BRITISH COLUMBIA

Information Gathering and Management –
Monitoring Values for SFM Activity Area –
***Aquatic Biological and Physical Monitoring* and**
Terrestrial Biological and Physical Monitoring
FIA Activities –
Requirements for Innovative Projects 2003/04

1.0 INTRODUCTION

At present, FIA standards exist for "environmental monitoring" as described in Procedures for Environmental Monitoring in Range and Wildlife Habitat Management. This manual is designed to provide a common system for the collection and analysis of data to measure changes in range and wildlife habitat that result from resource management activities. However, much of the recent focus on monitoring by licensees and government is slightly different – data and information are being collected and analyzed for different purposes than what was envisioned when these standards were developed. The focus has become monitoring aquatic and terrestrial values as a means of achieving sustainable forest management, and includes measuring and tracking indicators that were selected as part of sustainable forest management planning.

The document, Monitoring Land Use Impacts on Fish Sustainability in Forest Environments, defines criteria, indicators, data sources, and data collection methods for examining land use impacts on fish and fish habitat in forest environments, and is working towards developing a toolkit of monitoring standards. The document notes it is critical that the selection process for indicators evaluates existing and developing sources of data and information, particularly those that form part of ongoing collection programs.

Regardless of the specific focus of the monitoring, it is important to have standards for data collection, eg, sampling intensities, plot layout, data attributes, precision and accuracy margins, and statistical complexities at both a research and operational level. The reference, Components of BC's Biodiversity (CBCB) series, and other inventory standards may still be applicable for some aspects of FIA projects.

Monitoring projects in 2002/03 (and likely in 2003/04) entailed all or some of the following:

- Using existing inventory standards for monitoring applications;
- Developing new/different ways of measuring inventory attributes (ie, not to RISC standards) for monitoring applications;
- Collecting data/information on new/different attributes, eg, species for which there are no RISC inventory/data measurement standards;
- Collecting data and information and reporting at various levels and across administrative boundaries (eg, management unit, regional, provincial), sometimes with various responsibilities (eg, licensee responsibility to report for forest management certification, Ministry of Water, Land

and Air Protection responsibility to report provincially to meet national and international agreements, etc.); and or

- Analyzing data in new/different ways for monitoring applications, which may include developing and testing new models.

The above mentioned standards may not cover all aspects of these types of projects. Consistent with the Forest Investment Account process, licensee monitoring projects that do not follow standards are considered innovative. Recognize that certain aspects of a project may follow existing standards, but if one or more aspects do not, the project becomes innovative. ***The primary goal for innovative FIA Aquatic and Terrestrial Physical and Biological Monitoring Activities is to identify and monitor a suite of indicators and protocols necessary to meet provincial responsibilities for reporting on the achievement of sustainable forest management (SFM) and or FRPA requirements for monitoring the achievement of resource objectives. The secondary goal is to test the selection of SFM indicators and develop monitoring protocols/procedures for SFM indicators pertinent to forest management certification or similar purposes.***

A supporting document, "Strategic and Operational Checklists for Biodiversity Monitoring & Reporting" is available on http://wlapwww.gov.bc.ca/wld/documents/fia/innov_monitor_checklist_s.pdf, to ensure the work carried out under the FIA: a) meets provincial consistency; b) provides the most useful results; and c) demonstrates optimum credibility.

The general requirements for FIA innovative projects apply to *Aquatic Biological and Physical Monitoring* and *Terrestrial Biological and Physical Monitoring* activities, as well as the requirements below*:*

2.0 REQUIREMENTS

A. Principles:

The following principles should guide preparation of forest and range biodiversity monitoring projects, to be funded by the Forest Investment Account (FIA).

- Biodiversity monitoring is primarily intended to address the broad conservation criterion that *Native organisms in British Columbia are not lost through human-induced activities.*
- Monitoring begins with a conceptual model of the ecosystem as a system of stressors and responses represented by measurable indicator variables.
- Sound statistical models are the key to detecting and understanding change. If there is no well-justified statistical model the monitoring is unlikely to be effective.
- The most informative approaches combine two or more types of monitoring. For example, combining effectiveness monitoring with monitoring to improve, including validation monitoring; or effectiveness monitoring combined with compliance. The different strengths required to implement these kinds of monitoring emphasizes the merit of cooperative approaches.
- Design-based approaches to monitoring are based on drawing random samples from a specific target population of variables, likely based on some stratification. Inferences from the sample to the population at large follow naturally. Design-based approaches are best suited for comparisons between different populations (e.g. dispersed and group retention). Design based approaches contribute usefully to effectiveness monitoring.
- Modelling-based approaches do not rely on random sampling. Rather, an attempt is made to identify representative sites that are intensively studied for the purposes of constructing a more detailed model of the processes in question. This model is then applied more widely to similar sites or

locations. Modelling-based approaches are most useful in monitoring to improve, including validation monitoring.

- Design-based conventional trend analyses may have utility in effectiveness monitoring, but are unlikely to provide ecological understanding without long time series. Measuring regional trends across numerous sites is especially problematic, unless these are effectively stratified.
- Available historical baseline data can be used to establish current status and trends.
- Available information on natural range of variation and management objectives is used to help interpret trends in the data.
- Indicators and measures must be responsive to status and trends in biodiversity and relevant to management.
- Indicators and measures are intended to represent status of native species.
- Projects may be intended to develop, or test, indicators and measures.
- Projects may be developed that intend to represent all native species within the study area.
- Indicators and measures help to identify factors causing changes in biodiversity.
- Measures of high values at risk: for example species or ecosystem types that are Threatened, Endangered, endemic, or for which British Columbia contributes 1/3 or more of global populations; are included.
- Science peer-review processes are used in design of studies and analysis of results.
- Monitoring project designs and methods are documented in a manner that is transparent and allows comparable sampling to be repeated in the future.
- Results are publicly reported in a transparent manner and the underlying data or summaries are made freely available to the general public, to provide opportunities for independent review.

B. Content – Innovative Project Work Plan

As with any innovative activity, the work must build on existing efforts. For *Aquatic Physical and Biological Monitoring*, the document, Monitoring Land Use Impacts on Fish Sustainability in Forest Environments, must be considered and referenced in the project work plan.

All proposals for FIA funding for monitoring aquatic and terrestrial SFM values should include the following categories of information.

1.0 Ecosystem Divisions

Indicators can be determined for monitoring aquatic and terrestrial values for SFM within each of these major ecosystem divisions. Ecosystem classifications provided, or endorsed, by Ministry of Sustainable Resource Management are to be used.

1. Terrestrial Ecosystems.
2. Freshwater Ecosystems.
3. Wetlands – associated with terrestrial and freshwater ecosystems.
4. Nearshore Marine Ecosystems – includes brackish or saltwater marshes and estuaries, and all marine areas affected by forest related developments such as log sorts.

2.0 Categories of Indicators

Include sub-indicators or measures under the 4 main categories of indicators, for each broad ecosystem division, affected by forestry activities. The specific measures, or sub-indicators, under each indicator category must be supported by existing standards, or a research process to validate them.

1. Representation. Measures the extent to which all ecologically distinct habitat types are represented in the unmanaged land base, to maintain lesser known species and ecological functions. This indicator is intended primarily to ensure that poorly known species and functions that may not be assessed by the other indicators are sustained. It also serves to identify unmanaged "benchmarks" or "baselines".

2. Landscape condition. Measures the extent to which the amount, distribution, and heterogeneity of landscape structure important to sustain biological richness are maintained over time. This indicator complements the Representation indicator by evaluating landscape requirements of many species and projecting consequences of changes in those requirements through time. Landscape condition must be linked to habitat condition.

3. Habitat condition. Measures the extent to which the amount, distribution, and heterogeneity of habitat structure important to sustain biological richness are maintained over time. This indicator complements the Representation indicator by evaluating habitat requirements of many species and projecting consequences of changes in those requirements through time. Habitat condition must be linked to landscape condition.

4. Focal species. Measures the extent to which distributions of productive populations of native species are not compromised by human activities. This indicator is intended to assess whether native species present in the province are likely to continue as well-distributed, productive populations, or are being compromised by human activities. It serves as a test of the more "coarse filter" approaches of the other indicators.

3.0 Categories of monitoring

"Monitoring" is a term that covers many aspects of management. Consider and differentiate in the project work plan which of these standard categories of monitoring will be undertaken as part of the project. (Note that there are FIA Activities titled "Treatment Effectiveness Evaluations" under the respective treatment Activity Area, which cover part of #2 below).

Monitoring — Repeated, systematic measurements done with a specific purpose in mind. Monitoring is focused on measurements over time in order to detect the change toward, or away from, a stated standard or objective. Monitoring is part of cycle of assessment and evaluation that is linked to management activities.[2]

Effective communications around environmental monitoring can hampered by ambiguous language and words with different meanings to different people.

The best way to talk about environmental monitoring is to be as specific as possible about what you are monitoring. This may require stringing together several descriptors (e.g. water quality objective attainment monitoring; Forest and Range Practices Act compliance monitoring). This is potentially awkward, but may save you considerable effort in the long term unravelling the misunderstandings created by less specific terms.

Below are a suite of terms that tend to infiltrate communications around environmental monitoring. Clarification of the possible meanings of these terms will help people understand each other better.

4.0 Common Types of Monitoring

1. Compliance — Measures performance against some environmental standard to establish a compliance record[2]. Compliance monitoring may include audits, assessments, and reviews.
Compliance Monitoring - Legal: Measurement of performance against practices required by law (e.g. regulations under the Fish Protection Act, Wildlife Act, etc.).
Compliance Monitoring - Practices: Measurement of performance against environmental standards, policies, best management practices or plans that are recommended but not required by law.

2. Effectiveness —Measures environmental condition in the context of a program, policy, plan, or activity to gauge progress toward its desired outcomes or effects.[2]

Note the distinction between compliance and effectiveness. Compliance monitoring addresses whether people are complying with environmental standards (e.g. is a forest licensee retaining a riparian buffer?) whereas effectiveness monitoring attempts to uncover whether those standards are having an effect in the environment (e.g. does the buffer retain the ecological character of the riparian area?).

3. Environmental Condition (also Ambient or Trend) —Measures the changing status of a component of the environment over a time series, often to determine trend[2] (e.g. long-term changes in amphibian diversity in BC). Because it does not set out to evaluate effectiveness, and is thus not confined by existing programs, one strength of this type of monitoring is its ability to catch emerging issues.

Some people consider environmental condition monitoring to be similar to effectiveness monitoring. However, environmental condition monitoring tracks status of biological variables, without reference to a practice such as snag retention. Effectiveness monitoring relates the biological variable to practices, so is not equivalent to condition monitoring.

4. Implementation — Measurement of activities (what took place, where and when). This information provides necessary context (what was done) for interpretation of the results of effects monitoring (ecological outcomes).

Implementation monitoring can sometimes be very similar to what is measured for monitoring compliance with practices. For example, what is measured by government to determine compliance with a management plan may be the same as what is measured by the proponent to document the implementation of the plan.

5. Reference/Baseline —Used, with regard to monitoring, to characterize existing environmental conditions to form a basis for interpretation and future comparisons (e.g. measuring air quality in undisturbed areas as context to reveal local changes in air quality).

There is some room for confusion here as “baselines” may refer to several approaches. These include establishing simultaneous control sites to track natural variability over time, evaluating historical rates of variability using available information, or setting a “benchmark” (i.e. starting point) from which to monitor into the future.

6. Validation — Refers to research activities that evaluate the strength of the relationships and assumptions on which a monitoring program is based. Validation is generally sought around the degree to which monitoring indicators and techniques measure real environmental conditions and trends (e.g.

whether road density is a suitable indicator of water quality within an ecosystem); and the cause–effect relationship between environmental condition and management interventions (e.g. whether changes in effluent discharge result in downstream changes in diversity of benthic organisms).[2]

Some scientists consider "validation" a misnomer which overstates our ability to definitively prove (i.e. validate) how variables relate. People with this opinion prefer to describe these activities in terms of their focus on improvement (e.g. monitoring to improve). A contrary strain of thinking suggests the idea of "improvement" is not specific to this type of monitoring, as all types of monitoring should be undertaken with improvement in mind.

5.0 Other Useful Terms (in alphabetical order)

Audit (noun) — A single set of tests, analyses and confirmations to verify the acceptability and quality of work or data. Audits are usually comprehensive, complex and spatially/temporally discrete. Audits can be considered a type of compliance monitoring.

Criterion — A category of conditions or processes which form the basis for an assessment.[4] Criterion are assessed using a set of related indicators which are monitored to track change.[3] E.g. maintain species diversity.

Indicator — Variable or index (i.e. a value derived from parameters) that points to, provides information about and/or describes the state of the environment, and has a significance extending beyond that directly associated with any given parametric value.[5] An indicator measures an aspect of a criterion. The term may encompass indicators of environmental pressures, conditions and responses. E.g. number of threatened or endangered species, population levels of selected species, etc. Beware of confusion from people who consider that indicators are only variables and are not indices.

Index — A composite numerical value derived from multiple parameters, including variables, constants and other items of information.[6] E.g. A water quality index may be derived from several variables, including levels of different pollutants, turbidity, etc.

Inventory — A single enumeration of an ecological system; generally carried either as a basis for estimating potential yield or to establish a benchmark.[1] An inventory may act as one point in time in a monitoring program. Ecological inventories may be more comprehensive and spatially/ temporally discrete than monitoring activities.

Measurement — The determination of the amount or quantity of a substance.[6]

Protocol — The rules of, and steps in, a procedure; standards.

Reporting — The process of effectively communicating the results of monitoring and their potential implications to a target audience.

Research — The most intensive level of data collection, carried out on relatively small areas to achieve a better understanding of complex relationships.[1] Validation or improvement monitoring is a specific type of research.

Variable — Something that is measured. E.g. number of animals, concentration of a chemical.

Sources (current definitions may be adapted from originals):

1. Brown, D. and J. Dick. 2001. Environmental Monitoring: Business and Information Needs Study. Prepared for Land Information and Inventory Coordinating Committee. Victoria, BC. 79 pp.
2. Jones, RK, R. Ellis and K Gustavson. 2002. Towards an environmental monitoring strategy for British Columbia. Phase I: Provincial Government Natural Resources. Part 3: Appendices. Prepared for Ministry of Sustainable Resource Management. Victoria, BC. 58 pp.
3. The Santiago Declaration, The Montreal Process.
4. BC Ministry of Forests Glossary and Service Plan.
5. European Environmental Agency.
6. Dunster, J. and K. Dunster. 1996. Natural Resource Management Dictionary. Univ. of BC. Vancouver, BC. 380 pp.

6.0 Scale

Consider indicators at these scales and time frames.

Early Warning – indicators that identify potential reductions in values at the early stages, for example potential reductions in endemic species populations as related to biodiversity. Presence of early warning signals of potential loss to biodiversity should trigger more intensive study to determine if there is a major developing problem and help identify solutions.

Long Term – indicators that are measured over the long term to show trends.

Prediction – use of modeling techniques, such as habitat supply modeling, to forecast trends and to assess potential alternate forest management scenarios.

C. Further Requirements

1. Information on indicators must be reported in a form and format that is consistent with MSRM requirements, e.g. mapping units – Ecosections, BEC variants, and Watersheds.
2. Partner, where possible, with the following institutions which are acknowledged as providing scientific support to monitoring: UBC, SFU, UNBC, UCC.
3. Prepare to share current work and participate in an information exchange forum, e.g., workshop, that will be organized by ministries Jan-Mar 2004.
4. Cooperate with ministries and partners in data management; in particular the establishment of a public repository/data warehouse for data not currently housed.
5. Submit the approved "project management plan" to [specify contact]
6. Submit final report to [the above or NRIN], which must include, in addition to the general requirements for innovative project reports, the following:
    a) Describe the objectives of the project, clear objectives are essential to properly design the project including selection of relevant indicators.
    b) Indicators being measured/monitored, in the format of #1 above.
    c) Standard data (ie, for which standards exist and are being followed) – indicate where they are being housed.
    d) Non-standard data (ie, for which standards do not exist, or existing standards are not being followed) – indicate where they are being housed.
    e) Data collection methods, data format and analysis methods sufficiently so the project could be duplicated.
    f) Identification of proprietary data and how these data may be purchased if that possibility exists.

g) Management implications related to linking the scale of data collection/reporting of the project to broader scales, eg, linking MU data to regional reporting.
h) Scientific review of the workplan (i.e., reiterate the section from the workplan), the actual project implementation, and what is proposed for the final report.
i) Recommended future action related to the project results, eg, future monitoring, expanding test sites, further modeling and analysis, etc.
j) Describe how the project report will be made freely available, and how the data will be managed so as to be available to independent reviewers.

D. Data Management

New attributes and new analysis, i.e., new meta data, may require new public repositories/warehouses to be built so various people can access the data for use or interpretation. The ministries will be working to develop repositories/warehouses during 2003/04 with the intent of having such repositories identified by April 1, 2004. Licensees are encouraged to develop projects that will lead to the development and implementation of data repositories/warehouses.

All reports must be submitted to FORREX NRIN as required for innovative projects.