Duncan Dam Project Water Use Plan

Monitoring Program Terms of Reference

- DDMMON-17  Duncan Reservoir Kokanee Stock Assessment

December 15, 2008
1.0 MONITORING PROGRAM RATIONALE

1.1 BACKGROUND

During the Duncan Dam Water Use Plan (DDM WUP), the WUP Consultative Committee (DDM WUP CC) identified fish productivity as a key value for consideration in the decision process. However, there are significant data gaps related to fish use and abundance in the reservoir, limiting the CC’s ability to make operating decisions that would minimize impacts or improves conditions to fish populations. To address these data gaps, the CC recommended a set of monitoring programs for the reservoir to:

- Assess fish life history use and distribution (DDMMON#10);
- Assess the status and influence of reservoir operations on burbot populations (DDMMON#11); and
- Assess the status of kokanee populations (DDMMON#17).

Kokanee are a good indicator of reservoir productivity as they are dependant on healthy limnological processes to flourish. In reservoirs, productive processes can be limited due to reservoir fluctuation, entrainment of nutrients and instability of spawning and rearing habitats. Habitat use by kokanee will be investigated in DDMMON#10, but additional study is required for stock assessments to provide a baseline from which future evaluations of reservoir operation impacts can be derived. Because little was known about the habitat use and status of kokanee in the reservoir, there were no operating constraints recommended during the WUP for fisheries benefits. Rather, the CC recommended that habitat use information be collected and a baseline population level be measured during the review period for consideration in future planning processes. This monitoring program terms of reference describes the approach required to measure a baseline kokanee population level in Duncan Reservoir.

Completing this monitoring program will result in partial fulfillment of requirements ordered by British Columbia’s Comptroller of Water Rights, and will specifically address clause 6(f) of BC Hydro’s Duncan Dam Conditional Water License 27027, to monitor kokanee populations in Duncan Reservoir.

1.2 MANAGEMENT QUESTIONS

The CC recommended this monitoring program to address the following key management question:

What is the baseline population level for kokanee in Duncan Reservoir?

This monitoring program will provide this information to consider the following questions for future planning processes:

1. How does the kokanee population compare with other reservoirs and natural lakes in the Columbia-Kootenay area?

2. In consideration of the habitat use and stock assessment information collected over the review period, what are the possible bottlenecks to productive success for kokanee in Duncan Reservoir?
This program will integrate existing knowledge with other monitoring information to define impact pathways for consideration in future monitoring/assessment programs.

1.3 MANAGEMENT HYPOTHESIS

To address the management questions above, the following null hypotheses are provided to be tested during the review period:

H01: There is no difference in kokanee population aspects (density/size at age) in Duncan Reservoir in comparison with populations in other comparable reservoirs or natural lakes in the region.

Where production (fish per unit area) is lower than anticipated for the region (in consideration of production limiting variables such as temperature and local nutrient loading), habitat use and limnologic monitoring conducted in DDMMON#10 will be assessed to define impact pathways that describe operational influences on kokanee productivity. These pathways will be assessed in a preliminary manner to address the following hypotheses:

H02: Kokanee production in Duncan Reservoir is limited by operations through habitat instability.

H03: Kokanee production in Duncan Reservoir is limited by operations that limit food availability.

H02 and H03 will be addressed in consideration of results from DDMMON#10. The assessment will include a review of both habitat availability for all kokanee life histories, and specific DDM WUP operations that potentially limit success of particular life histories.

1.4 KEY WATER USE DECISION AFFECTED

This monitoring program was recommended by the CC to inform future water planning processes on the Duncan Reservoir, by identifying potential issues in kokanee recruitment and/or specific operating windows that potentially limit kokanee productivity. Specifically, the program will provide information required to support future operating decisions by providing the rationale for deviating from recommended DDM WUP operations.

2.0 MONITORING PROGRAM PROPOSAL

2.1 OBJECTIVES AND SCOPE

The overall objectives of the monitoring program are to:

a) Provide baseline information on the biological characteristics, distribution and abundance of kokanee populations in Duncan Reservoir, and

b) Provide information required to link the effects of reservoir operation to population levels.

The program will improve understanding of the effects of reservoir operation on kokanee populations, and will lead to a better understanding of the implications of entrainment on kokanee populations to assist in future decisions regarding the operation of Duncan Reservoir.
The scope of the monitoring program will be to study kokanee populations in Duncan Reservoir through completion of three annual hydroacoustic and midwater trawl surveys. The data will be collected to monitor the status of the reservoir kokanee populations, and verify and compare population trends in abundance for consideration in future planning processes. In concert with results on habitat use and distribution defined in DDMMON#10, this data will serve as a useful indicator of productivity in Duncan Reservoir, and contribute to future operating decisions to improve conditions for kokanee.

2.2 APPROACH

The general approach of the monitoring program will be to collect a three-year dataset on kokanee populations in Duncan Reservoirs to resolve current gaps on how reservoir operations affect abundance, distribution and age structure over time. This will be accomplished by:

- Collecting three years of information on the abundance, distribution and age-structure of kokanee populations;
- Identifying recruitment changes and, using available habitat use information, identifying potential causal factors related to reservoir operations, and
- Recommending safe operating ranges and future study programs to assess fisheries impacts.

This data will be reviewed in conjunction with data obtained through the reservoir habitat use study (DDMMON#10) and other large lake/reservoir programs (e.g., from the Columbia monitoring programs) to improve our understanding of how reservoir operations influences trends in kokanee growth and abundance.

2.3 METHODS

2.3.1 Project Coordination

Project coordination will involve the general administrative and technical oversight of the program. This will include, but not be limited to 1) budget management, 2) study team management, 3) logistic coordination, 4) technical oversight for field and analysis components, and 5) facilitation of data transfer among related investigations.

A safety plan must be developed and submitted to the BC Hydro contact, for all aspects of the study involving field work, in accordance with BC Hydro procedures and guidelines. Specific safety training may be required.

2.3.2 Field Sampling

*Hydroacoustic surveys*

Hydroacoustic and trawl surveys will be conducted in Years 9, 10 and 11 of the 11-year review period in Duncan Reservoir to monitor trends in the distribution, abundance, and age structure of the kokanee population in Duncan Reservoir. Survey design and methods will closely follow existing protocols established for BC Ministry of Environment's hydroacoustic sampling program (Sebastian in press, Manson 2005). Trawl catch data will provide representative samples of fish.
throughout the reservoir, and at different depths to properly characterize fish size at age for the majority of fish detected in the hydroacoustic surveys.

It is preferred that surveys will be consistent with the timing of mid-spring water quality sampling in DDMMON#10 – Duncan Reservoir Fish Habitat Use Monitoring.

**Limnological Monitoring**

To facilitate interpretation observed trends in kokanee abundance, supplemental habitat information will be collected during the hydroacoustic surveys, including water temperature, conductivity, dissolved oxygen concentrations, Secchi disc profiles, and zooplankton sampling. Provisions for four sample sites are provided in the study budget. Reservoir water level at the time of the survey will be recorded to allow determination of reservoir volume, surface area and limnetic habitat area for extrapolating kokanee abundance. Sampling will occur during the same period as the hydroacoustic sampling. Zooplankton sampling will be consistent with that done in DDMMON#10 – Duncan Reservoir Fish Habitat Use Monitoring (if trawl sampling is used for zooplankton sampling as opposed to the site sampling done in DDMMON#10, then zooplankton population estimates must be comparable between studies).

**2.3.3 Data Analysis**

**Physical Habitat**

Sampling transects and limnological station locations will be recorded by GPS and plotted on a location map. Reservoir water surface elevation will be used to adjust surface area and limnetic habitat areas for the habitat zones surveyed in Duncan and Revelstoke reservoirs.

**Fish Abundance Estimates**

Several statistics will be computed to show abundance trends over time for each reservoir/year combination, including kokanee density by transect and depth stratum and population size by zone.

**Fish Size Distribution**

The acoustic size distribution, along with target strength distribution and species-specific fish size at age information from trawl samples, will be used to proportion fish into two size classes representing age 0 and age 1-3 fish, as described by Sebastian (2004, 2005). Trawl data variance will be integrated into stock assessment analyses to properly report ranges in stock assessment values.

**2.3.4 Operations Analysis**

**Information Review**

The data collected to date under the reservoir fish habitat use study (DDMMON#10) will be reviewed annually and integrated with results observed in this study, starting in Year 9. Life history timing and spawning requirements defined in DDMMON#10 will be the basis for defining impact pathways between reservoir operations and reproductive success. Any statistics on recreational fisheries in the area will be integrated as well to provide context for potential population influences.
Existing data on kokanee production in the region will be compiled for a relevant time period to determine the status of the Duncan kokanee population in comparison with other regulated and natural lakes. A statistical comparison of indexed values (e.g., fish per unit area) will be conducted to determine if significant differences exist. Limnological values (water quality, nitrogen and phosphorous concentrations, photosynthetic rates, etc.) will be compared between those collected for this reservoir and those collected under other monitoring programs and historic assessments in the region. Significant differences will be evaluated to determine if these contribute to population level differences.

**Operations Impact Analysis**

The hypotheses defined above will be tested according to the inferences the data in this study provide (age structure changes between the three years of data). Analyses will be conducted on a life stage basis to determine if there is a statistical correlation between operating parameters of the reservoir (i.e., minimum elevation, maximum elevation, annual drawdown) and the abundance or growth of kokanee populations in Duncan Reservoir. The strength of inferences will depend of the amount of contrast in operations over the duration of the monitoring program.

2.3.5 **Reporting**

A brief technical report of the findings of the program will be prepared for Years 9 and 10 of the review period (the first two years of the monitoring program), which will include results of between-year trend analyses that determine whether abundance, age, growth rates and distribution of kokanee are changing over time with reservoir operations.

Upon completion of the monitoring program (Year 11 of the review period, Year 3 of this monitoring program), a comprehensive final synthesis report will be prepared for use in the next review of the Duncan Dam Water Use Plan, which will include:

a) an executive summary;

b) a description of the methods employed;

c) a data summary;

d) a comparison of results between years;

e) a detailed summary of the findings as they relate to the ecological hypotheses and the key management questions, including a review critical operating windows/constraints, and recommendations for future studies.

Reports will follow the standard format that is being developed for WUP monitoring programs. All reports will be provided in hard copy and as Microsoft Word and Adobe Acrobat (*.pdf) format, and all maps and figures will be provided either as embedded objects in the Word file or as separate files.

2.4 **INTERPRETATION OF MONITORING PROGRAM RESULTS**

The proposed monitoring program will provide valuable information to address three specific categories of uncertainty as it relates to operational impacts of Duncan Reservoir on kokanee populations.

H01: Where significant differences are detected between indexed stock assessment results observed for Duncan Reservoir kokanee populations in
comparison with other reservoirs and natural lakes, operations analysis will be conducted to determine any operational triggers exist under the current operating regime.

H02: Data collected during the monitoring program will allow quantitative inferences in the trends in kokanee abundance in relation to reservoir operations, and will help determine the impact of the current operating regime of Duncan Reservoir on kokanee production. Supplemental data on habitat conditions, in conjunction with results of the fish habitat use study (DDMMON#10), will be analyzed to support inferences about the relationship between operations and observed trends.

H03: Analyses will be conducted to determine whether there is a statistical correlation between kokanee populations and limnological values. Qualitative inferences will then be drawn on the relative importance of pelagic productivity (e.g., food availability) in limiting population abundance.

2.5 SCHEDULE

It is proposed that this program be conducted annually for Years 9, 10 and 11 of the Duncan Dam review period. Note that conditions on these reservoirs, particularly Duncan, can be dangerous and unpredictable and that sampling may be altered, interrupted, or curtailed in any given year. It is anticipated that these assessments will be conducted in spring, draft reporting in Fall (Year 9 and 10) and early Winter (Year 11) and final reporting January (Years 9 and 10) and February (Year 11).

2.6 BUDGET

The total annual budget for the 3-year Duncan Reservoir Kokanee Stock Assessment program was originally approved by the DDM WUP CC at $84K (in 2004 dollars), assuming Ministry of Environment would coordinate data collection and analysis. The budget as proposed is estimated to cost $154K (2004$), a 80% increase, due primarily to the revised assumption that field work will be carried out by independent consultants. The program has an anticipated inflated cost of $199K.

3.0 REFERENCES


**Personal Communication**