Columbia River Project Water Use Plan

Monitoring Program Terms of Reference

KINBASKET RESERVOIR
FISH AND WILDLIFE INFORMATION PLAN

- **CLBMON-4 Kinbasket Reservoir Fish Stranding Assessment**

24 October 2007

Terms of Reference for the Columbia River Project Water Use Plan Monitoring Programs Kinbasket Reservoir Fish and Wildlife Information Plan

1.0 OVERVIEW

This document presents Terms of Reference for monitoring programs under the Kinbasket Reservoir Fish and Wildlife Information Plan (Table 1). These programs will evaluate the potential effects of Mica Dam and Kinbasket Reservoir operations on fish habitat and fish populations, wildlife habitat and wildlife populations.

This document provides detailed Terms of Reference for the following programs:

1) CLBMON-1 Mica Dam Total Gas Pressure Monitoring and Abatement Program: a 2-year study to determine dissolved gas supersaturation with synchronous condense operation of Units 3 and 4 in relation to Units 1 and 2, which have been previously monitored.

2) CLBMON-2 Kinbasket and Revelstoke Reservoirs Kokanee Population Monitoring: a 12-year program to monitor trends in the biological characteristics, distribution and abundance of kokanee populations in Kinbasket and Revelstoke reservoirs, and provide information required to link the effects of reservoir operation to population levels.

3) CLBMON-3 Kinbasket and Revelstoke Reservoirs Ecological Productivity Monitoring Program: a 12-year study to define the trophic web mechanisms and dynamics of Kinbasket and Revelstoke reservoirs, and determine if changes in pelagic productivity are associated with reservoir operations.

4) CLBMON-4 Kinbasket Reservoir Fish Stranding Assessment: a 3-year study to qualitatively evaluate the extent of fish stranding caused by the annual drawdown of Kinbasket Reservoir.

5) CLBMON-5 Kinbasket Reservoir Burbot Life History and Habitat Use Assessment: a 3-year study to obtain baseline data on the biological characteristics of burbot populations in Kinbasket Reservoir, and provide information to evaluate potential effects of reservoir operation on burbot population productivity

6) CLBMON-6 Kinbasket Reservoir Bull Trout Life History and Habitat Use Assessment: a 3-year study to obtain baseline data on the life history and habitat characteristics of juvenile bull trout in Kinbasket Reservoir, and provide preliminary information to determine if reservoir operations could have an effect on bull trout populations.

7) CLBMON-7 Kinbasket Reservoir Rainbow Trout Life History and Habitat Use Assessment: a 3-year study to obtain baseline data on the biological characteristics of rainbow trout in Kinbasket Reservoir, and provide the information required to evaluate the impacts of reservoir water levels on the productivity of rainbow trout populations.

8) CLBMON-8 Kinbasket Reservoir Monitoring of the Valemount Peatland: a 3-year monitoring program to address key uncertainties regarding the relative contribution and importance of the current reservoir operating regime to the erosion processes affecting the

wetland, obtain an inventory of plant and wildlife species, and determine whether the long-term viability of the wetland, and associated plant and animal species, are being affected by erosion processes related to reservoir operations, and how these effects may be mitigated.

Table 1 Kinbasket Reservoir Fish and Wildlife Information Plan Monitoring Program Terms of Reference Submission Information

Name of Monitoring Program	Order Clause Fulfilled	Submitted with this Package	Previously Submitted To CWR	Submission Date	Leave to Commence
CLBMON-1 Mica Dam Total Gas Pressure Monitoring and Abatement Program	Schedule A: 5.a	Yes	No	24 October 2007	No
CLBMON-2 Kinbasket and Revelstoke Reservoirs Kokanee Population Monitoring	Schedule A: 5.b Schedule B: 1.a	Yes	No	24 October 2007	No
CLBMON-3 Kinbasket and Revelstoke Reservoirs Ecological Productivity Monitoring Program	Schedule A: 5.c Schedule B: 1.b	Yes	No	24 October 2007	No
CLBMON-4 Kinbasket Reservoir Fish Stranding Assessment	Schedule A: 5.d	Yes	No	24 October 2007	No
CLBMON-5 Kinbasket Reservoir Burbot Life History and Habitat Use Assessment	Schedule A: 5.e	Yes	No	24 October 2007	No
CLBMON-6 Kinbasket Reservoir Bull Trout Life History and Habitat Use Assessment	Schedule A: 5.f	Yes	No	24 October 2007	No
CLBMON-7 Kinbasket Reservoir Rainbow Trout Life History and Habitat Use Assessment	Schedule A: 5.g	Yes	No	24 October 2007	No
CLBMON-8 Kinbasket Reservoir Monitoring of the Valemount Peatland	Schedule A: 5.h	Yes	No	24 October 2007	No

2.0 MONITORING PROGRAM RATIONALE

Early on in the Columbia River Water Use planning (WUP) process, the WUP Consultative Committee (WUP CC) recognized that there was a great deal of uncertainty regarding whether the lack of constraints on operation of Kinbasket Reservoir was having a significant impact on fish and wildlife and associated habitat. A number of key hypothesized impacts were identified during the issue scoping phase (e.g., entrainment at Mica Dam, and interruption of natural sturgeon recruitment processes).

However, a general lack of data on the relative abundance, distribution, life history and seasonal patterns of habitat use and supporting ecosystem processes in the upper Columbia River and Kinbasket Reservoir, precluded incorporation of these concerns into Water Use Plan assessments.

The WUP CC explored alternative ways of operating Kinbasket Reservoir to provide benefits to fish and wildlife by imposing minimum elevation constraints. However, the ability to track the performance of the alternatives was limited to use of habitat-based measures (pelagic productivity), which were developed based on limited site-specific data and professional judgment. Initial modeling results showed that some improvements to pelagic productivity could be achieved through a minimum elevation constraint, but that this constraint would incur a high cost in foregone power generation. While the WUP CC agreed to stop exploring water management options for Kinbasket Reservoir for more cost-effective non-operational works, it was acknowledged that this decision was based on a number of uncertain assumptions about reservoir ecology and the influence of reservoir operations. The WUP CC underscored the need for better information to support future decision-making as a key outcome of the Columbia River Water Use planning process.

The operational link for many of the proposed monitoring studies, developed to address current data gaps, was considered tenuous given that there were no operational changes being considered for Kinbasket Reservoir. However, the WUP CC recognized that a large obstacle to recommending operational or physical works for the reservoir was the lack of quantitative data on fish and wildlife populations. Therefore, the proposed monitoring studies were accepted as meeting the Water Use Plan monitoring criteria, because they are the only tool available to validate the assumptions made by the WUP CC when deciding on operational changes.

Although no operating changes were considered for Revelstoke Reservoir, the WUP CC recommended that some of the fish-related studies in Kinbasket be linked to studies in Revelstoke to provide a comparison of trends to inform on operational impacts.

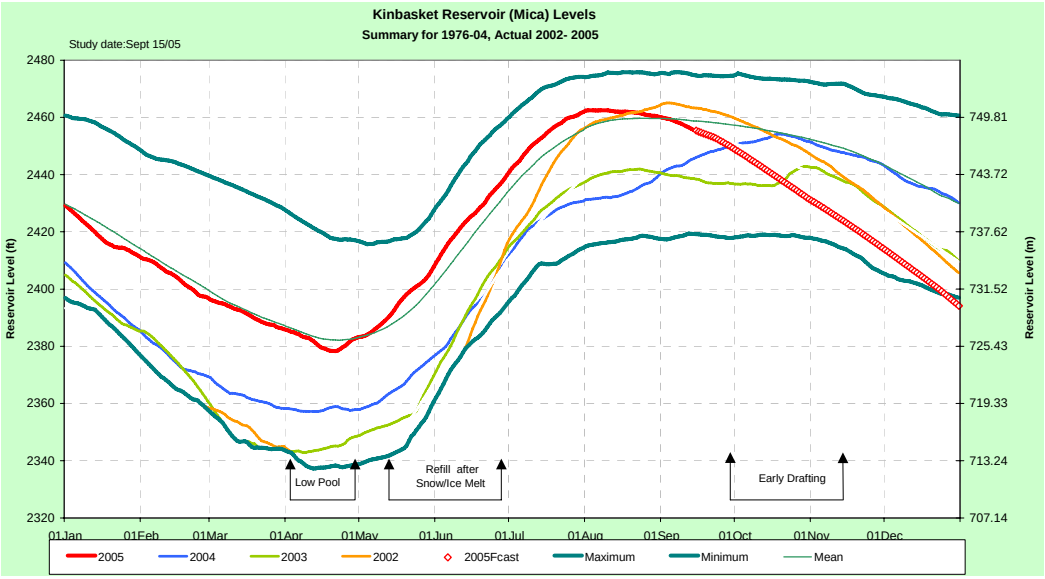

Figure 1 Seasonal pattern of water level drawdown and refill for Kinbasket Reservoir

Monitoring Study No. CLBMON-4
Kinbasket Reservoir Fish Stranding Assessment

1.0 MONITORING PROGRAM RATIONALE

1.1 Background

Operation of Kinbasket Reservoir is dictated largely by the need to capture spring runoff to meet flood control and power generation requirements. The reservoir water level generally begins to increase in May, when Mica discharges are reduced due to lower system demands and increased local inflow at Revelstoke Dam. The reservoir usually reaches its annual maximum storage level by August or September. Drawdown generally begins in September or October when inflows diminish and system load increases. In most years, Kinbasket Reservoir is at or near low pool by April. Although the reservoir is licensed to operate to a minimum pool elevation of 707.14 m, it has normally been operated to El.725 m in recent years, creating an operating range of 29 m. It has not been drawn down below El. 712.4 m since the reservoir was initially filled in 1976.

Although anecdotal observations of juvenile fish being stranded in isolated pools have been reported (RSMI 1994), there have been no systematic studies undertaken to determine the extent of fish stranding in the drawdown zone of Kinbasket Reservoir under various discharges and drawdown conditions or on impact of fish stranding on fish population levels. While there is a heightened risk of stranding due to the magnitude of the annual drawdown, previous qualitative examination of reservoir topography and seasonal patterns of reservoir operation has suggested that stranding likely does not affect a large portion of the fish community in the reservoir, given that most of the reservoir shorelines are rocky and have steep gradients. The topography thereby limits areas prone to formation of isolated pools relative to the size of the drawdown zone (RL&L 2001).

When reviewing the existing information, the WUP CC recognized that there was considerable uncertainty about these inferences, which led to completion of a high-level review by the Fish Technical Subcommittee to identify potential elevation thresholds and high-risk areas within the drawdown zone of Kinbasket Reservoir (Failing 2002). Based on a review of pre-impoundment topographic maps, it was noted that the majority of the upper elevations of the drawdown zone are steep sided; however, there are areas in the main arms of the reservoir (Bush Arm, Canoe Reach and the upper end of Columbia Reach) that have some potential for stranding due to their lower gradient slopes. Some high-level estimates of reservoir surface area changes at various water elevations indicated that drafting the reservoir from 754.4 m to 740 m would cause the loss of about 10 per cent of the reservoir surface area, while a drop in elevation from 740 m to 725 m could cause the loss of about 20% surface area.

The WUP CC acknowledged that further work would be required to assess the effects of reservoir drawdown on pool formation and potential fish stranding, and proposed a 2-year study to inform future water use planning decisions. It was recommended that an assessment be conducted to document key areas of concern, to determine the extent of

fish stranding due to reservoir drawdown, and to develop mitigative options for future consideration.

It is believed that minimum reservoir elevation is a key operational parameter related to the potential for stranding in Kinbasket Reservoir. Although the results of this study would not likely change reservoir operations in a significant way, they could inform on times of the year where minor operational adjustments could be made, or where physical works (e.g., recontouring) could be undertaken to reduce the incidence of stranding.

1.2 Management Questions

A key management uncertainty encountered during development of the Columbia River Water Use Plan related to the influence of current operating parameters of Kinbasket Reservoir (minimum annual elevation, reservoir filling and drafting schedules) on fish stranding risk. As such, the fundamental management questions to be addressed by this study are:

1) What is the extent of fish stranding as a result of annual drawdown of Kinbasket Reservoir?
2) Which areas of the reservoir have the greatest risk of fish stranding, and why?
3) What is the area covered by isolated pools in the dewatered zone during maximum drawdown, relative to the total surface area of the drawdown zone?
4) What percentage of isolated pools contains stranded fish?
5) At what time of year and/or reservoir elevations is stranding risk highest (e.g., at maximum drawdown)?
6) What fish species and life history stages are potentially most affected by stranding as the reservoir is drawn down?
7) Are operational or non-operational changes recommended to mitigate or to reduce the risk of fish stranding?

The ability to inform on key uncertainties related to the extent of fish stranding throughout the drawdown zone and survival rates of trapped fish (as a function of species composition in pools, length of stranding time, time of year affecting temperature, dissolved oxygen levels, and predator abundance) will be limited by several logistical challenges associated with field sampling in Kinbasket Reservoir:

- The window of opportunity to conduct field verification of fish stranding will be restricted largely to the late fall and late spring/early summer periods, because snow and ice accumulation during much of the drawdown period (November-April) will severely hamper the effectiveness of sampling efforts;
- Late fall sampling will need to occur before snow and ice cover prevents effective sampling. As drafting of the top of the reservoir is generally slow (0.3 m/week), this time frame will provide limited conditions for the formation of isolated pools due to the steepness of the shorelines. Review of pre-impoundment maps indicates that the majority of potential high-risk areas are likely to be located mid-elevation through the drawdown range. Late spring/early summer sampling will need to be initiated after snow/ice melt, which coincides with refilling of the reservoir. Kinbasket Reservoir tends to refill at a much faster rate than drafting; and
- Boating safety considerations and accessibility of boat ramps during the drawdown period will restrict boat-based surveys. In addition, the nature of the sediments in

much of the shallow-sloped areas (silt, clay) can further hinder access to sampling sites.

1.3 Management Hypothesis

Due to the constraints described above and the limited sampling effort that can be carried out within the set budget and 2-year time horizon, this study will be qualitative in nature. While results will not be interpreted through hypothesis testing, descriptive inferences can still be made to address the management questions. Therefore, the intent of the study to address key uncertainties around annual drawdown and associated fish stranding does not change.

Results of this monitoring program are expected to establish the linkage between current reservoir operations and fish stranding risk, as an indicator of relative stranding impact on fish populations. However, given the large size of the reservoir and limited sampling effort, it will not be possible to collect sufficient data to establish the significance of stranding losses on reservoir fish populations. While inferences can be made based on limited seasonal sampling and general habitat use information, quantitative data on length of stranding time, mortality rates and annual variability in stranding mortality will be lacking.

1.4 Key Water Use Decision Affected

The key water use decision influenced by the results of this monitoring program is whether minor adjustments to the current operating regime of Kinbasket Reservoir are possible or physical works in lieu of an operational change could be implemented to mitigate stranding risk. The monitoring program will provide information needed to better understand how reservoir operations affect fish stranding and inform on the need for future changes during review of the Columbia River Water Use Plan. Specifically, information is required to validate the assumptions that reservoir topography and current seasonal patterns of reservoir operation limit the potential for fish stranding within the reservoir drawdown zone.

2.0 MONITORING PROGRAM PROPOSAL

2.1 Objectives and Scope

The key objective of this monitoring program is to qualitatively evaluate the extent of fish stranding caused by the annual drawdown of Kinbasket Reservoir. The program will focus on assessing the risk of stranding under current reservoir operations, and verifying fish stranding through field surveys of those areas of the drawdown zone that pose the greatest risk of stranding. The program is to be conducted opportunistically over a 2-year time frame to ensure investigations are conducted in optimal conditions. The program will also incorporate a modeling component to determine fish stranding risk, which will be completed prior to the implementation of field surveys.

2.2 Approach

This monitoring program involves two study components: 1) a modeling exercise to estimate fish stranding risk, and 2) field surveys to provide input into and to verify the results of this analysis, as well as to obtain an estimate of relative numbers and species of fish affected by the formation of isolated pools.

1) Assessment of Fish Stranding Risk

As the formation of isolated pools during drawdown should be controlled largely by reservoir bottom topography, it is assumed that areas with minimal topographical change, localized channelization and depressions have the greatest potential to support large areas of stranding pools. Using the digital elevation model (DEM) of Kinbasket Reservoir (prepared through CLBMON-10, KIN Inventory of Vegetation Resources), it will be possible to predict the number, location and size (ha) of individual isolated pools, as well as the total area of the dewatered zone that poses a risk of fish stranding. Assuming that stranding risk is a function of total area draining into stranding pools, it should be possible to predict the relative degree of risk as a function of reservoir water surface elevation, and to identify specific elevations and times of year of greatest concern.

2) Conducting Field Surveys

Field surveys of the drawdown zone of Kinbasket Reservoir will be conducted to verify the inventory of isolated pools and predictions of stranding risk generated from the DEM, and to inform on relative numbers, fish species, and life history stages affected by stranding in various isolated pools during low reservoir elevations. The field component will likely consist of aerial overflights of the reservoir drawdown zone, followed by ground-based surveys.

To capture potential worst-case conditions, field sampling will be carried out on an opportunistic basis in two of the 12 years of the Water Use Plan when water supply forecasts predict low minimum pool elevations for Kinbasket Reservoir. Three surveys will be conducted in each year, which will aim to capture a range of reservoir water levels and exposure durations. These surveys will coincide with drafting of the reservoir prior to snow accumulation and ice cover, low minimum pool, and early refill of the reservoir after snow/ice melt and before the majority of high-risk areas are re-inundated.

2.3 Tasks

2.3.1 Task 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 selection, 3) technical oversight in field and analysis components, 4) logistic coordination, and 5) facilitation of data transfer among other relevant programs.

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 Task 2: Stranding Risk Assessment

Using a combination of GIS modeling and field surveys, the risk of fish stranding will be evaluated against reservoir operations. The DEM, produced through the KIN Inventory of Vegetation Resources program (CLBMON-10), will be used in conjunction with historical water level data to predict specific elevations and quantify areas where isolated pools are likely to form during drawdown of Kinbasket Reservoir. Tasks shall follow the methodology developed by Korman and Buszowski (2000).

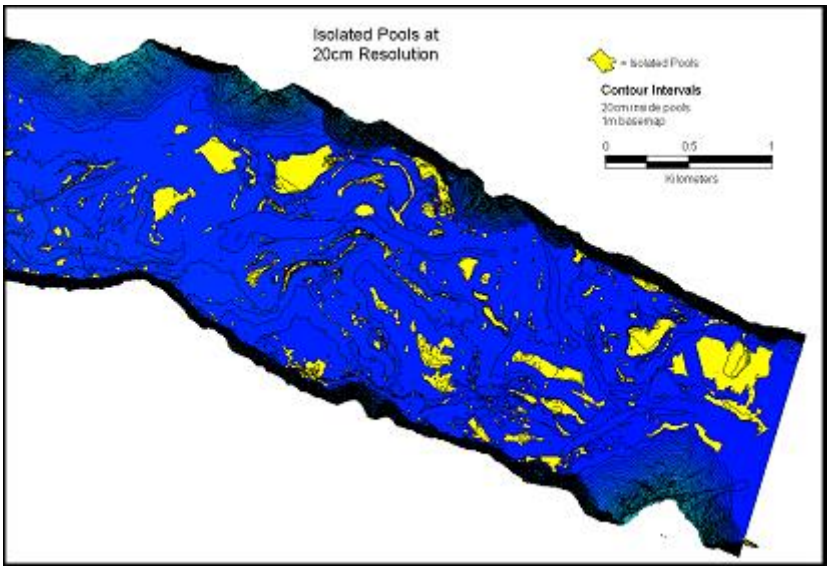

Figure CLBMON-4-1 **Example map showing the distribution of isolated pools computed using 20 cm contour intervals from a digital elevation model (taken from Korman and Buszowski 2000)**.

2.3.3 Task 3: Field Survey

Based on the detailed inventory of isolated pools generated from the DEM, key areas of the drawdown zone will be identified as candidate sites for field verification of fish stranding. As some pools could drain between the time they are exposed and the time of the field surveys, helicopter overflights of the reservoir will be conducted to verify the existence of pools selected for sampling. This approach will also provide the opportunity to compare observed pool formation with the inventory to address uncertainty related to drainage rates and verify predictions of the GIS analysis.

Timing of Field Surveys

Aerial overflights and ground surveys will be conducted in each year of the 2-year program, occurring on three occasions each year (Figure 1).

- During the late fall period to obtain counts of newly stranded fish;
- During the late winter/early spring period when the reservoir elevation has reached minimum pool level; and
- During the late spring/early summer period once snow and ice cover no longer prevent effective sampling of the pools.

Helicopter Overflights

At the initiation of each field survey, a flight of Kinbasket Reservoir will be conducted to document the location, approximate size (ha) and number of isolated pools within the reservoir drawdown zone. Observational data related to fish presence in pools, vegetation and evidence of wildlife (e.g., tracks, direct counts) around pools will also be recorded during the overflights. The areas of interest may be videotaped with GPS locations embedded on the tape.

Data Collection

Based on the detailed inventory and direct observations made during the aerial flights, a number of isolated pools will be selected for sampling. Selection of sampling sites will consider sampling logistics, relative location within the reservoir to obtain a representation of pools isolated over various time periods, and relative abundance of pools of similar size throughout the drawdown zone.

Environmental data collected at each sample pool will include water turbidity, dissolved oxygen levels and water temperature. Pool depth, surface area and substrate type/size will also be measured. Observational data on wildlife use of the area will also be collected during the winter surveys, including direct counts of wildlife observed entering or leaving holes in the ice and counts of animal signs. These data will assist in linking fish counts made during the late fall (start of drawdown) with those made during the late spring/early summer surveys (start of refill), and will provide an indication of predation effects on numbers of live fish/carcasses found within the stranding pools.

Photodocumentation will be obtained for each sample site, the location will be recorded using a GPS unit, and a general description of site conditions will be noted. Where possible, the same pools should be sampled among seasonal surveys to determine natural survival rates and to enable qualitative comparisons for stranding risk at different times of the year.

2.3.4 Task 4: Data Analysis and Reporting

A brief data report will be prepared at the end of Year 1 of the field study, followed by a more detailed technical report at the conclusion of the program, 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; and
f) any recommendations for (i) modifying the operating parameters of Kinbasket Reservoir to reduce the impact of fish stranding; and (ii) undertaking physical works (e.g., recontouring) to reduce the formation of isolated pools.

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

A key result of this monitoring program is the evaluation of fish stranding risk under current operating parameters of Kinbasket Reservoir, to address management questions 1-3. The degree of risk will be a function of the proportion of the drawdown zone that forms isolated pools as the reservoir is drafted to its minimum operating level based on field verification of model predictions.

Further information to address the management questions will be gained from observed trends in duration that isolated pools can support stranded fish (estimates based on observations of dewatering and ice formation). Information gained through the burbot, bull trout and rainbow trout life history and habitat use assessments (Refer to CLBMON-5, 6 and 7) may assist in further evaluating the potential risk of stranding.

2.5 Schedule

Initiation of the first year of field work will occur on an opportunistic basis, when water supply forecasts predict low minimum pool elevations for Kinbasket Reservoir (Figure 1). The stranding risk assessment (modeling) may be undertaken as soon as the DEM for Kinbasket Reservoir is complete – for budgeting purposes, this has been assumed to occur in Year 2 (2009).

Although the exact timing of the field surveys will depend on the draft/refill schedule for Kinbasket Reservoir and severity of winter weather conditions, efforts should be made to schedule field work to maximize the quality of information gained through the surveys. The late fall surveys will need to be initiated before sampling efficiency is compromised by snow and ice accumulation, but well enough into the draft to capture conditions that are conducive to pool formation. Conversely, the timing of the late spring surveys should be conducted as early as possible during the refill phase, once snow/ice conditions permit, due to the rapid refill rate.

2.6 Budget

The total annual cost for the Fish Stranding Assessment is estimated at $62,478 (in 2004 dollars). The estimated budget breakdown by task for each year is provided in the Table CLBMON-4-1 below.

3.0 REFERENCES

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