THERMAL AND VELOCITY CHARACTERISTICS IN THE LOWER SNAKE RIVER RESERVOIRS, WASHINGTON AS A RESULT OF REGULATED UPSTREAM WATER RELEASES

by

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January 1992

BACKGROUND

In late summer and fall 1991, water temperature and velocity were monitored in the lower Snake River Reservoirs to assist in calibration of the Army Corps of Engineer's model COLTEMP (Karr et al. 1991). Numerous data points collected at a critical time provided an opportunity to assess the potential for temperature regulation to enhance migrating conditions for salmon (*Oncorhynchus* spp.). To fully provide data for calibration of the model higher flow conditions must be examined. The goal of this project is to continue monitoring water temperature and velocity in the lower Snake River reservoirs under higher flow conditions.

OBJECTIVE

1. To assess velocity and water temperature characteristics in the lower Snake River system.

PROCEDURES

Monitoring of temperature and velocity would continue at the 16 transects established upstream, within, and downstream of the lower Snake reservoirs. Transects locations in the summer and fall monitoring were (upstream to downstream): the Snake (No. 1) and Clearwater (No. 2) rivers upstream of Lower Granite Reservoir, three each in each of the four lower Snake River reservoirs (Nos. 3-14), one downstream of Ice Harbor Dam (No. 15) and one downstream of the confluence of the Snake and Columbia rivers (No. 16). Transect locations in the reservoirs were at approximately 10 mile intervals; each of the reservoirs are approximately 30 miles long. The transect downstream of Ice Harbor Dam would be located about half the distance from the Dam to the confluence with the Columbia River. Transects immediately below the Clearwater and Snake and Snake and Columbia rivers would be located approximately 1/2 to 1 mile downstream of the confluences at a point where complete thermal mixing possibly occurs. Channel morphometry and shoreline development will also determine transect locations.

The thermal and velocity characteristics at each of these 16 transects would commence in late winter and spring 1992 when flows increased to approximately 50 kcfs. Velocity profiles would be taken at the surface, two locations, each at approximately 1/3 the depth from the surface to the bottom, and immediately off the bottom (total of four vertical points) at three to five locations across the transect. Water temperature would be measured to the nearest 0.1 C using a YSI (Yellow Springs Instrument) temperature probe. Velocity measurements would be taken concurrently with temperature using a Swoffer Velocity meter. Velocity would be measured to the nearest 0.01 feet/second.

Sampling would be conducted late winter through the spring. Frequency of sampling at the established transects would coincide with changes in flow characteristics.

Reporting would consist of submitting data on a floppy diskette entered into a Quattro Pro/Lotus spreadsheet. Information presented would include: time, transect location, cross sectional location (1-3/5), depth, water temperature, and water velocity. Temperature plots would be made and FAXed to agency personnel for rapid analysis.

In addition, continuous recording Ryan TempMentors positioned in the fall, 1991 would be serviced at monthly intervals. Temperatures would be downloaded into a portable computer, transferred into QuatroPro spreadsheets and daily ranges and averages computed. Temperature recorders would be reset into position and checked again the following month. During the proposed drawdown, temperature recorders will be positioned on the bottom of Lower Granite and Little Goose reservoirs.

→ what's location of these in water column

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EVALUATION OF THE PROPOSED DRAWDOWN IN LOWER GRANITE AND LITTLE GOOSE RESERVOIRS AND RESERVOIR OPERATIONS AT MINIMUM OPERATING POOL

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February, 1992

BACKGROUND

Population characteristics of fishes residing in reservoirs that are subjected to significant changes in water levels can be substantially affected. Fish population studies on Long Lake, Spokane River, Washington (Hatch 1991), and Box Canyon Reservoir, Pend Oreille River, Washington (Liter 1991), have suggested that emigration can occur in resident fish population inhabiting reservoirs that are subjected to increased flows events or drawdowns. Resident fishes are believed to over-winter close to cover in deeper waters. Loss of these cover/over-winter areas associated wtih pool evacuations could stimulate excessive downstream mugration especially in smaller fishes. Anadromous fishes that are subjected to abrupt changes in flow patterns may exhibit downstream migration that could ultimately contribute to increased mortality or other adverse affects. At present, little information exists on the presence and abundance of juvenile anadromous salmonid fishes in the lower Snake River reservoirs during winter and early spring. Sampling in Little Goose Reservoir in 1979 indicated that numerous juvenile rainbow trout/steelhead *Oncorhynchus mykiss* were abundant in late fall samples and were still present in spring 1980 prior to the spring out-migration (Bennett et al. 1983). Sampling in fall and winter 1985-1986 indicated that juvenile kokanee/sockeye salmon *O. nerka*, chinook salmon *O. tshawytscha* and steelhead were present in Lower Granite Reservoir to varying levels of abundance depending upon the year. Sampling was limited to specific stations in the reservoir although numbers collected suggested fairly large numbers of fish could have been present.

The proposed drawdown of the Lower Granite and Little Goose reservoirs on the Snake River would create conditions far more significant than a drawdown of a few feet. As proposed, Lower Granite Reservoir will be drawndown from minimum operating pool (733 ft) to 705 ft or about 28 ft. The potential for out-migration of resident fishes and premature downstream migration of anadromous salmonids in Lower Granite Reservoir seems significant and will be investigated in this study.

Widely fluctuating water levels are commonly associated with decreased recruitment of some fishes. Maintaining operations at minimum water levels in the lower Snake River reservoirs could potentially have beneficial effects on recruitment of fishes that require stable water levels for spawning and/or rearing in shallow water. For example, predator species such as northern squawfish *Ptychocheilus oregonenesis* and smallmouth bass *Micropterus dolomieui* that rear in shallow water may have increased survival compared to that under "normal" operating conditions where water levels fluctuate about 5 ft in the lower Snake River reservoirs. Preliminary comparison of larval fish abundance on Lower Granite Reservoir has indicated that the abundance of larval fishes increased substantially in 1991 when reservoir pool levels were maintained at minimum operating levels (MOP). Numerous differences occur from year to year in the timing and magnitude of peak flows, temperature, nutrient levels, and reservoir operations. However in 1991, one major difference in Lower Granite Reservoir was operating at minimum operating pool or 733 ft elevation. These levels were maintained for the spring and early summer with about a 1 ft fluctuation. Water levels in 1991 were considerably more stable than those in the past that have fluctuated frequently from 738 to 733 ft elevation. Stable water levels could enhance recruitment of fishes and especially potential salmonid predators. Part of this study will be directed at evaluating the effects of maintaining a constant water level at minimum operating pool in Lower Granite Reservoir.

OBJECTIVES

1. To assess the presence of juvenile salmonid fishes in Lower Granite Reservoir in winter/spring 1992, prior to the drawdown, and in Little Goose Reservoir following the drawdown;

2. To assess the occurrence of Gas Bubble Disease in juvenile salmonids in Little Goose Reservoir during and immediately following the drawdown in 1992;

3. To assess the occurrence of outmigration of anadromous and resident fishes from Lower Granite Reservoir associated with the proposed drawdown;

4. To assess the effect of the drawdown on size and species composition of fishes in Lower Granite Reservoir;

5. To assess the effects of drawdown in Lower Granite Reservoir on white sturgeon *Acipenser transmontanus* distribution and abundance;

6. To assess year-class strength of potential predator species from 1991 in rearing habitat in Lower Granite Reservoir;

7. To quantify larval fish abundance in 1992 when water levels in Lower Granite Reservoir are maintained at minimum operating pool (MOP) during the spring and early summer of 1992; and

8. To compare abundance of larval fishes from 1992 with that from previous years of fluctuating and MOP operations in Lower Granite Reservoir.

PROCEDURES

To assess the abundance of juvenile salmonids in Lower Granite Reservoir, we would sample along the shoreline and pelagically during the daytime and along the shoreline at night at random locations. Previous sampling indicated that juvenile salmonids were predominantly shoreline oriented during the winter. We would make replicate samples with a 100 x 8 ft beach seine with a 8 x 8 x 8 bag at 35 random locations in Lower Granite Reservoir. We would also sample at night using shoreline electrofishing (what are effects on Juv. salmonids) using the same design. At 35 locations we would sample for 10 minutes of effort at each of the locations. From these samples, we would be able to expand our estimates using a simple randomized sampling design and estimate the number of salmonids by species. We would also calculate 90% confidence intervals on our estimate (Scheaffer et al. 1986).

Pelagic sampling would be conducted by using a two boat surface trawl. We would randomly sample transects in Lower Granite and Little Goose reservoirs to assess the abundance of salmonid fishes in pelagic waters. From pelagic sampling we would be able to expand our estimates of abundance to the entire reservoir and compute confidence intervals.

To assess the effects of drawdown on resident fishes in Lower Granite Reservoir, we would conduct extensive fish community sampling in Lower Granite and Little Goose Reservoirs. Sampling would consist of shoreline electrofishing, beach seining and gill netting conducted at random locations throughout the reservoir in the spring and summer. Beach seining would be conducted during the daytime whereas electrofishing and gill netting would be conducted at night. Fish would be netted, examined for marks, measured and released. Sampling was conducted in Lower Granite Reservoir during spring through fall, 1991 to assess gear selectivity. All fish were fin clipped or opercle punched to identify them at some later time. Sampling in both reservoirs would provide and opportunity to assess their presence in Lower Granite or outmigration into Little Goose Reservoir. We will also attempt to electrofish during the period of water level stabilization at 705 ft elevation. All fish would be fin clipped for future identification and possible recovery in either Lower Granite Reservoir or Little Goose Reservoir.

Extensive fish sampling has been conducted in Lower Granite Reservoir from previous studies. The size composition and species composition of the community has been determined for littoral, pelagic and profundal habitats in Lower Grnaite Reservoir (Bennett and Shrier 1987; Bennett et al. 1988, 1990, 1991). We will compare the species and size composition of Lower Granite Reservoir following drawdown with that prior to drawdown to assess the effects of the drawdown on Lower Granite Reservoir.

To assess differences in community structure from pre-to post drawdown, comparisons of catch/effort of the more abundant species and proportional composition will be made. Random sampling in Lower Granite and Little Goose reservoirs will facilitate these comparisons. Also, sampling at specific stations as part of another research effort in Lower Granite Reservoir will provide additional information.

these are being marked

We would also sample for sturgeon during the drawdown and following to further assess the effects of the drawdown on resident fishes. Extensive sampling conducted in 1990 and 1991 has provided background information on distribution, abundance and size composition. Sampling in 1992 will provide a comparison with results from the 1990 and 1991 sampling that was also conducted seasonally. Selected areas in Lower Granite Reservoir provided substantially higher catch rates than others; catch rates in these areas will be compared between pre and post drawdown years.

Larval fish abundance would be determined as in previous years using 1/2 m tow nets and a hand drawn beam trawl (Bennett et al. 1991). We would sample twice at biweekly intervals from June through mid-September 1992. Paired nets would be towed at night approximately 1.6m/s at the surface and 1 m in depth for 3 min at each depth. Three paired hauls would be made at each station each night we sampled. Samples from each net would be preserved separately which would provide six samples/smapling location/sampling date. The beam trawl (LaBolle et al. 1985) would be pulled along the shoreline by two people over a standard distance of 15 m during the daytime. Three hauls would be made along the shoreline in shallow (<1m) and deeper (>1m) water for a total of six hauls/station/sampling date. All samples would be preserved in 10% formalin for later enumeration.

To assess year-class strength of predator fishes from 1991, we would beach seine selected shallow water habitats in Lower Granite Reservoir during spring and summer 1992. Beach seining would be conducted in a standardized fashion, identically to previous years to facilitate comparison of results (Bennett and Shrier 1987; Bennett et al. 1988, 1990, 1991). We would sample during the day twice monthly during May, June, July and August using a 100 x 8 ft (30.5 x 2.4m) seine constructed of 1/4 inch (0.64cm) knotless nylon mesh with a 8 x 8 x 8 ft (25.4m^3) bag. A standard haul would be made by setting the seine parallel to the shoreline using 50 ft (15m) extension ropes which sample approximately 0.08 acres (454m^2). Three hauls/station would be made each time sampling was conducted.

Comparison of abundance among years would be made by analysis of variance (P=0.10). Because of the assumptions of normality and equal variances using analysis of variance, we would transform the catches into ranks and use the ranks in the analysis.

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ELECTROFISHING DESIGN

Lower Granite Reservoir was divided into 440 yard sections, for a total of 250 sampling units. Each 440 yard sampling unit was assigned a number corresponding to an associated shoreline habitat type. The following were the 5 categories of shoreline habitat:

1- Talus
2- Rip Rap
3- Sand
4- Embayment
5- Cliff

With the above breakdown, the number of possible sampling units for each habitat were as follows:

Talus	RipRap	Sand	Embayment	Cliff
33	122	22	1	70

To determine the number of sample units needed to be sampled within each habitat type we used a Proportional Allocation formula (Scheaffer et al. 1990), because we are interested only in the total mean.

Proportional Allocation:

$n_i = n(N_i/N)$

n = Number of possible sampling units,
N_i = Total number of samples to be taken, (an arbitrary number, we chose 80 sampling units for our effort),
N = Total number of sample units.

Example: Talus (35 possible Units)
$n_i = n(N_i/N) = 33(80/250)$
n_i = 12 transects need to be for Talus shorelines.

Number of samples needed for each shoreline habitat type.

Talus	RipRap	Sand	Embayment	Cliff
12	39	7	1	22

The total mean for all shoreline habitat is computed with the following formula:

Mean

$$\bar{y}_{st} = \frac{1}{250}\left(\frac{\bar{y}_1}{35} + \frac{\bar{y}_2}{122} + \frac{\bar{y}_3}{22} + \frac{\bar{y}_4}{1} + \frac{\bar{y}_5}{70}\right)$$

Variance

$$\hat{V}(\bar{y}_{st}) = \frac{1}{250^2}\left(\frac{1}{35^2}\left(\hat{V}ar(\bar{y}_1)\right) + \ldots\right.$$

$$\text{Bound} = 2\sqrt{\hat{V}(\bar{y}_{st})}$$

SURFACE TRAWLING DESIGN

Lower Granite Reservoir was divided into three reaches. Upper reach (RM 139.0-RM 127.0), mid-reach (RM 127.0-RM 119.0) and lower reach (RM 119.0-107.5). Each reach was divided into 1 mile transects. The upper reach has 24 sampling units, the mid-reach has 16 sampling units and the lower reach has 24 sampling units, for a total of 64 sampling units. We selected 35 as the number of samples to be taken by surface trawling.

The number of sample units needed in each reach was also determined by the Proportional Allocation formula.

$n_i = n(N_i \backslash N)$

The number of samples to be taken in each reach are as follows:

Upper Reach - 14
Mid- Reach - 9
Lower Reach - 14

The same variance and bound formulas will be used.