly. It is significant to note that the region around Cape Thompson is on the geographical and cultural edge of the Arctic where Wilimovsky asserts that fishing in general was never a highly important or significant occupation.

None of the three authors cited here considers salmon other than pinks and chums to range in the waters under consideration.

B. From interrogation

At Kotzebue only chum salmon appeared important though natives said that small numbers of pinks and kings were taken on occasion. Over 40 chums constituted the catch of one gill net during the night of August 7-8, and the owner said it had been a good night. He reported that the chum run would last about a month - roughly throughout August. The natives claim that most of the chums will ascend the Kobuk and Noatak Rivers, and say some fish are taken from the Kobuk by Kotzebue fishermen in years when the local catches are inadequate to meet the winter needs. It was also reported that salmon catches in 1958 were very light but that 1959 had been a good year. (Vague reports from a variety of sources later in the season affirmed 1959 as a year of outstanding chum production on the Kobuk.)

Hunting parties from Kivalina reported no salmon in the small streams between their village and Point Hope. They said "sometimes a few" and "just about none" when asked about the abundance of salmon in local streams. However, there is a small run to the Wulik River at Kivalina reported and these salmon, probably chums for the most part, are fished locally.

At Tigara residents showed a polite disinterest in matters of salmon utilization. No salmon were observed on any of the drying racks although scraps of meat were in evidence. Facilities for drying large quantities of fish were

conspicuously absent - in marked contrast with the rows of fish racks one encounters farther south. Although fish may be placed in pits in the permafrost and thus frozen indefinitely no such instances were encountered. On the beach at Point Hope local fishermen hauled small seines in which they were seen to capture half a dozen dolly varden during a fishing interval of some 30 minutes. The inefficiency of the small seines as compared with a short gill net appears obvious, and one must conclude that salmon are not in serious demand or gill nets would be in use.

Discussions with the native workmen at the project base, and with local white men, notably Mr. John Crosse, station manager and veteran pilot with Wein Alaska Airlines at Kotzebue, confirmed the impressions gained in direct interrogation of the fishing and hunting population.

C. From aerial survey

The streams between Cape Thompson and Point Hope all appeared small and incapable of supporting salmon runs. Furthermore the larger of these empty into lagoons which at the time of the survey were closed to the sea.

The Kukpuk River enters Maryatt Lagoon through a series of channels which dominate the lower four or five miles of stream. Immediately above this region of multiple channels, and throughout a distance of some 15 miles, approximately 5000 pink salmon were observed on August 12. Less than 50 dead salmon were seen during this flight and inasmuch as conditions for surveying were excellent, i.e. good light, little wind, and clear water, both live and dead estimates are believed reasonable.

On August 17, the Kukpuk was resurveyed in part. At that time many hundreds of salmon were dead, but otherwise there was no apparent change in the numbers and distribution of the population. About 50 salmon were seen in the Ipewik River just above the mouth. No others were observed though visibility was excellent.

Ogotoruk Creek demands attention as the stream which flows through the excavation site. It has a moderate gradient, and useful gravel sizes but its spawning facilities are not extensive. No salmon were seen in the stream this year, though the water level was reported to have been extraordinarily low* - in common with all the streams in the area. (R. Kachedorian, U.S.C.G.S., and John Crosse, Wein Alaska Airlines - personal communications) During the period of observation, August 10 - 18, the stream reached the ocean only by seepage through the gravel bar at its mouth. The flow in the stream was quite inadequate for salmon.

The small streams southeast of the project as far as Cape Seppings are very small. Only two, the first in the "control" valley eight miles away, and the second draining into the second lagoon southeast of the base are significant in terms of potential salmon production. However, no salmon were seen in them and it is doubtful that fish could ascend either of them this year on account of the low water level.

The Singoalik River empties into a large lagoon which is probably open to the sea only during higher water stages. It has a moderate gradient and on August 13 at a point one and one half miles from the lagoon its width was 12 feet, its depth one foot and its surface flow was at a rate of approximately one foot per second. Nineteen pink salmon were observed in a single pool one mile above the lagoon. These were the only salmon observed in the river though Dr. Wilimovsky captured two pink salmon in a gill net in the lagoon on August 4. No live salmon and only 5 dead were observed in the river during the survey of

*stream discharge measurements will be available later from the constant recorder on the stream. The discharge during the observation period probably approximated 2 cu. ft. sec.

August 18 though it was established that spawning facilities are good throughout the four miles surveyed, and there are numerous pools affording good protection for schooled fish.

D. From water reconnaissance

It was apparent that like the streams southeast of the project, those to the northwest are generally not accessible to anadromous fishes except possibly during periods of very high water or when wind induced tides may provide temporary flow in to the lagoons from the sea.

The Kukpuk River appears to have excellent spawning facilities throughout the section surveyed from the air. Average dimensions were about 130 feet in width, 18 inches in depth and the surface flow was at about two feet per second. The river appears susceptible to high water but probably seldom suffers from severe gravel scouring. Salmon were spawning at the heads of most of the riffles, and by August 17 virtually all were actively spawning or spent. A few bear kills were observed. A total of 75 fish were measured to establish the approximate size range of this population, and a sex ratio was established from a total of 122 fish observed over a distance of about two miles. These were 75% males. No salmon, other than pinks were observed in the Kukpuk River.

CONCLUSIONS

The biological "costs" of project CHARIOT, insofar as salmon production is concerned will be a function of (1) the numbers of fish destroyed (if any), and (2) their value to the economy of the region.

The first of these will depend upon the lethal range of the explosive device and the duration of harmful effects, neither of which appear well defined at present. The second is the concern of this paper which deals with the Cape Thompson area as defined.

The return of salmon to the Cape Thompson area in 1959 probably amounted to 6-7000 fish, chiefly, if not all pinks. It is not possible to relate this numerical return to that of other years but it appears likely that this was a "normal" year. Significant chum runs may well occur from time to time however, and it is possible that in years of higher water than that observed in 1959, small numbers of salmon may enter a few of the smaller streams in the area.

It seems quite certain that salmon contribute very little to the economy of the region. The villagers of both Kivalina and Tigara are primarily hunters rather than fishermen, and though the meagre stocks of salmon are easily within reach they appear virtually unexploited. On the basis of present knowledge only two streams in the study area appear important. They are the Kukpuk and Singoalik Rivers which both produce pinks, and probably some chums occasionally, during the month of August. The possibility of salmon utilizing the streams of the area either before or after the 1959 survey period is slight. Thompson (1951) pointed out that as one proceeds northward along the Pacific Coast the races of salmon concentrate their spawning periods into a progressively shorter period in order that they take advantage of the progressively shorter periods of environmental optima. It is therefore probable that in order to adapt within the stringent environmental limitations of the Arctic, the salmon must enter the streams, spawn, and die in a very short period and virtually together.

RECOMMENDATIONS

In view of the shortcomings of an evaluation of salmon production based upon a single year's observations, the following recommendations are made for 1960.

1. An aerial survey of the Kukpuk, Singoalik, and in order to improve the understanding of salmon runs in the area, the Wulik River. These surveys should be conducted as near to August 15 as practicable.

2. A landing on the Kukpuk River to establish definitely the species observed from the air. If dead salmon are available a sample of 50 of each sex should be measured from each species available. If chums are available scales should be taken from each fish measured so the age of fish in the population can be determined.
3. Visits to the villages of Kivalina and Tigara in order to question local people about the season's catch, and to observe the extent of salmon utilization in 1960.
4. Visits to all the small streams between Point Hope and Kivalina which may conceivably support salmon, in order that their productive potentials may be re-evaluated in the light of "even year" pink salmon production, and different water levels.
5. A collection of scales from 100 male and 100 female chum salmon taken in the personal use fishery at Kotzebue. This will permit an evaluation of the groups comprising the local catch and is of particular value if no chum samples are available within the study area.

Reference Cited

Thompson, W. F. (1951)

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