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JANUARY-MARCH, 1969

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Environmental and Life Sciences Division

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COLUMBIA RIVER THERMAL EFFECTS STUDY

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JANUARY-MARCH, 1969

Edited by

R. F. Foster
R. E. Nakatani

Environmental and Life Sciences Division

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March, 1969

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COLUMBIA RIVER THERMAL EFFECTS STUDY

QUARTERLY PROGRESS REPORT

JANUARY-MARCH, 1969

R. F. Foster and R. E. Nakatani, Editors

INTRODUCTION

The Columbia River Thermal Effects Study is an interagency study being carried out jointly by the Atomic Energy Commission, the Federal Water Pollution Control Administration, and the Bureau of Commercial Fisheries. Leadership for the study as a whole has been assigned to the Northwest Region of the FWPCA.

By agreement among the participating agencies, a brief progress report on each project of the study is to be provided each quarter to the FWPCA on a standardized format. The FWPCA consolidates the submissions from all contributors and re-issues the combined report to the participating agencies and to the Technical Advisory Committee.

This report documents the submissions by Battelle-Northwest staff members to the progress report for the first quarter of 1969. It is expected that the AEC will transmit the submissions by the individual authors to the FWPCA, and that FWPCA will reproduce them in their consolidated report.

COLUMBIA RIVER THERMAL EFFECTS STUDY

AEC/PNL PROGRESS REPORT

P. A. Olson

Name of Project: Effects of Fluctuating Temperatures on Juvenile Salmon.

Reporting Period: January-March, 1969.

Date Project Initiated: October, 1968.

Date Project to be Completed: Continuing.

Progress During Reporting Period:

Experimental lots of fall chinooks continue to be exposed to temperatures 1, 2 or 3° F above and then below reference temperature on alternate days, and also to daily temperature changes from 3° F above the reference temperature for eight hours to 3° F below for 16 hours. These studies are to determine to what extent water temperatures can fluctuate and still be acceptable for development of young chinook. In addition, four lots are being studied under non-oscillated temperature conditions but following the seasonal river temperature pattern to provide a basis of comparisons for the oscillating temperature conditions.

All lots have now reached the feeding stage. To date none of the fluctuating temperature conditions appears to have caused any significant differences in mortalities or growth from those in the non-oscillated conditions. Table I summarizes the mortality and growth data for the eight lots from each of the two spawns.

TABLE I. MORTALITY AND GROWTH SUMMARY

Spawn Number		1		2	
Trough No.	Temperature Condition	% Mortality	Mean wt.,g	% Mortality	Mean wt.,g
4	Reference Temperature + 3 F > Alternate - 3 F days	5.2	0.61	47.1	0.58
3	Reference Temperature + 2 F > Alternate - 2 F days	4.4	0.59	42.2	0.56
7	Reference Temperature + 1 F > Alternate - 1 F days	6.6	0.57	43.1	0.55
2	Reference Temperature (a)	7.7	0.57	46.2	0.58
5	Reference Temperature + 3 F (8 hrs. day) - 3 F (16 hrs. day)	6.2	0.53	41.2	0.49
8	Reference Temperature - 1 F (Same daily mean tem- perature as trough 5)	5.2	0.50	44.5	0.48
6	Reference Temperature + 3 F	70.8	0.94	83.0	0.86
1	Reference Temperature - 3 F	2.5	0.45	44.0	0.44

(a) Averages about 6° F above Columbia River temperature.

Spawn 2 has experienced considerably greater pick-off than Spawn 1 in all lots. Excessive mortalities have only occurred in the warmest lot (Trough 6). The young chinooks will continue to be reared under these regimes until they reach migrant size.

COLUMBIA RIVER THERMAL EFFECTS STUDY

AEC/PNL PROGRESS REPORT

C. D. Becker

Name of Project: Relationship of Thermal Discharge to Food and Feeding of Juvenile Chinook Salmon.

Reporting Period: January-March, 1968.

Date Project Initiated: March, 1968.

Date Project to be Completed: Continuing.

Progress during Reporting Period:

Field investigations were restricted during this period because the eggs of fall-spawning chinooks develop in the gravel of the central Columbia River during the winter when water temperatures are low and juvenile fish were not available. Emphasis was focused instead on the planning of imminent field operations, procurement and manufacture and testing of equipment, and outlining methods of data processing and analysis.

However, seining for juvenile chinooks commenced March 4 in order that samples of the first emerging fry were obtained. Small numbers of fry have appeared in one area, of intergravel seepage, which was warmed to 10-12° C. No fry are available in other areas of the river where temperatures during March remained at 2-4° C. This suggests that, as has been observed experimentally, young chinooks select warmed areas when their normal environs is below their thermal preferendum (12-14° C).

Stomach analysis of premigrant fish in 1969 will involve not only identification and enumeration of invertebrate food organisms (predominantly aquatic insects), but also the total food biomass (by weight) contained by each individual, for correlation with collection site, water temperature, and fish size. Food biomass is perhaps as important ecologically in evaluating the effect of heated discharges as the specific prey species and their numbers. While the numbers and types of insects ingested by the fish are greatly influenced by uncontrollable variables such as water level, current flow, and substrate type, total food biomass appears to be a more reliable criterion.

We have modified a standard beach seine to facilitate collection of young salmonids. The primary changes were installation of a bag in the center of the seine and deepening of the wings to entrap fish in deep water hauls.

Evaluation of invertebrate drift (aquatic insects) will be integrated with stomach analyses in 1969. We have developed a metal frame for our river skiffs for sampling with modified Nitex nets. The nets can be lowered or raised to a desired depth, up to 20 feet, on a "flagpole type" pulley and cord arrangement. Samples will be obtained simultaneously above (Vernita) and below (100-F Area) the effluent discharges for qualitative and quantitative comparison of invertebrate drifts.

COLUMBIA RIVER THERMAL EFFECTS STUDY

AEC/PNL PROGRESS REPORT

D. G. Watson

Name of Project: Hanford Chinook Salmon Population Studies

Reporting Period: January-March, 1969.

Date Project Initiated: 1946.

Date of Project to be Completed: Continuing.

Progress During Reporting Period:

Data were collected and organized for a summary report on chinook salmon spawning near Hanford. Much of these data were concerned with hydrographic conditions, such as temperature, flow, and diurnal fluctuation in river level, that may have a significant influence on local chinook spawning.

COLUMBIA RIVER THERMAL EFFECTS STUDY

AEC/PNL PROGRESS REPORT

C. C. Coutant

Name of Project: Temperature Tolerances of Adult Salmon

Reporting Period: January-March, 1969.

Date Project Initiated: Summer 1967.

Date of Project to be completed: Continuing.

Progress during Reporting Period:

Initial plans have been developed in the past quarter for tests to be conducted in the fall of 1969. In order to fully describe the responses of adult salmon to acute thermal shock the initial BNW study outline to the AEC called for two types of experiments, resistance times experiments and TLM_{96 hr.} experiments. Resistance time measurements, requiring a minimum of tank space, define the lethal and equilibrium loss responses to high lethal temperatures which occurred within an 8-hour working day. The results of these completed experiments have indicated that resistance to temperature down to 26° C could be successfully determined in this manner. Resistance times to lower lethal temperatures and determination of the ultimate incipient lethal temperature would be determined in 1969 by the bioassay technique used for determining TLM_{96 hr.}, that is, simultaneous subjection of several groups of fish to several temperatures spanning the range in

question. Fish will be given acute thermal shocks of 26, 25, 24, 23, 22, 21 and 20° C in the fall of 1969. Limited facilities and limited availability of jack fall chinook and adult coho have necessitated using three years for this overall study.

COLUMBIA RIVER THERMAL EFFECTS STUDY

AEC/PNL PROGRESS REPORT

C. C. Coutant

Name of Project: Sonic Tracking of Adult Salmonids

Reporting Period: January-March, 1969.

Date Project Initiated: Summer 1967.

Date of Project to be Completed: Summer 1969.

Progress during Reporting Period:

Detailed analyses have been made of the frequency of point locations of sonic tagged adult chinook salmon and steelhead trout during August, September and October 1968. These analyses indicate a distinct non-uniform distribution of fish throughout the area between Vernita Bridge and Hanford Village that was surveyed extensively. Two areas are notable for a consistent abundance of records, 1) the three kilometers below the KW reactor pumphouse, and 2) a three kilometer stretch opposite the inactive D reactor area. Notable for a paucity of records is the two-Km stretch downstream from the N reactor pumphouse.

Migration speeds of fish tracked through the reactor stretch have been compared with the frequencies of point locations noted above. For many tracked fish, the migration rate increased in areas with a paucity of point records and the rate slowed in areas where point records were abundant.

Coincident with intensive BNW sonic tracking in the vicinities of Hanford reactors, the BCF conducted weekly surveys for tagged fish between Priest Rapids Dam and Richland. These surveys indicate the pattern of fish locations in areas above the below the reactors and are useful for comparisons. BCF has made the survey data available to BNW to determine whether fish locations near reactor areas are peculiar to that stretch, but the analysis of this data is not yet complete. In general, the summer pattern of higher fish densities along the Franklin-Grant County (North and East) shoreline is continuous throughout the Priest Rapids to Richland reach although it is most pronounced in the stretch of operating reactors.

COLUMBIA RIVER THERMAL EFFECTS STUDY

AEC/PNL PROGRESS REPORT

C. D. Becker and E. F. Prentice

Name of Project: Effect of Thermal Shock From Effluent Discharge
on Young Salmon

Reporting Period: January-March, 1969.

Date Project Initiated: March, 1968.

Date Project to be Completed: Continuing

Progress during Reporting Period:

Methods used in 1968 have been refined in order to obtain data with greater suitability for precise evaluation of thermal exposure and potential thermal shock, encountered by young salmon under natural river conditions at Hanford. No juvenile fish are available in the central Columbia during the winter. A few fry have emerged in March, but the bulk of the emerging population will not become available until mid April.

In 1969, as in 1968, young chinook salmon held in live boxes will be drifted through areas of thermal discharge (midriver plumes and shore-line seepage areas), while the ambient temperatures encountered by the fish are monitored.

Innovations for this year's operations, completed during the reporting period, are as follows:

- 1) Acclimation float, a specially devised acclimation float was

installed in the river above Hanford for acclimation of the test fish. The fish will be protected from the full force of the current, but receive complete and rapid circulation of river water, in compartments holding various experimental lots.

2) Drift Live Boxes, new live boxes to retain the fish during the drifts will be used. These are constructed of nylon netting (fry) and rubber web (finglerlings), to permit more rapid exchange of water while protecting the fish from excess physical stress. Temperatures will be recorded simultaneously within and outside of the live boxes.

3) Rapid response temperature probes, new probes with a short temperature response time are available. These probes, normally used in the laboratory, are relatively delicate for field work and must be protected with special wrappings. A better record of the extent, fluctuation, and duration of exposure temperatures will be provided.

4) Plume markers, the locations of midriver plume discharges have been marked by anchored fluorescent floats. The direction of the drifts downriver through the plumes can thus be more rigidly controlled, exposing the test fish to maximum temperature increase, by directing the drifts through the approximate center of the plumes.

5) Depth control, a device consisting of a vertical pipe that can be lowered to a depth of 20 feet has been developed and fastened to our river skiffs. Attached to the lower end of the pipe, the live boxes and test fish can be held at a given depth throughout each drift. Exposure to subsurface as well as surface temperature conditions thus can be tested.

6) Retention liveboxes, a modified float holding retention liveboxes has been installed well below the effluent discharge points. The test fish will be examined for latent, delayed mortalities after several days as well as for direct, immediate mortalities following each drift.

River temperatures in March, 1969, were 2-3° C. Spring drifts will commence in late March. We will use yearling chinooks initially until fry of this year's hatch are available. Because of variable river flow, regulated upriver at Priest Rapids Dam, emphasis will be placed on drifting the fish during period of low water when, theoretically, maximum conditions exist for thermal shock. This requires that drifts be conducted on weekends and during early morning hours. A floating, inclined plane trap anchored behind a midstream plume will indicate if any thermally shocked, naturally emigrating fish are carried by discharge turbulence to the surface of the river.

COLUMBIA RIVER THERMAL EFFECTS STUDY

AEC/PNL PROGRESS REPORT

C. C. Coutant

Name of Project: Performance of Thermally Shocked Young Salmon

Reporting Period: January-March, 1969.

Date Project Initiated: Summer 1967.

Date of Project to be Completed: Summer 1969.

Progress during Reporting Period:

Preliminary runs have been made in the swim test flume to determine relative swimming performance of heat shocked and control juvenile rainbow trout and coho salmon acclimated to river temperature (3-4° C), 7° C, and 10° C. No results have been analyzed in sufficient detail to be reported.

COLUMBIA RIVER THERMAL EFFECTS STUDY

AEC/PNL PROGRESS REPORT

M. P. FUJIHARA

Name of Project: Effects of Temperature on Fish Disease

Reporting Period: January-March, 1969

Date Project Initiated: January, 1969

Date Project to be Completed: Continuing

Progress During Reporting Period:

Dermocystidium salmonis

More than 50 percent of spawned out summer-run chinook salmon sampled from the Wells Dam spawning channel were found to be heavily infected with cysts of D. salmonis. A month after the spawned out chinooks had died, field tests were carried out to determine if the D. salmonis was transmitted to other species of fish in the channel. Gross and microscopic examination of internal organs and gills were made of six jack sockeye salmon and twenty coarse river fishes including Columbia River chub, squawfish, largescale suckers and whitefish. Fifty percent of the sockeye salmon were infected; however, all of the coarse river fishes were free of the disease. The data suggest that the infective stage of D. salmonis disease is temperature related and is not transmitted from infected to non-infected fishes while in the cyst stage. Coarse river fishes appear to be more resistant to the disease than salmon.

Fry from the summer chinooks were obtained from the Wells spawning channel for a disease transmission experiment. As yet, the exposed progeny are free of dermocystidium disease. The unusually low water temperature this past winter may have inactivated the pathogen.

A. salmonicida and D. columnaris

A survey has been started at White Bluffs, on the Columbia River within the Hanford Reservation, and below Ice Harbor Dam on the Snake River, to determine any relationship between seasonal changes in water temperature and the incidence of exposure and infection of coarse river fishes to furunculosis and columnaris disease. Fish are being sampled at monthly intervals while river temperatures are still cold, but the frequency will be increased to twice each month after temperatures reach 60°F.

Agglutination tests and standard isolation techniques will be used to determine exposure and infection of fishes.

Water temperatures were 40°F and 42°F respectively at the Columbia River and Snake River sampling sites during the first sampling period. Because of low water temperature, no columnaris isolates were found on any of the fish at the two sites. Residual antibodies of 1:20 to 1:160 from exposure to columnaris during 1968 were observed in 28 percent of 53 fish at White Bluffs and 36 percent of 14 fish from the Snake River.

One to two furunculosis organisms were isolated from 9 percent of the fish at White Bluffs and 1 to 4 organisms from 22 percent of the fish on the Snake River. Fifty percent and 71 percent respectively of these fish had A. salmonicida agglutinating antibodies against furunculosis disease. No conclusions can be made from this initial sampling.

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