

**Gaps in
Past Monitoring Studies
and
Current Monitoring Responsibilities
in the
Babine Watershed**

prepared for

the Babine Monitoring Trust Governance Design Group

by

Dave Daust and Karen Price

December 16, 2004

Summary of Monitoring Gaps

The Babine Monitoring Framework is designed to produce three lists of monitoring priorities. These priorities are based on the need for collecting indicator data (akin to implementation monitoring), for monitoring to reduce uncertainty (in risk curves), and for monitoring to detect negative consequences (the classical definition of effectiveness monitoring). Some of these priorities may be the responsibility of a particular agency. Ongoing work may be already working towards completing other priorities. The following two sections on Roles and Responsibilities and Complete Monitoring Projects provide background to help delineate where gaps and priorities coincide.

In general, current indicator values for the Bulkley portion of the Babine watershed are compiled and described clearly in the State-of-the-Forest Report. No similar compilation exists for the Kispiox portion of the Babine. Agencies (particularly the Ministry of Forests and the Ministry of Water, Land and Air Protection) and companies (particularly Pacific Inland Resources) collect information piece by piece according to individual project requirements, but there is no impetus to provide a summary for a specific area. The lack of such a summary for the Kispiox is an important gap.

Monitoring to reduce uncertainty is most often needed in the middle section of risk curves. The risk associated with either end of a management indicator spectrum is usually reasonably well defined. Uncertainty in the middle of the curve often arises because different watersheds, types of organisms or user groups respond differently to management activities. The risk curves currently used in Appendix 2 are quite general and in need of local research and monitoring to tailor them to specific cases. Thus, local research to decrease uncertainty is the second major gap.

Although monitoring to detect negative consequences has been undertaken for several values in the Babine, these studies have often been inconclusive. In particular, when estimating populations, studies require intensive sampling over many years, with controls for confounding effects, to detect trends. This gap is not easily filled. Well-defined risk curves can, to some extent, reduce the necessity of monitoring to detect negative consequences unless management activities pose high risk to an objective. The Monitoring Framework redirects some of the effectiveness monitoring effort towards improving risk curves, but also highlights important topics to monitor for negative consequences.

The Ministry of Forests and the Ministry of Water, Land and Air Protection share the bulk of the responsibility for effectiveness monitoring (including reducing uncertainty and detecting negative consequences). PIR takes some responsibility for monitoring specific topics related to certification. DFO takes responsibility for monitoring salmon.

There will remain gaps that are not resolvable. No amount of research will be able to predict stochastic events such as disturbance location. In other cases, confounding effects may be insurmountable. Even large-scale, expensive experiments have been unable to decrease uncertainty about the use of corridors, for example. These gaps will remain.

Roles and Responsibilities for Monitoring

Implementation monitoring

In many cases, implementation monitoring is not directly required by legislation, however, it is often necessary to collect information (informal monitoring) to fulfill resource stewardship obligations. Two forest Licensees (Pacific Inland Resources and British Columbia Timber Sales), three provincial ministries (Ministry of Forests, Ministry of Water, Land and Air Protection and Ministry of Sustainable Resource Management) and one federal department (Department of Fisheries and Oceans) share the majority of the responsibility for monitoring in the Babine River Watershed.

Forest companies

Forest companies must measure various landscape-scale indicators in order to address objectives set out by the Forest and Range Practices Act (FRPA)¹. FRPA lists objectives to guide forest management (objectives come from regulations, approved landscape unit plans and sustainable Resource Management Plans and directives set by appropriate ministers). Forest licensees have the responsibility to propose results and strategies in Forest Stewardship Plans (FSPs) that are consistent with objectives. In order to do this effectively, licensees must know the condition of the landscape to ensure that harvesting does not threaten landscape-level objectives. In many cases, a rough estimate of landscape-scale indicator values may suffice for the purposes of FSP preparation.

In general, forest companies measure some, but not all, stand-level indicators. Although forest companies must deliver results and strategies on the ground, they can use professional judgement and standard practices to fall within acceptable limits without actually measuring all relevant indicators (compliance and enforcement measures the compliance of field activities with proposed results and strategies). PIR conducts several surveys to measure stand conditions including regeneration surveys, free-growing surveys, fire hazard assessments, forest health surveys, waste and residue utilization assessments, soil disturbance surveys, and post harvest assessments². Silvicultural prescriptions or site plans also provide estimates of some stand-level indicators (e.g., planned wildlife tree retention). In addition, Pacific Inland Resources (PIR) conducts in-house (corporate) audits of field practices³.

PIR measures selected stand-level indicators for the purposes of certification⁴. PIR is currently certified with the International Organization for Standardization (ISO) and is seeking certification with the Sustainable Forestry Initiative (SFI). SFI provides objectives for sustainable forestry and lists indicators that assess progress towards objectives. Many of the SFI objectives overlap with objectives described for the Babine, however, only some of the SFI objectives specify indicators that must be measured on the ground. SFI field monitoring

¹ pers. comm. Gary Quanstrom, Pacific Inland Resources, Smithers, BC

² pers. comm. Gary Quanstrom, Pacific Inland Resources, Smithers, BC

³ pers. comm. Gary Quanstrom, Pacific Inland Resources, Smithers, BC

⁴ pers. comm. Gary Quanstrom, Pacific Inland Resources, Smithers, BC

addresses soil, water, air, plants and wildlife values; other region-specific indicators may also be monitored in the field⁵.

Ministry of Forests (MOF)

The MOF District shares responsibility with forest companies for measuring selected landscape-scale indicators. District staff must know the condition of the landscape to ensure that the results and strategies proposed by Licensees are consistent with objectives before approving FSPs⁶. District staff mainly assess whether or not limits described in FSPs will be exceeded (e.g., old forest area < target limit). More details may be desirable (e.g., old forest area = 45%) to track trends over time.

The Compliance and Enforcement Section (C&E) of the Ministry of Forests measures several stand-level indicators. They have the responsibility for ensuring that results are being delivered and that strategies are implemented. Stand-level indicator information collected by C&E has limitations. C&E mainly assess whether or not limits described in FSPs have been exceeded (e.g., soil disturbance < 5% limit). More details may be desirable (e.g., soil disturbance = 3%) to track trends over time.

Ministry of Water Land and Air Protection (MWLAP)

MWLAP monitoring tends to focus on effectiveness monitoring (e.g., population surveys, water quality) rather than implementation monitoring⁷. Responsibilities for biodiversity stewardship may lead to habitat monitoring that falls under implementation.

Ministry of Sustainable Resource Management (MSRM)

Tentatively, MSRM will take a coordinating role, collating information from other agencies, but will not actually conduct monitoring⁸.

Department of Fisheries and Oceans (DFO)

The Department of Fisheries and Oceans (DFO) monitors impacts of specific projects (e.g., bridge installation) on fish habitat⁹.

The Forest Practices Board

The Forest Practices Board conducts independent audits and will measure many landscape-level indicators to evaluate FSPs and stand-level indicators to assess compliance¹⁰.

Forest Professionals

Professional Foresters have the responsibility to ensure that legal requirements will be met and to collect and incorporate relevant background information¹¹. Thus, professionals working for

⁵ pers. comm. Gary Quanstrom, Pacific Inland Resources, Smithers, BC

⁶ pers. comm. Jane Lloyd-Smith, Operations Manager, Skeena Stikine Forest District, Smithers, BC

⁷ pers. comm. Steve Gordon, Section Head, Ecosystem Section, Environmental Stewardship Division, MWLAP, Smithers, BC

⁸ pers. comm. Eamon O'Donoghue, Manager, Planning Section, Resource Management Division, MSRM, Smithers, BC

⁹ pers. comm. Tom Pendray, Habitat Biologist, Department of Fisheries and Oceans, Smithers, BC.

¹⁰ pers. comm. Liz Osborn, Vice-Chair, Forest Practices Board

government agencies and forest companies have a responsibility to ensure that information about landscape condition is collected prior to preparing FSPs.

Effectiveness Monitoring

Legislation provides a mandate for stewardship and sets out objectives (e.g., Wildlife Act, Fisheries Act, Water Act, Forest Practices and Range Act). Monitoring of progress towards objectives is considered necessary to support sound stewardship¹².

Forest Companies

PIR has indirect responsibility for research. They must demonstrate support for research on certain topics under SFI certification: forest health and productivity, water quality, wildlife management, ecosystem functions and conservation of biodiversity.

Ministry of Forests

As the lead agency overseeing forest management, the ministry of forests should (arguably) have significant responsibility for ensuring that land use objectives are being met (if power and responsibility are to be commensurate)¹³. MOF and Ministry of Environment, Lands and Parks, (MELP, now MWLAP) both committed to developing a monitoring strategy to assess objectives¹⁴. MOF took responsibility for developing monitoring methods for timber, recreation and visual quality. MOF and MELP agreed to share responsibility for developing monitoring methods in Special Management Zones.

Ministry of Water Land and Air Protection (MWLAP)

The general responsibilities of the MWLAP¹⁵ include

- environmental protection of water land and air quality
- environmental stewardship of biodiversity, including wildlife, fish and protected areas
- park and wildlife recreation management
- environmental monitoring and enforcement, including state of the environment reporting

Under the Babine and Nilkitkwa LUPs, MELP (now MWLAP) took responsibility for developing methods for monitoring wildlife, biodiversity and fish. Under the Kispiox SRMP, WLAP should participate in a collaborative monitoring process for the Babine Watershed as part of a Trust.

Steve Gordon is currently coordinating monitoring efforts for the ecosystem section of the MWLAP region. The total monitoring effort depends on the amount of funds and resources allocated to the Ministry, and on priorities identified in the service plan¹⁶. Priorities set by ministry staff determine allocation of monitoring effort to different topics and to different areas in the region.

¹¹ ABCFP. 2004. Standards of Professional Practice: Guidelines for Interpretation.

¹² comments from Jane Lloyd-Smith, Steve Gordon, Dana Atagi

¹³ pers. comm. Jane Lloyd-Smith, Operations Manager, Skeena Stikine Forest District, Smithers, BC

¹⁴ Babine and Nilkitkwa Landscape Unit Plans, Ministry of Forests, Smithers, BC.

¹⁵ follow links from BC Government Web Site

¹⁶ pers. comm. Steve Gordon, Section Head, Ecosystem Section, Environmental Stewardship Division, MWLAP, Smithers, BC

The ministry is divided into several divisions and sections, each taking responsibility for different environmental issues. Of relevance to the Babine Watershed,

- water quality is addressed by the Environmental Quality Section of the Environmental Protection Division
- biodiversity and habitat management is addressed by the Ecosystem Section, Environmental Stewardship Division (ESD)
- wildlife and fish populations are addressed by the Fish and Wildlife Science and Allocation Section, ESD
- the Babine River Corridor Park is addressed by the Protected Areas Section of the ESD
- recreation use in the entire area is addressed by the Recreation Section of the ESD

Environmental Quality Section

The Environmental Quality Section (EQS) provides technical expertise related to water quality and promotes development of systems to monitor and assess water quality (focussing on non-point source discharges)¹⁷. It does not have a specific responsibility to conduct monitoring. The EQS is currently collaborating with other agencies and forest companies on monitoring related work through the Bulkley Aquatic Resources Committee and through a sister committee in the Kispiox. The EQS has developed a monitoring toolbox that measures physical (e.g., water column depth, suspended sediment, deposition) and biological indicators (e.g., benthic invertebrates, fish) of water quality.

Water quality is also addressed by the Environmental Management Section of the Environmental Protection Division, however, this group only monitors impacts of point source discharges (e.g., associated with mines or factories).

Ecosystem Section

The role of the Ecosystem Section for monitoring biodiversity overlaps with the role of the Ministry of Forests and will become clearer over time¹⁸.

Fish and Wildlife Science and Allocation Section

The Fish and Wildlife Section manage for the conservation of fish and wildlife¹⁹. Monitoring addresses both populations and habitat and often occurs in collaboration with the Ecosystem Section. Past monitoring includes projects on grizzly bears, goats and fish in the Babine Watershed²⁰. Current monitoring includes goat inventories during winter months²¹.

¹⁷ pers. comm. Ian Sharpe, Section Head, Environmental Quality Section, Environmental Protection Division, MWLAP, Smithers, BC

¹⁸ pers. comm. Steve Gordon, Section Head, Ecosystem Section, Environmental Stewardship Division, MWLAP, Smithers, BC

¹⁹ pers. comm. Dana Atagi, Section Head, Fish and Wildlife Science and Allocation Section, Environmental Stewardship Division, MWLAP, Smithers, BC.

²⁰ de Groot, Adrian. 2004. The Babine River watershed: an annotated bibliography of monitoring, inventory, research and planning reports. Prepared for Bulkley Valley Centre for Natural Resource Management and Research.

²¹ pers. comm. Len Vanderstar, Ecosystem Specialist, Ecosystem Section, Environmental Stewardship Division, MWLAP, Smithers

Protected Areas Section

The Protected Areas Section has responsibility for managing natural resources and wildlife and for regulating human use in the Babine River Corridor Park²². Monitoring tends to focus on the ecological impacts of recreation use. Monitoring in the Babine River Corridor Park includes²³

- Backcountry Recreation Impact Monitoring
- monitoring interactions among fishers, fish and grizzly bears
- inspecting sites and facilities associated with Park Use Permits

The Protected Areas Section conducts user satisfaction surveys, but typically do this in front country parks and have no plans for conducting surveys in the Babine River Corridor.

The Protected Areas Section collaborates with DFO and Conservation Officers from other MWLAP Sections to monitor impacts on fish and wildlife in the park.

Recreation Section

The Recreation Section of the Environmental Stewardship Division monitors the satisfaction and ecological impact of recreation users, mainly in protected areas and in collaboration with the Protected Areas Section²⁴. They conduct some limited monitoring outside of protected areas. Their role in monitoring commercial recreation is currently uncertain because Land and Water BC takes some portion of this monitoring responsibility. Land and Water BC has a compliance and enforcement officer to monitor obligations specified in commercial permits, however, systematic monitoring is limited by funding²⁵.

MWLAP State of the Environment Reporting

MWLAP responsibilities include reporting on the state of the environment across the province. In addition to collaborating with other agencies on new monitoring initiatives, MWLAP has a State of the Environment reporting unit based in Victoria. The unit gathers information from a variety of sources, including ministries, universities and the private sector, to show the state of various ecological indicators²⁶. The latest report was published in 2002. The State of the Environment Reporting Unit is also preparing a discussion paper outlining gaps in monitoring information. In the future, the unit hopes to be able to work with regional staff to set monitoring priorities.

Federal Department of Fisheries and Oceans

DFO is responsible for managing fish and fish habitat under the Federal Fisheries Act²⁷. While not limited to particular fish species, DFO tends to focus on salmon, letting MWLAP focus on steelhead and fresh-water species. Of particular relevance to forest management, DFO has

²² Anonymous. 2004. Park Act.

²³ pers. comm. Larry Boudreau, Protected Areas Section Head, Environmental Stewardship Division, MWLAP, Smithers, BC

²⁴ pers. comm. John Howard, Section Head, Recreation Section, Environmental Stewardship Division, MWLAP, Smithers, BC

²⁵ pers. comm. Terry Pratt, Land and Water BC, Smithers, BC

²⁶ Linda Gilkeson, State of the Environment Report Unit, MWLAP, Victoria; contact James Quayle for details.

²⁷ pers. comm. Tom Pendray, Habitat Biologist, Department of Fisheries and Oceans, Smithers, BC.

responsibility to enforce laws preventing harmful alteration, disruption or destruction of fish habitat.

DFO monitors salmon in streams to assess stock for fisheries management and monitor impacts of specific projects (e.g., bridge installations) on fish habitat. While DFO has no systematic monitoring program related to forest practices, it does collaborate with other agencies on such monitoring.

Ministry of Sustainable Resource Management

Tentatively, MSRSM will take a coordinating role, collating information from other agencies, but will not actually conduct monitoring.

The FRPA Resource Evaluation Program

Under the policy framework that accompanied the release of FRPA, the newly created FRPA Resource Evaluation Program takes responsibility for evaluating the effectiveness of management at achieving objectives²⁸. The program is a co-operative effort of the Ministry of Forests and the Ministry of Water Land and Air Protection (and possibly MSRSM). One of the main objectives of the program is to evaluate the status or trends of resource and ecosystem values and to determine causal factors²⁹. Including causal factors allows feedback to alter management practices, but sometimes necessitates more rigorously designed studies.

The program has been under development for the last 18 months³⁰. Teams were created, including representatives from appropriate ministries, to identify monitoring priorities for each objective described by FRPA regulations (objectives in landscape unit plans have not yet been adequately considered). Pilot monitoring projects have begun across the province. Pilot projects focus mainly on implementation monitoring. The results of pilot projects will help to identify topics for effectiveness monitoring. Tentatively, most routine implementation monitoring will occur at the Forest District Level, involving Stewardship and Tenures staff (MOF District), MWLAP staff and resource specialists from various levels and agencies; most intensive effectiveness monitoring will involve staff from Forest Regions and Victoria³¹.

The Forest Practices Board

In the past, the Forest Practices Board has conducted limited monitoring to assess the effectiveness of forest management. Under FRPA, the focus of monitoring for the board will shift more towards assessing effectiveness. The board has developed a list of monitoring indicators³².

²⁸ Province of British Columbia. 2004. FRPA Training Companion Guide: Forestry Modules.

²⁹ FRPA Resource Evaluation Working Group. 2003. FRPA Resource Evaluation Program Charter. <http://www.for.gov.bc.ca/eefinder/> and then follow link to business initiatives

³⁰ pers. comm. Peter Bradford, currently coordinating FRPA Resource Evaluation Program. Stewardship Evaluation Officer, Range and Integrated Resources Section, Forest Practices Branch, MOF, Victoria, BC

³¹ Province of British Columbia. 2004. FRPA Resource Evaluation Program: Activities at the Regional and District Level—Discussion Paper. <http://www.for.gov.bc.ca/eefinder/> and then follow link to business initiatives

³² Forest Practices Board Website

Forest Professionals

Professional staff should have reasonable confidence that their prescribed strategies will achieve the stated objective. This suggests that either uncertainty about cause effect relationships should be low or that an objective should be monitored for negative consequences. Thus, professionals should promote effectiveness monitoring to reduce uncertainty or to detect negative consequences of management activities.

Gaps and Overlaps

Implementation Monitoring

Many implementation indicators will be measured by forest companies or by the Ministry of Forests as part of their current practices (Table 1). Some stand-level indicators are likely to be missed. Some indicators will be estimated rather than measured accurately and will provide insufficient detail for tracking trends over time.

Effectiveness Monitoring

The Ministry of Forests and MWLAP share the bulk of the responsibility for effectiveness monitoring, according to the Babine and Nilkitkwa LUPs, the FRPA Resource Evaluation Program Charter and the FRPA Training Companion Guide (Forestry Modules). PIR takes some responsibility for monitoring or researching specific topics, under obligations for SFI certification. DFO takes some responsibility for monitoring related to salmon. The Forest Practices Board will provide independent assessments of effectiveness, but likely on a limited range of topics.

Although government agencies and PIR have responsibilities for monitoring (Table 1), monitoring activity is still limited by funding. Provincial government funding for monitoring is scarce, but should hopefully increase under the FRPA Resource Evaluation Program.

Goals in LRMPs that are not directly included in approved landscape unit plans or sustainable resource management plans have not legal force, thus monitoring is not explicitly required by legislation. LRMP objectives, however, should not be ignored because they represent (arguably) the best available information describing public wishes for a specific area and Professional Foresters should be considering public direction in their planning and management.

Table 1. Agencies with responsibility for monitoring in the Babine River Watershed

The table below lists goals (in bold) with objectives and indicators under each goal. For implementation monitoring, the table identifies the phase of forest planning, surveying or monitoring where information is collected for each indicator. In many cases sufficient information is collected only to ensure that limits will not or have not been crossed. If implementation monitoring is to be used to assess trends or risk, more detailed information (i.e., the actual indicator value) may be required.

Acronyms used in the table follow:

C&E: information typically collected by Compliance and Enforcement Section, MOF

FGS: Licensee collects information about tree species and forest health during Free Growing Surveys

FSP: information needs to be collected to prepare (Licensees) or to review (MOF) Forest Stewardship Plans

SP: information usually described by Licensees in silvicultural prescriptions (professional requirement)

For effectiveness monitoring, the table identifies the responsible agency next to each goal and objective. The first agency listed generally has the primary responsibility. Agency responsibility was assigned using the following assumptions. MOF was given some responsibility for all objectives included in landscape unit plans or SRMPs, but not for LRMP goals (effectiveness monitoring is likely to be carried out by regional and branch staff of the MOF). Primary responsibility was assigned to MOF for habitat related objectives (although MWLAP probably shares primary responsibility in some cases); primary responsibility was assigned to WLAP for population related monitoring or water quality related monitoring. PIR was assigned some responsibility (e.g., collaboration) for topics identified as requiring research support under SFI certification.

Acronyms used for effectiveness monitoring follow:

ES: Ecosystem Section, Environmental Stewardship Division, MWLAP

EQS: Environmental Quality Section, Environmental Protection Division, MWLAP

F&W: Fish and Wildlife Science and Allocation Section, Environmental Stewardship Division, MWLAP

MOF: Ministry of Forests; probably staff from regions and branches

PIR: Pacific Inland Resources

Parks: Protected Areas Section, Environmental Stewardship Division, MWLAP

RS: Recreation Section, Environmental Stewardship Division, MWLAP

Goals, objectives and indicators	Implementation	Effectiveness
Maintain Biodiversity		ES, MOF, PIR
Maintain Core Ecosystems		MOF, ES, PIR
<ul style="list-style-type: none"> • % alteration in core areas 	FSP	
Maintain Natural Seral Stage Distribution of Ecosystems		MOF, ES, PIR
<ul style="list-style-type: none"> • % old by BEC subzone • % old and mature by BEC subzone • % young by BEC subzone 	FSP FSP FSP	
Maintain Connectivity in Landscape Corridors		MOF, ES, PIR
<ul style="list-style-type: none"> • % mature and old forest • % of cutblocks > 3 ha • km of road per km² • % winter harvesting 	FSP FSP FSP FSP?	
Maintain Sensitive Riparian Areas		MOF, ES, PIR
<ul style="list-style-type: none"> • percent alteration of fluvial ecosystems • percent of water body surrounded by target reserve width or better 	C&E C&E	

Goals, objectives and indicators	Implementation	Effectiveness
<ul style="list-style-type: none"> percent of water body surrounded by target management zone width or better 	C&E	
Attain Natural Landscape Pattern		MOF, ES, PIR
<ul style="list-style-type: none"> % of area logged in each patch size class (see SRMP and LUPs) in each identified land class in the Kispiox. % of area nearing rotation age (e.g., 80 to 100 yr) in each patch size class in each identified unit (Bulkley) 	FSP FSP	
Maintain Stand Structure		MOF, ES, PIR
<ul style="list-style-type: none"> % area in wildlife tree patches by block size and land class % of wildlife tree patches (by area) that are < 500m from another wildlife tree patch or mature or old forest volume of downed wood per hectare by subzone number of snags per hectare by size class and subzone number of live trees per hectare by size class and subzone 	SP estimates, C&E? ? C&E? ? ?	
Maintain Rare Ecosystems		MOF, ES, PIR
<ul style="list-style-type: none"> % reduction in functional area of listed ecosystems 	SP for estimate?	
Maintain Tree Species Diversity		MOF, ES?, PIR
<ul style="list-style-type: none"> % area of natural deciduous-leading ecosystems % tree species component of early seral stands 	? FGS	
Maintain wildlife		ES, F&W, MOF, PIR
Maintain wildlife habitat and populations		ES, F&W, MOF, PIR
<ul style="list-style-type: none"> % of high wildlife use area managed for wildlife in Enhanced Timber Development areas number of days of public use of Nichyeskwa Connector during summer 	FSP, SP? ?	
Maintain Grizzly Bears		F&W, MOF, PIR
Reduce Human/bear Interaction		F&W, ES, MOF, PIR
<ul style="list-style-type: none"> density of open roads per watershed; length of road in high-value habitat; length of road <150 m from critical habitat % of road through listed areas and habitats with screening; % of road with >300m sight distance in Babine River SMZ and SM2 initiate education programmes 	FSP, ES FSP, ES F&W	
Minimise Disruption of Bear Activity		F&W, ES, MOF, PIR
<ul style="list-style-type: none"> amount of motorised use by type and by zone in active season % of harvesting activity in active season by zone duration of inactivity by zone 	FSP estimates FSP estimates FSP estimates	
Maintain High-value Habitat		MOF, ES, PIR
<ul style="list-style-type: none"> % of intact high-value habitat 	FSP	

Goals, objectives and indicators	Implementation	Effectiveness
<ul style="list-style-type: none"> • % of intact critical habitats; % of critical habitats with sufficient adjacent forested habitat for cover and bedding 	FSP, SP estimates	
Maintain mountain goats		F&W, MOF, PIR
Maintain goat habitat		MOF, ES, F&W, PIR
<ul style="list-style-type: none"> • % of forested connectors between mountain ranges in Kotsine Pass that are harvested • % of harvesting within 200 m of identified habitat that uses clearcuts > 5ha • % area in Barbeau Creek SM1 harvested • number of days of public use of Nichyeskwa Connector during summer • area harvested within Atna-Shelagyote SMZ 	FSP FSP FSP RS? FSP	
Maintain goat populations		ES, MOF, PIR
<ul style="list-style-type: none"> • road density (km/km²) within 1 km of identified habitat • area harvested within 200 m of habitat during natal time period 	FSP FSP	
Maintain fish habitat and populations		F&W, DFO, MOF
Maintain fish habitat		MOF, F&W, ES
<ul style="list-style-type: none"> • percent of water body surrounded by target reserve width or better • percent of water body surrounded by target management zone width or better • number of cases of gravel or fill being removed from riparian management areas • number of cases of bank instability in riparian management zones that feed S1, S2 or S3 streams • number of cases of temperature increases in temperature sensitive streams following harvesting • number of cases of erosion/sedimentation associated with stream crossings • number of cases where fish passage is hindered • number of cases of injury of fish or of damage to fish habitat • number of cases of livestock related damage of riparian areas • number of days of public use of Nichyeskwa Connector during summer 	C&E, ES C&E, ES C&E, ES C&E, ES C&E? EQS? C&E, EQS, F&W, ES, DFO C&E? ES C&E? F&W, ES C&E? RS, F&W?	
Maintain bull trout		MOF, F&W
<ul style="list-style-type: none"> • number of permanent bridges within 750 m of known bull trout staging areas on Shelagyote River • km of permanent motorised access within Babine River SMZ • presence of need assessment for monitoring by-catch 	FSP FSP F&W	
Maintain steelhead		F&W
<ul style="list-style-type: none"> • presence of assessment of risk to steelhead including risk of repeated capture 	F&W	
Maintain Water Quality		EQS, EQS, PIR
Maintain Water Flow		EQS, EQS, MOF, PIR

Goals, objectives and indicators	Implementation	Effectiveness
<ul style="list-style-type: none"> equivalent clearcut area (ECA) 	?	
Maintain Water Quality		EQS, MOF, PIR
<ul style="list-style-type: none"> proportion of landslides related to forestry development that deliver sediment to streams sediment input at road crossings within Nicheyskwa, Babine and Shelagyote watersheds presence of stability mapping and management plans for fans and erosion 	C&E C&E?, F&W? DFO?, EQS? MOF?	
Conserve and respect cultural heritage		Parks, MOF
Protect cultural heritage values		?
<ul style="list-style-type: none"> presence of report that collates existing information on values within park degree of Gitksan satisfaction with consultation process presence of plan for managing camping use near park entrance developed jointly with Wud'at residents and Ned'u'ten Nation presence of report investigating opportunities for partnership/employment related to park 	Parks Parks Parks Parks	
Maintain Opportunities for Forestry		MOF, PIR
Promote rapid timber growth		MOF, PIR
<ul style="list-style-type: none"> % of old, slow-growing stands on high productivity sites % of disturbed sites promptly reforested (addresses NSR and prompt reforestation strategies) 	? FGS, partly	
Minimize unsalvaged timber mortality		MOF, PIR
<ul style="list-style-type: none"> proportion of landbase susceptible to beetles proportion of insect and disease damage controlled salvage efficiency (proportion of natural mortality salvaged) 	MOF? MOF? MOF?	
Reduce rotation age or increase yield in enhanced timber development areas		MOF, PIR
<ul style="list-style-type: none"> proportion of harvested areas planted with improved stock proportion of brush-limited sites treated with brushing and weeding proportion of appropriate sites pre-commercially thinned proportion of appropriate sites commercially thinned proportion of appropriate sites pruned proportion of appropriate sites fertilized 	? ? ? ? ? ?	
Conserve soil		MOF
Conserve soil		MOF
<ul style="list-style-type: none"> area of cutblocks where soil disturbance exceeds specified limit (10% or 5% if soils are sensitive) number of cutblocks where soil disturbance exceeds 25% in roadside work areas percent of harvested area occupied by permanent access area of landslides associated with roads and cutblocks number of cases of altered surface drainage patterns along access routes 	C&E C&E C&E C&E? C&E?	

Goals, objectives and indicators	Implementation	Effectiveness
Maintain Opportunities for Tourism and Recreation		Parks, RS, MOF
Maintain Wilderness Value of Babine River Corridor		see fish and wildlife and aesthetic quality
Maintain Fish and Wildlife in the Babine River Corridor		see fish and wildlife sections
Maintain the Aesthetic Quality of the Babine River Corridor		MOF, Parks
<ul style="list-style-type: none"> perceptible industrial activity during peak season (August – October) viewscape quality within visually sensitive areas (within and outside mapped Tourism Node) 	<p>?</p> <p>FDP</p>	
Maintain Sustainable Levels of Use		MOF, Parks
<ul style="list-style-type: none"> type and location of roads within the Babine River SMZ and SM2 indicators based on Recreation Management Plan cumulative frequency distribution of people who have exceeded their limit for wilderness experience for different zones and activities 	<p>?</p> <p>Parks?</p> <p>Parks?</p>	
Maintain a Wilderness Setting for Gunanoot Lake		Parks, MOF
<ul style="list-style-type: none"> amount of permanent roads within 1km 	?	
Maintain Access to Recreational Opportunities		MOF, Parks, RS
<ul style="list-style-type: none"> number of inaccessible recreation destinations 	?	
Maintain visual quality		MOF
Maintain scenic areas		MOF
<ul style="list-style-type: none"> proportion of defined viewsapes that meet or exceed visual design criteria 	FDP	
Maintain access to mineral and energy resources		MOF?
Maintain exploration and development opportunities		MOF?
<ul style="list-style-type: none"> % of crown land outside protected areas where exploration and development have been prevented 	?	
Maintain habitats for botanical forest products		MOF?
Maintain high-value pine mushroom sites		MOF?
<ul style="list-style-type: none"> % of ICHmc1(01b) and ICHmc2(01b) sites that exceed 80 years old 	FDP	
Maintain berry habitat within berry management areas		MOF?
<ul style="list-style-type: none"> % exposure to sunlight on cutblocks within berry management % area harvested in winter or with low ground disturbance system % of traditional berry picking areas burned % of traditional berry picking areas planted at low density 	<p>SP estimates</p> <p>SP estimates</p> <p>SP estimates</p> <p>SP estimates</p>	

Summary of Monitoring Projects to 2004

Almost 200 projects have been completed for parts of all of the Babine watershed, most during the past two decades (deGroot 2004). Some projects were specific to the Babine and included several years of information gathering (e.g. grizzly bear monitoring); others were completed as standard forest management practice (e.g. stream inventories, terrain assessments). About 25 of the reports dealt with planning or access options, and contain little information directly applicable to monitoring. Another eight were monitoring summaries, reporting on several topics. The remaining projects focussed on three areas: terrain stability and water quality (over 30 projects), fish (about 50 reports plus another 40 reconnaissance inventories of lakes and streams) and grizzly bears (21 reports). Several of the water quality projects were part of larger, regional projects designed to improve knowledge of relationships between forestry and water; others examined specific sedimentation issues. Fish reports were primarily population surveys of salmonids in the Babine River, and include more than 50 years of data from the DFO weir. Grizzly bear reports include ten years of population estimates based on a monitoring programme designed for the Babine, as well as habitat suitability mapping and surveys of habitat use and movement. Fewer projects considered tourism and recreation (11 reports), elements of biodiversity (5 reports), cultural heritage (3 reports), or forestry (2 reports).

Overall, the monitoring effort to date has not been coordinated, but has proceeded based on funding and changing, often ad-hoc, priorities. One outstanding exception is the 2004 State of the Forest Report for the Bulkley Forest District, that attempts, and succeeds in most cases, to include information necessary for implementation monitoring of the entire Bulkley LRMP. No similar effort has been completed for effectiveness monitoring, although the Bulkley Aquatic Resources Committee (BARC) is working on such a project for objectives relating to water quality.

A successful monitoring effort will gather information needed to define indicator levels, to improve risk curves and to detect negative consequences as priorities define. Table 2, below, summarises completed work (based on deGroot 2004) under each land-use objective class defined in Appendix 1, and notes whether each study can be used to define indicator level, to improve a risk curve or to detect negative consequences. In general, studies that measure population alone can only be used to detect negative consequences, while studies that attempt to relate changes in population to indicator values can be used to improve curves as well as to detect negative consequences. Where Appendix 2 lists particular areas of uncertainty around the risk curve, the tables below list projects by each type of uncertainty.

Table 2. Summary of projects completed in the Babine River Watershed up to 2004.

Maintain Natural Seral Stage Distribution of Ecosystems			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		Current status for Bulkley (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap in Kispiox
Improving Risk Curve	Ecosystem resolution	PEM for entire Bulkley TSA (Trowbridge et al. 2002); TEM for two map sheets in Nilkitkwa (Oikos 1998); no information for Kispiox	Analysis gap in Bulkley; local information gap in Kispiox
	Middle of curve	None	Local, regional and international information gap
Detecting Consequences		PEM for entire Bulkley TSA (Trowbridge et al. 2002); TEM for two map sheets in Nilkitkwa (Oikos 1998); no information for Kispiox	Analysis gap in Bulkley; local information gap in Kispiox
Maintain Core Ecosystems in an Ecosystem Network			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		Current status for Bulkley (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap in Kispiox
Improving Risk Curve	Middle of curve	None	Local, regional and international information gap
Detecting Consequences		Unnecessary unless risk changes	No
Maintain Connectivity in Landscape Corridors			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap

Measuring Indicator Level		Current status for Bulkley (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap in Kispiox
Improving Risk Curve	Seral stage resolution	Seral stage information available for Bulkley (SOFR 2004); no information for Kispiox	Analysis gap in Bulkley; local information gap in Kispiox
	Uncertainty about connectedness	None	Local, regional and international information gap
Detecting Consequences		None	Local information gap in Bulkley and Kispiox
Maintain Sensitive Riparian Areas			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		Cuell (2001) gives amount of riparian ecosystems (altered or not) in corridors in Bulkley; none for Kispiox; target for Kispiox, not for Bulkley	Local information gap Bulkley and Kispiox
Improving Risk Curve	Fans	Brookes and Kossman (2002) investigated a fan after a channel changed location; Wilford et al. (2000) investigated a fan after a spring flood	Analysis gap in Bulkley; local information gap in Kispiox
	Floodplains	None	Local and regional information gap
	Small streams	None	Local, regional and international information gap
	Riparian zone width	None	Local and regional information gap
Detecting Consequences		Baseline inventories of 18 lakes and many streams (see list in deGroot 2004); McElhanney (1997) completed watershed restoration plans for several watersheds, including measurements of riparian buffers	Analysis gap in Bulkley; local information gap in Kispiox

Attain Natural Landscape Pattern			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		Current status for Bulkley (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap in Kispiox
Improving Risk Curve	Uncertainty associated with other age classes	None	Local information gap
Detecting Consequences		None	Local information gap
Maintain Stand Structure			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		Current status for Bulkley for temporary and permanent reserves combined (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap in Bulkley (permanent reserves) and Kispiox
Improving Risk Curve	Uncertainty associated with natural levels of post-disturbance structure	None	Local information gap
Detecting Consequences		None	Local information gap
Maintain Rare Ecosystems			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		No information on current status; target from land-use plans for Kispiox, no target for Bulkley	Local information gap in Kispiox and Bulkley
Improving Risk Curve	Identification of rare ecosystems and original coverage	deGroot and Bartemucci (2003) discuss known rare ecosystems in parks; there have been no field surveys	Local information gap
	Middle of curve	None	Local, regional and

Detecting Consequences		PEM for entire Bulkley TSA (Trowbridge et al. 2002); TEM for two map sheets in Nilkitkwa (Oikos 1998); no information for Kispiox	international information gap Analysis gap in Bulkley; local information gap in Kispiox
Maintain Tree Species Diversity			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		None	Local information gap
Improving Risk Curve	Natural distribution of deciduous stands Tree species composition in landscape unit	None None	Local information gap Local information gap
Detecting Consequences		None	Local information gap
Maintain Wildlife Habitat and Populations			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		Current status for Bulkley (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap in Kispiox
Improving Risk Curve	Applicability of general biodiversity risk curve to individual species	None	Local, regional and international gap
Detecting Consequences		Marshall (1999) surveyed moose populations	Local information gap
Reduce Human-bear Interactions			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap

Measuring Indicator Level		Access control listed for Bulkley (SOFR 2004); MacHutcheon and Wellwood (2002) describes potential for conflict at campsites; none for Kispiox; targets from land-use plans	Local information gap
Improving Risk Curve	Unknown mortality	MacHutcheon (1996) describes impacts of trapping bears on human/bear interactions	Local and regional information gap
	Mortality outside Babine	None	Local and regional information gap
	Resolution of critical habitat	See studies under habitat, below	Local information gap
Detecting Consequences		Grizzly bear monitoring programme (Hatler 1995, 1996, 1997, 1998, Wellwood 2002, 2004); no patterns detected	Low ability to detect
Minimise Disruption of Bear Activity			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		Access control listed for Bulkley (SOFR 2004); MacHutcheon and Wellwood (2002) describe potential for conflict at campsites; none for Kispiox; targets from land-use plans	Local information gap
Improving Risk Curve	Uncertainty associated with complexity of bear behaviour	Grizzly bear monitoring programme (Hatler 1995, 1996, 1997, 1998, Wellwood 2002, 2004); no patterns detected	Local, regional and international information gap
Detecting Consequences		Grizzly bear monitoring programme	Low ability to detect
Maintain High Value Grizzly Bear Habitat			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		Current status for Bulkley (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap in Kispiox
Improving Risk Curve	Habitat effectiveness	Many studies have examined bear habitat suitability (see deGroot 2004 for list). These studies have been used to develop grizzly bear treatment units for planning. Few studies have looked at habitat use (effectiveness). MacHutcheon and Mahon (2003) looked at the effects of forest development on habitat use	Partial information gap
	Uncertainty about	None	Local information

	critical habitat outside “high value” habitat		gap
Detecting Consequences		MacHutcheon and Mahon (2003) looked at the effects of forest development on habitat use	Partial information gap
Maintain Mountain Goat Habitat			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level Improving Risk Curve	Curve not developed	Current status for Bulkley (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap in Kispiox Risk curve gap
Detecting Consequences		None	Local information gap
Maintain Mountain Goat Populations			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level Improving Risk Curve	Curve not developed	Current status for Bulkley (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap in Kispiox Risk curve gap
Detecting Consequences		Population surveys have been completed periodically (van Drimmelen 1985, Schultze 1990, 1994, 1999)	No
Maintain Fish Habitat			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level Improving Risk Curve	Curve not developed	Current status of watershed assessments in Bulkley (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap in Kispiox Risk curve gap
Detecting Consequences		Watershed assessments on four Babine watersheds (Beaudry 2000), and culvert inspections (Kossman et al. 2002) directly examined the risk of negative consequences to fish. A study of	No, although power is low

water temperature in fish streams (Torunski and Chaplin 2002) also looked at negative consequences. There have been many local surveys of fish populations, including DFO reports since 1946 on salmon counts at Babine weir. Reviews include those by DeGisi (2000), Gottesfeld et al. (2002) and Schell (2004). Many reconnaissance studies (1:20,000) have classified streams and mapped fish distribution and habitat (see deGroot 2004 for list). Fish distribution and habitat has been mapped at 1:5,000 level during cutting permit development.

Maintain Bull Trout			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		No current information; targets from Kispiox land-use plan	Local information gap
Improving Risk Curve	Curve not developed	Baseline information on bull trout habitat and distributions were collected by Giroux (2001) and Triton Environmental Consultants (2003)	Risk curve gap
Detecting Consequences		None	Local information gap
Maintain Steelhead			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		None	Local information gap
Improving Risk Curve	Curve not developed		Risk curve gap
Detecting Consequences		Several population estimates exist (see deGroot 2004 for list). There is high uncertainty and no agreed-upon effective method for surveying within the Babine River (Beere 1991, 1996, 1997, Bison 1993, Saimoto 1995).	Low power to detect
Maintain Hydrological Integrity			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap

Topic			
Measuring Indicator Level		Current status of watershed assessments for Bulkley (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap in Kispiox
Improving Risk Curve	Ability to detect flow changes	Watershed assessments (McElhanney Consulting Services 1997, Beaudry 2000) could be compiled to examine the relationship between flow and development, although power is very low	Analysis gap in Bulkley; local information gap in Kispiox
	Appropriate scale to measure sediment	Again, watershed assessments could be useful in refining local risk curves. Other studies, usually part of larger, regional projects, could be useful in improving sediment risk curves (e.g. Dykens and Rysavy 1998, 1999, Harper 1999, 2000, Bennett 2001, Bennett and Rysavy 2003). Many studies have performed slide hazard assessments, terrain classification and terrain stability mapping (see deGroot 2004 for list). This information could be used to examine appropriate scales.	Local, regional and international information gap
Detecting Consequences		Terrain stability mapping studies provide locations of instable terrain. Some studies (Maloney 1997, Schell 2003) have examined point changes in sediment following development. Monitoring summaries (Maloney et al. 1995) document sediment studies over time.	Requires continuous updating
Maintain and Respect Cultural Heritage			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		Current status of mapping of known and potential features for Bulkley (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap in Kispiox
Improving Risk Curve	Inappropriate to develop risk curve without First Nations consultation	Planning documents such as Gitxsan Treaty Office—Watershed Planning Group (2002) could be used to initiate consultation for developing risk curves	Risk curve gap
Detecting Consequences		None	Local information gap
Maintain Timber Supply			

Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		Current status for Bulkley (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap in Kispiox
Improving Risk Curve	Uncertainty associated with moderately productive ground	None listed in deGroot (2004)	Local information gap
Detecting Consequences		None listed in deGroot (2004)	Local information gap
Manage Enhanced Timber Development Areas Intensively			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		No current information; target in Bulkley land-use plans	Local information gap
Improving Risk Curve	Response to intensive silviculture	None listed in deGroot (2004)	Local information gap
Detecting Consequences		None listed in deGroot (2004)	Local information gap
Maintain Wilderness Value of Babine River Corridor			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		Information on access controls in Bulkley (SOFR 2004); none in Kispiox; targets in land-use plans	Local information gap in Kispiox
Improving Risk Curve	Uncertainty associated with auditory disturbance	None	Local information gap
	Uncertainty associated with sustainable levels of use	Hillcrest Recreation Consulting et al. (2001) formed the basis of the risk curves developed for recreation along the Babine River;	
Detecting Consequences		Hillcrest Recreation Consulting et al. (2001) examined the level of use of the Babine River in relation to the desired experience. Similar studies could be used to detect changes over time.	Some local information

Information from previous monitoring studies (Laing and McCulloch 1994, Harris 1995, Saimoto and Rysavy 1996) provide historical data. Cichowski et al. (1998) collected baseline information on the consequences of recreation to backcountry campsites along Babine River; Travers (2002) examined the value of wilderness tourism in a linear park surrounded by forest development.

Maintain Wilderness Setting for Gunanoot Lake			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		No current information; target in Kispiox land-use plan	Local information gap
Improving Risk Curve	Curve not developed		Risk curve gap
Detecting Consequences		None	Local information gap
Maintain Access to Recreational Opportunities			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		Current status for Recreation Opportunity Spectrum for Bulkley (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap
Improving Risk Curve	Curve not developed		Risk curve gap
Detecting Consequences		None	Local information gap
Maintain Backcountry Opportunities			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		Current status for Bulkley (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap in Kispiox
Improving Risk Curve	Curve not developed		Risk curve gap

Detecting Consequences		None	Local information gap
Maintain Trails			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		No current information; target in Bulkley land-use plan	Local information gap
Improving Risk Curve	Curve not developed		Risk curve gap
Detecting Consequences		None	Local information gap
Ensure Babine River Corridor is Safe			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		No current information; target in Park Management Direction Statements	Local information gap
Improving Risk Curve	Curve not developed		Risk curve gap
Detecting Consequences		None	Local information gap
Maintain Scenic Areas			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		Current status for Bulkley (SOFR 2004); none for Kispiox; targets from land-use plans	Local information gap in Kispiox
Improving Risk Curve	Risk curve not developed		Risk curve gap
Detecting Consequences		None	Local information gap
Maintain Opportunities for Mineral Exploration and Development			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap

Measuring Indicator Level		No current information; specific objectives for Kispiox only	Local information gap
Improving Risk Curve	Curve not developed		Risk curve gap
Detecting Consequences		None	Local information gap
Maintain Opportunities for Botanical Forest Products			
Monitoring Topic	Type of Uncertainty	Information (Source)	Gap
Measuring Indicator Level		No current information; targets in Kispiox land-use plan only	Local information gap
Improving Risk Curve	Curve not developed		Risk curve gap
Detecting Consequences		None	Local information gap