

Peace River Water Use Plan

Monitoring Program Terms of Reference

- **GMSMON-17 Tributary Habitat Review**

July 30, 2008

Terms of Reference for the Peace River Water Use Plan Monitoring Program: Tributary Habitat Review

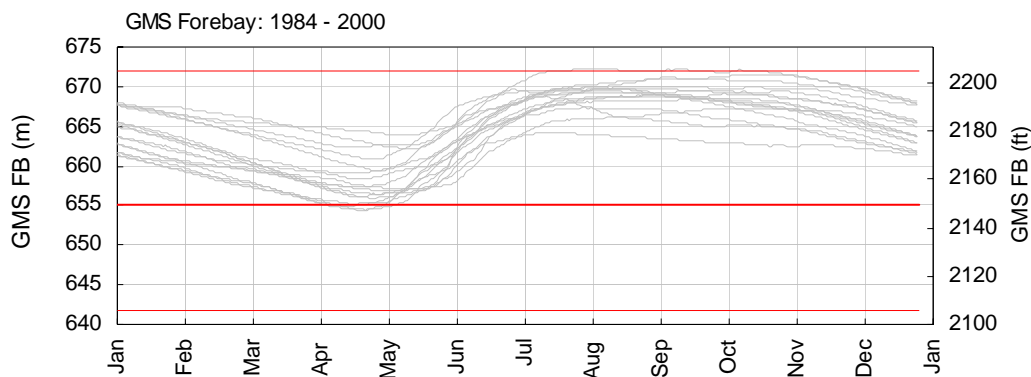
1.0 MONITORING RATIONALE

1.1 Background

Annual reservoir cycling generally results in water levels reaching a minimum in late April or early May and peaking in late summer or fall (Figure 17-1; BC Hydro 2003). Tributaries of Williston Reservoir may become inaccessible to fish in the spring due to (i) drawdown and (ii) interference from wood debris fields. Alluvial barriers become exposed to varying degrees when the reservoir is drawn down from its high pool elevation. Woody debris becomes stranded in tributary mouths from a combination of prevailing winds and drawdown history. While debris can provide habitat for fish, in some cases the amount and extent of the debris field can present barriers to fish passage. At low reservoir elevations, migration of spawners up tributaries in the spring is potentially restricted by alluvial barriers and debris. Furthermore, debris fields are often mobile, subject to winds and reservoir levels. Scouring of the banks associated with the debris fields can quickly reduce any natural littoral and/or riparian vegetation that may be growing in the area.

The Tributary Habitat Review monitoring program is a component of the Williston Tributary Access Management Plan. The Williston Tributary Access Management Plan was proposed by the Peace Water Use Plan Committee (hereafter known as the Committee) to improve access to tributaries excluded by drawdown zone morphology and/or debris fields for fish and wildlife. The plan consists of a tributary inventory for Williston Reservoir, selection of tributary sites for enhancement based on the inventory, followed by enhancement of the sites. Enhancement will include removal of obstructions blocking fish access and/or prevention of habitat destruction by mobile debris. The Tributary Habitat Review monitoring program will assess the effectiveness of the tributary enhancement in improving fish and wildlife habitat. This monitoring program is described here.

Figure 17-1: GMS Monthly Forebay Levels: 1984–2000 (BC Hydro 2003)



1.2 Management Questions

The key management questions are:

- 1) Does fish abundance and diversity in tributaries increase as a result of enhancement?
- 2) Is the area and quality of fish habitat created by the tributary enhancement maintained over time?
- 3) Does riparian vegetation along tributaries increase in abundance and diversity as a result of enhancement?
- 4) Does abundance and diversity of song birds (passerines) around tributaries change as a result of enhancement?
- 5) Does amphibian abundance and diversity in tributaries change as a result of enhancement?
- 6) Does tributary enhancement change the area and quality of amphibian breeding habitat over time? If so, is the area and quality maintained over time?

The monitoring program will primarily focus on the effectiveness of tributary enhancement to improve fish access and habitat but will also include monitoring for changes in vegetation and wildlife. Enhancement is expected to improve fish access to tributaries during low reservoir elevation when it is used for spring spawning. Riparian recruitment along the banks is hypothesized to be inhibited by debris accumulation and debris scouring the banks.

The Peace WUP did not explicitly specify the wildlife benefits that are expected from the tributary enhancement. To provide some indication of wildlife response to the tributary enhancement, this terms of reference identifies song birds and amphibians as the target species groups for the monitoring program. Enhancement of tributaries via the removal of large volumes of debris clogging tributary mouths and installation of barriers to prevent further debris accumulation will provide an opportunity for vegetation to establish in the scoured and debris-covered areas. Thus, a response by song birds may be measurable with vegetation re-growth. The monitoring program will also target amphibians as they generally have small home ranges, are highly philopatric, and have limited dispersal ability—characteristics that make them sensitive to environmental perturbations (Blaustein 1994; deMaynadier and Hunter 1995 *in* Keystone Wildlife Research Ltd. 2007). Amphibians may show a positive or negative response to the enhancement depending on the post-enhancement conditions relative to pre-enhancement conditions of the tributary. However, once enhancement sites are selected by the Trial Tributaries implementation project, different target species groups may be deemed more appropriate than those defined in this terms of reference. In this event, modifications to this monitoring program will be considered.

Monitoring of amphibians and birds will also provide an opportunity to improve our knowledge of these species groups as little data is presently available about them in Williston Reservoir. Reconnaissance surveys for amphibians were completed in 1998 and 1999 to document the presence and distribution of amphibian species suspected to reside in the watersheds (Hengeveld 1999, 2000). Detected during these surveys

were western toads, wood frogs, Columbian spotted frogs, striped chorus frogs, and long-toed salamanders. Bird surveys, up to the present, have largely been limited to waterfowl (Hengeveld and Corbould 2000) and birds of prey (Booth and Corbould 2003) with the exception of the Donna Creek Forest/Biodiversity project (Hentze and Cooper 2006).

1.3 Detailed Hypotheses about the Ecological Impacts

The primary hypotheses¹ to be tested are:

- H₁: Fish abundance and diversity in tributaries increases as a result of tributary enhancement;
- H₂: Total rearing area for fish increases following enhancement to tributaries;
- H₃: Riparian vegetation abundance and diversity along the tributaries increases following enhancement to tributaries;
- H₄: Amphibian abundance and diversity in and near tributaries changes following tributary enhancement;
- H₅: Total amphibian breeding area changes following enhancement;
- H₆: Song bird abundance and diversity near tributaries increases following tributary enhancement.

Total habitat area, in addition to species utilization, at pre- and post-enhancement sites will be tested hypotheses. Indices of habitat are often more useful measure of project success due to constraints in sampling intensity associated with remote locations.

1.4 Key Water Use Decision Affected

Information from this monitoring program, in combination with other programs within the Williston Management Plans will be used to inform future decisions on reservoir operating elevations, and in particular limiting drawdown to optimize access to key tributaries by reducing woody debris accumulation. Any future decisions on limiting drawdown of the reservoir would have implications for reservoir fish, dust, wildlife, and power generation.

2.0 MONITORING PROGRAM PROPOSAL

2.1 Objective and Scope

The objective of the monitoring program is to address the management questions identified in Section 1.2 by collecting the data necessary to draw inferences and to test the hypotheses outlined in Section 1.3. The scope of the monitoring program, outlined within Committee Report, also includes monitoring primary productivity. However, the information gained by monitoring primary productivity would be of little value in assessing the overall effectiveness of tributary enhancement to fish and wildlife. Furthermore, intensive sampling would likely be required to gather adequate

¹ For clarity, the hypotheses are stated as the alternate hypotheses. Analyses will test the null hypotheses of no effect or difference.

information on the community of primary producers which are highly sensitive to environmental variables. Their habitat would also be changing dramatically from shallow tributary water to deep reservoir water as the reservoir inundates the tributary from May to August.

The study area will include the tributaries selected for enhancement (selected as part of Trial Tributaries implementation project). The monitoring program will occur annually during the 10-year Williston Tributary Access Management Plan. At least one year of baseline data, will be collected prior to the commencement of any enhancement activities.

Data collection, data analyses, and reporting will be completed annually over the study period and a final study report will be produced in Year 10 that summarizes the results of the entire monitoring program and the conclusions that can be drawn pertaining to the management questions and hypotheses.

2.2 Approach

The general approach to the monitoring program is a before-after impact study that will consist of annual fish surveys, fish habitat assessment, riparian vegetation assessment, songbird survey, as well as amphibian and amphibian-habitat inventory assessments (Table 17-1).

2.3 Methods

2.3.1 Task 1: Project Coordination

Project coordination will involve the general administrative and technical oversight of the monitoring program. This task will include but not be limited to: 1) budget management, 2) study team management, 3) logistic coordination, 4) technical oversight of field and analysis components, and 5) facilitation of data transfer among other investigators associated with the Williston Tributary Access and the Riparian and Wetland Habitat Enhancement management plans.

In particular, coordination with the (i) Trial Tributaries implementation project will be necessary to determine study locations and timing of the enhancement activities, (ii) Targeted Debris Management for timing/methodology of debris removal, (iii) Williston Reservoir Aerial Photos and DEM implementation project for aerial photos and digital elevation model, and (iv) Williston Debris Trends monitoring program for aerial photos.

Cost efficiencies will be sought out among the various monitoring components of this program and other programs in the Williston Reservoir Management Plans to reduce project costs of working in this remote location.

2.3.2 Task 2: Site Selection

Enhancement sites will be pre-selected as part of the Trial Tributaries implementation project.

2.3.3 Task 3: Field Sampling Program: Fish and Fish Habitat

Fish Surveys

Following sampling methodologies outlined in Johnston and Slaney (1996) and RIC (2001), fish surveys will be conducted in spring and late summer. Exact survey timing will be discussed with the BC Hydro Peace Water Licence Requirements Study Lead once tributaries have been selected for monitoring. Methodologies for surveying are suggested below but may require modification once tributaries have been selected. Survey design will vary according to tributary length and diversity of in-stream habitat. Thus, the sample size and location of sampling within the study sites is at the discretion of the researcher and subject to the available budget; however, a clear rationale of these decisions will be required. The following information will be collected for all surveys to provide an indication of the reliability of the data:

- Date and time
- Crew and skill level
- Data collection method and equipment specifications
- Effort
- Weather conditions

The spring survey will be a visual count survey (e.g., snorkel, stream walk) of spawners and/or redds. The target species for the survey will depend on which tributaries are selected. Arctic grayling or rainbow trout will be considered as potential target species. Arctic grayling will be entering tributaries when reservoir levels are at their lowest (end of April–May) while rainbow trout spawners are expected to access tributaries during June. The target species for the survey will be confirmed with BC Hydro Peace Water Licence Requirements Study Lead. The survey area will be at the discretion of the researcher to define but will extend further upstream beyond the area of enhancement and zone of impoundment (if present) created by the debris. At a minimum for each survey, the observer will record observations on number of redds (if applicable), fish abundance and distribution, sex, size, water temperature, and water clarity.

The summer survey will provide an estimate of relative abundance by targeting small fish and young of the year and juveniles of large fish. Captured fish will be anaesthetized, enumerated, and its taxon identified to the nearest species. They will also be measured to the nearest 1 mm for fork length and wet weight to the nearest 1 g. In addition, scale samples will be collected and stored on slides for future reference. Once processed, the anaesthetized fish will be allowed to recover and then released. Methods for fish collection in the summer survey will be specific to site conditions but should be consistent for each location. A suggested method for an electrofishing operation is to isolate an area at each site and estimate abundance through successive removal. Stratified sampling by habitat type such that all representative in-stream fish habitats (i.e., riffle, runs, glides, pools) are sampled will provide a more sensitive estimate.

Fish Habitat Assessment

A habitat assessment will be conducted annually in each tributary to determine the quality of fish habitat, as well as accessibility of the tributary for reservoir fish. Habitat conditions will be evaluated to identify factors that are limiting fish production in the

impacted/enhancement area as well as upstream beyond the area of enhancement and zone of impoundment (if present) created by the debris. Field methods and data requirements for the assessment are referenced to Fish Habitat Procedures (Johnston and Slaney 1996). A Level 1 Field Assessment will be conducted. Field data forms will be prepared in advance to capture all relevant information (please review the fish habitat assessment procedures [Johnston and Slaney 1996] for more information).

The assessment will be conducted concurrently with one of the spawner/redd count survey sessions when the reservoir is near or at low pool.

2.3.4 Task 4: Field Sampling Program: Vegetation

Through field surveys and aerial photo analyses, a vegetation assessment will be conducted annually to monitor composition, diversity, and spatial extent of vegetation in the impact/enhancement area.

In the first year of monitoring, the study area will extend upstream beyond the impact/enhancement area (and if present, zone of impoundment created by the debris) to ascertain the type and distribution of vegetation that may be expected to establish once the site is enhanced. This information may be a useful explanatory factor for the monitoring program over time. Sampling of vegetation upstream beyond the first year will be conducted as deemed necessary by the project coordinator and the BC Hydro Study Lead.

Field Survey

Field methods and data requirements for this task are referenced to Mackenzie and Moran (2004) and Watershed Restoration Program (Johnston and Slaney 1996) guidelines. Field data forms will be prepared in advance to capture all relevant information. A standard sampling window (e.g., June–July) will be established to ensure that representative results are obtained at each site and that valid comparisons can be made between years.

The sampling design (e.g., Braun-Blanquet method, transect sampling, quadrat sampling) will be specific to the actual site conditions. Additionally, the sample size and location of sampling within the study sites is at the discretion of the researcher and subject to the available budget; however, a clear rationale of these decisions will be provided. Information to be collected includes but is not limited to:

- Bank characteristics including: slope, stability, undercut, vegetation cover
- Riparian cover
- Debris cover
- Overstorey vegetation characteristics (tree species, densities and heights, per cent cover)
 - understorey vegetation characteristics (shrub, herb and moss species, per cent cover and height)
 - categorize the extent of canopy closure over the stream
 - record the structural stage of the dominant vegetation in the adjacent

Unknown species should be collected and preserved for proper identification. In the event that rare plants (e.g., federally or provincially listed species) are found during

the ground sampling, this data will be provided to the Conservation Data Center (CDC) by the contractor, using appropriate forms. Similarly, noxious weed species, if encountered, should be identified and weed sites should be entered into the Ministry of Forests and Range Invasive Alien Plant Program Application and forwarded to the BCH Hydro Vegetation Specialist. These sites should also be explicitly identified to determine if spread of these species is occurring over time.

The timing of the survey will be coordinated with the fisheries component to create cost efficiencies.

Aerial Photo Analysis

Using aerial photos taken in Years 1, 3, 5, 6 and 10 as part of the Williston Reservoir Aerial Photos and DEM project and the Williston Debris Trends project, photographs will be interpreted to assess for changes in debris accumulation, as well as spatial distribution and composition of vegetation over time. Guidelines for photo interpretation are set out in RIC standards for VRI-Vegetation Resources Inventory (RIC 2002).

2.3.5 Task 5: Field Sampling Program: Amphibian Inventory and Abundance

An inventory of amphibian species in the tributaries will be conducted using standard procedures (RIC 1998a). Breeding period for amphibians in the Williston watershed is thought to be from late April to the end of June (Hengeveld 2000). The exact period will vary depending on geographic location, elevation, and weather conditions. Timing of the inventory (late April to May) will correspond to the breeding period and low pool when tributaries may be clogged by debris. Snow and soft roads early in the season will be a necessary consideration when determining survey timing (Hengeveld 2000). The survey area will be defined at the discretion of the researcher but will include the impacted/enhancement area as identified by the Trial Tributaries project as well as the upstream areas such as where backwatering or pooling may be occurring.

If appropriate, this monitor will also conform to the inventory methods identified in RIC (1998b) for pond-breeding amphibians. The inventory information to be collected at each habitat site will follow that described in RIC (1998a). The required habitat attributes include but are not limited to:

- Location: geographic coordinates, Broad Ecosystem Unit, ecosection, biogeoclimatic subzones
- Site information: elevation, slope, aspect, and mesoslope position
- Topography: surface topography code
- Structural stage: structural stage code
- Basic vegetation: dominant/indicator plant species and per cent cover for each layer
- Simple CWD: coarse woody debris volume and volume by decay class
- Surface substrate: surface substrate composition

The survey crew is to use standard habitat attribute definitions and codes and is encouraged to use RIC (1998a) standard forms for data recording.

Though the minimum data requirements for this monitor is to establish Presence/Not Detected status of amphibians in the study area, the survey crew are encouraged to adopt an animal sampling strategy that allows measures of relative abundance to be made. This would maximize the information content of the survey, allowing the results of the monitor to be used as a reference for future trend analyses. This would be particularly important should any of the animals observed in the area be a species of SARA concern. The minimum data requirements of all observations, in addition to the habitat attributes listed above are species, sex, developmental stage, and approximate size. If applicable, survey sites will be marked and georeferenced. Permanent photo-monitoring points will also be established to provide a photographic record of site-specific conditions.

Handling of all observed animals should be kept to a minimum. Additionally, nets, boots and containers should be washed and any bits of vegetation removed before going to another site to prevent transfer of diseases

2.3.6 Task 6: Field Sampling Program: Songbird Inventory and Abundance

A survey of passerine bird species around the tributaries will be conducted using standard procedures to estimate relative abundance (RIC 1998a; 1999). Breeding period for song birds in the Williston watershed is thought to be from May-July (Hentze and Cooper 2006; RIC 1999). The study area will include the impacted/enhancement area as identified by the Trial Tributaries project as well as sites upstream. The sample size and location of sampling is at the discretion of the researcher and subject to the available budget; however, a clear rationale of these decisions will be provided. High observer variability in bird surveys will be taken into account when developing the sampling design/frequency.

Red- and Blue-listed passerines are present in the Peace River valley area (Keystone Wildlife Research Ltd. 2007) and if detected in the Williston tributary study areas, a ground inspection form (B.C. Ministry of Environment, Lands, and Parks and B.C. Ministry of Forests 1998) will be completed to record the habitat attributes. All bird observations and the ecosystem unit in which they were detected will be recorded on standard RIC datasheets. In the event that nests are observed, the location and description will be recorded on RIC standard nest site description forms.

2.3.7 Task 7: Data Entry and Analysis

The proponent will develop a Microsoft Access database to enter, check and store all data collected during the monitoring program. The format of the data will be consistent with RIC (1998a) standards, which include the use of standard attribute terminology, definitions, and coding schemes. Species at risk data will be submitted to the Conservation Data Centre (CDC) and other wildlife data will be submitted to the BC Ministry of Environment Species Inventory (SPI) database in appropriate formats. A map of the area will also be prepared to summarize key information including the locations of enhancement and access issues, sampling locations, and photopoints.

For all components of the monitoring program, statistical analysis will be based on a before-after design. Testing of time trends will largely depend on the nature of the data, but may include simple non-parametric correlation tests as well as more complex time series analyses (e.g., regression). Strength of the inference may be limited to some degree as the monitoring program will have only one year of pre-enhancement data for the analysis.

For the fisheries component of the field program, data analysis will focus on the ability of the enhancement project to maintain its enhanced state. Appropriate metrics such as total fry rearing area (m^2) will be analyzed to determine if habitat changes in area and quality of habitat over time. Additionally metrics for describing relative abundance (fish/ m^2 for each species for a given habitat type) and redd count will be analyzed to determine change in fish use within the tributary over time. Standard life history summaries will also be provided which will include length-frequency distribution, length-weight relationships.

For the vegetation component of the field program, metrics will describe species richness, community structure, and spatial distribution. Air photo analysis will simply consist of polygon delineation of vegetation communities, and will assist in determining changes in composition and spatial extent over time.

For the wildlife component, the suggested metric for songbirds is mean breeding bird use/ m^2 . Analysis of amphibian data will depend on whether it is possible to collect an index of abundance or if the data will be presence/not detected data.

2.3.8 Task 8: Reporting

Project reporting will consist of a series of annual data reports with a larger summary mid-project report and a final report at the conclusion of the monitoring program. The annual data report will document the methodologies (including map of sites and photodocumentation), findings of the year and will include a discussion on how the year's data compare with that collected in previous years. Included in this discussion will be the results of all pertinent hypothesis testing and recommendations for improving the monitoring program.

A comprehensive mid-project and final project report will be prepared that collates all of the data and includes:

- a) An executive summary of the project;
- b) Re-iterates the objective and scope of the monitor;
- c) Presents the methods of data collection (including map of sites and photodocumentation);
- d) Describes the compiled data set and presents the results of all analyses, and
- e) Discussion of the consequences of these results as they pertain to future tributary enhancement projects;
- f) Recommendations for future monitoring (if any) needed.

A report will be provided in hard-copy and as Microsoft Word and Adobe Acrobat (*.pdf) format. The required maps and figures will be included as embedded objects in the report. All maps and figures will also be provided in their native format as separate files. Raw data will be submitted in a Microsoft Access database. All photos will be submitted electronically.

2.4 Interpretation of Monitoring Program Results

The results of the monitoring program will provide support in the decision-making process to enhance additional tributaries impacted by reservoir fluctuations and debris in the Williston Reservoir. If fish, vegetation, and wildlife benefits are incurred as a result of tributary enhancement, then enhancement of additional tributaries should be considered for Years 6-10 of the study period. However, if results indicate that the enhancement is beneficial for some species and unfavourable to others then the decision to enhance additional tributaries will have to consider the tradeoffs in the aquatic system and social values.

2.5 Schedule

Monitoring is scheduled to occur annually during the 10-year study period of the Williston Tributary Access management plan. Survey timing will vary according to monitoring component and is subject to change once tributaries have been selected for monitoring and target species have been finalized (Figure 17-1).

Figure 17-1: Timing of the monitoring components of the Williston Tributary Habitat Review monitoring program

Monitoring Component	Approximate Timing
Fish spawning survey and fish habitat assessment	May-June (dependent on selection of target species)
Juvenile/small fish survey and fish habitat assessment	July
Vegetation survey	May-July
Amphibian survey and breeding habitat assessment	Late April -May
Song bird survey	Late May-July

2.6 Budget

The estimated total cost for the monitoring program over the 10-year study period is \$1,333,560. Table 17-2 summarizes the budget estimated in 2007 dollars. The budget accounts for the monitoring of the two tributaries selected for enhancement by the Trial Tributaries project; if additional tributaries are selected for enhancement in Year 5, then monitoring costs would increase beginning in Year 6.

Table 17-2: Estimated costs for the Williston Tributary Habitat Review

Sub-total		\$1,093,925
Inflation	2%	\$176,132
Contingency	5%	\$63,503
Total		\$1,333,560

2.7 References

BC Hydro. 2003. Consultative committee report: Peace River water use plan. Prepared by the Peace River Water Use Plan Committee.

B.C. Ministry of Environment, Lands, and Parks and B.C. Ministry of Forests. 1998. Field Manual for Describing Terrestrial Ecosystems. Land Management Handbook Number 25. <http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh25/Lmh25.pdf>

Booth, B.P. and F.B. Corbould. 2003. Abundance and distribution of osprey nest sites in the Williston Reservoir area, North-Central British Columbia 2002. PFWWCP Report No. 277.

Corbould, F.B. and P.E. Hengeveld. 2000. Distribution, species composition, and abundance of waterfowl wintering in the Parsnip River drainage, 2000 PFWWCP Report No. 233.

Hengeveld, P.E. 1999. Amphibian reconnaissance surveys in the Williston and Reservoir Watershed. PFWWCP Report No. 212.

Hengeveld, P.E. 2000. Presence and distribution of amphibians in the Williston and Dinosaur Reservoir Watersheds. PFWWCP Report No. 212.

Hentze, N.T. and J.M. Cooper. 2006. Donna Creek forestry/biodiversity project (phase II): breeding-bird and cavity-nest monitoring 2006. Interim Report. PFWWCP Report No. 309.

Johnston, N.T. and P.A. Slaney. 1996. Fish habitat assessment procedures. Watershed Restoration Technical Circular No. 8, revised April 1996. Watershed Restoration Program, Ministry of Environment, Lands and Parks and Ministry of Forests, Vancouver, B.C. 97 pp.

Keystone Wildlife Research Ltd. 2007. Peace River Wildlife Surveys 2006.

RIC (Resources Inventory Committee). 1998a. Species Inventory Fundamentals. Standards for Components of British Columbia's Biodiversity No. 1. Prepared by the Ministry of Environment, Lands and Parks Resources Inventory Branch for the Terrestrial Ecosystem Task Force Resources Inventory Committee. November, 1998. Version 2.0.

RIC.1998b. Inventory methods for pond-breeding amphibians and painted turtle. Standards for Components of British Columbia's Biodiversity No. 37. Prepared by the Ministry of Environment, Lands and Parks Resources Inventory Branch for the Terrestrial Ecosystem Task Force Resources Inventory Committee, March, 1998. Version 2.0.

RIC, 1999. Inventory Methods for Forest and Grassland Songbirds Version 2.0. Standards for Components of British Columbia's Biodiversity No.15. <http://ilmbwww.gov.bc.ca/risc/pubs/tebiodiv/songbird/assets/songml20.pdf>

RIC. 2001. Reconnaissance (1:20,000) fish and fish habitat inventory standards and procedures.

RIC. 2002. Vegetation Resources Inventory Photo Interpretation Procedures. http://ilmbwww.gov.bc.ca/risc/pubs/teveg/vri-photointerp2k2/photo_interp2k2.pdf.