

The Alberta Biodiversity Monitoring Program (ABMP): a cost-effective, multi-species, broad-scale, long-term biodiversity monitoring program

Jim Schieck¹

Abstract

To minimize risks of biodiversity loss, and to meet provincial, national, and international commitments to conserve biodiversity, a public/private partnership (composed of government, industry, and academia) developed the Alberta Biodiversity Monitoring Program (ABMP). This program is capable of relating changes in biodiversity to changes in human land use. The ABMP is based on a grid of 1656 sites spaced 20 km apart throughout Alberta. Field protocols to sample terrestrial biota (vascular plants, mosses, lichens, fungi, mites, birds, mammals), terrestrial habitats (trees, snags, logs, litter, vegetation heterogeneity) have been developed and peer reviewed (www.abmp.arc.ab.ca). Protocols for aquatic biota (benthic invertebrates, dragonflies, zooplankton, amphibians, fish), aquatic habitats (basin characteristics, water chemistry, nutrients), and remote sensing of vegetation polygons, landscape patterns, and human disturbances are presently being developed. A Prototype of the ABMP was initiated in 2003 to: i) test and refine the data collection protocols, ii) test the statistical power of the ABMP, iii) develop a comprehensive suite of biodiversity multi-metrics, iv) develop products and mechanisms for reporting changes in biodiversity, v) develop a web-based system to store, manage, manipulate, and disseminate ABMP information, vi) develop a business plan for the ABMP, and vii) to position the ABMP within the existing management and regulatory frameworks so it would be implemented effectively. A Board of Directors, composed of heads of government departments and presidents/vice-presidents from industry and environmental organizations, was created to manage the ABMP Prototype. A manager, with a proven track record of working with industry and government, was hired to help the Board position the ABMP so that it was cost effective and met the needs of resource sectors, and to secure long-term funding for the program. Research scientists have initiated a collaborative initiative to finalize all scientific aspects of the program. The ABMP is on track to be fully implemented in April 2007.

¹ Integrated Resource Management, Alberta Research Council, Bag 4000, Vegreville, Alberta, T9C 1T4

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Introduction

The rate, diversity, and magnitude of industrial development in the forested regions of Alberta have increased over the past several decades, and are projected to grow substantially in the future, as human populations and related infrastructure grow. This growth has already produced a considerable impact upon landscapes in the province, and careful management is required to ensure that the cumulative effects of developments do not adversely affect biodiversity, and the environment in general. Addressing this concern is important to the competitiveness of Alberta economies, because market forces are increasingly demanding that protection of ecosystems and biodiversity be clearly demonstrated as conditions of product sales. Industrial players in Alberta, especially the forestry and energy sectors, have demonstrated strong commitments to using adaptive management processes in the conduct of their businesses. Systems and processes that provide early warning of changes in biodiversity and their relationships to specific industrial and other human activities are urgently required. The Alberta and Canadian governments are similarly committed to conserving biodiversity (Alberta Environment 1999; Alberta Environmental Protection 1998; Canadian Council of Forest Ministers 1998; Environment Canada 1995).

Although the need for a comprehensive provincial biodiversity monitoring program was recognized during the 1990s, Alberta did not, at that time, have the integrated broad-scale, long-term monitoring program that was required. Monitoring must be a broad scales because species move through, and use different parts of the landscape at different stages in their life, and move following disturbances. Sustainability must be evaluated over long time periods because the long generation times for plants and animals result in slow changes to populations and communities. Thus, to effectively evaluate biodiversity sustainability, a focused broad-scale long-term monitoring program was developed for Alberta.

Program Development – PHASE I

Between 1998 and 2002, a partnership, which included Alberta industries, government, and research institutes, developed the ABMP. The program was designed to measure and report on the status and temporal changes in biodiversity, habitats and anthropogenic (man-made) disturbances in Alberta at the regional and provincial scales. The ABMP was developed to: (1) support existing commitments to biodiversity monitoring, (2) develop common, standardized methodologies that could be applied across all jurisdictions within Alberta, (3) monitor aquatic and terrestrial systems at a hierarchy of spatial scales, (4) occur in locations having a wide range of land use histories, including those with limited human influence, (5) include life forms from diverse taxonomic groups and trophic levels, (6) estimate natural variability to assist interpretations of the significance of observed changes, (7) be transparent and subject to rigorous technical review, and (8) provide data and information freely to everyone.

A team of more that 20 scientists identified protocols to survey a broad diversity of biota, habitat structures, vegetation communities, and landscapes patterns within Alberta (Table 1). These protocols were reviewed by other scientists from across North America and then amalgamated into an integrated design that would effectively and efficiently survey all elements (<http://www.abmp.arc.ab.ca/ABMPSummary.pdf>).

Survey Design

The ABMP is designed to monitor long-term, broad-scale changes in biodiversity, many of which are anticipated to be small and occur slowly over time. The basic survey design consists of 1656 sites, evenly spaced on a 20 km grid pattern throughout Alberta (Figure 1). Remote and ground-based surveys are conducted at each ABMP site.

Once the ABMP is fully operational, approximately 375 sites will be surveyed each year, resulting in each site being re-surveyed every 5 years. The program will facilitate comparisons among geographic regions, and will feed information into adaptive management processes used by land managers and regulators interested in evaluating long-term sustainability of biodiversity and ecological resources. The ABMP has been designed to detect a change of 3% per year within a region after 3 visits to a site, and a two-fold difference between regions after one complete set of surveys. The program will have a statistical power of 90% to detect change, and have less than a 10% probability of declaring a difference when there really was none.

Information and analyses generated from the ABMP will be used to delineate associations between development events and changes in biodiversity, which in turn, can be pursued by experimental research. Therefore, the program will provide early warning of biodiversity change, and reduce the cost of sustaining biodiversity by avoiding expensive species recovery programs. Above all, the ABMP is designed to be scientifically credible, transparent, and to satisfy the biodiversity monitoring needs of government, industry, and the general public.

ABMP Prototype Project (2003-2006) – PHASE II

By the end of 2002, much of the scientific and technical aspects of the ABMP were complete. A group of senior managers from government, industry, and non-government organizations reviewed the ABMP and decided that a “Prototype Project” would be the best method to move the ABMP from the developmental phase into the operational phase. This Prototype would be a cautious rollout of the ABMP to demonstrate its value. As such, the ABMP Prototype was initiated in January 2003. The Prototype is a 4-year project designed to position the ABMP for full implementation starting April 2007. During the early part of 2003 many Alberta industry and provincial government organizations committed their funding, and core staff were recruited. The funders, and associated researchers, formed the teams (Management Board, Secretariat Working Group, Science Committee, and Delivery Team) that are conducting and managing the Prototype (Figure 2). A website (www.abmp.ab.ca) was developed to house ABMP documents, inform everyone of the current status of the program and provide technical details on activities and results from the ABMP Prototype.

A wide variety of tasks will be completed during the ABMP Prototype to position the program for full implementation in 2007. For each of the tasks activities that have been completed, and that are ongoing, are describe below.

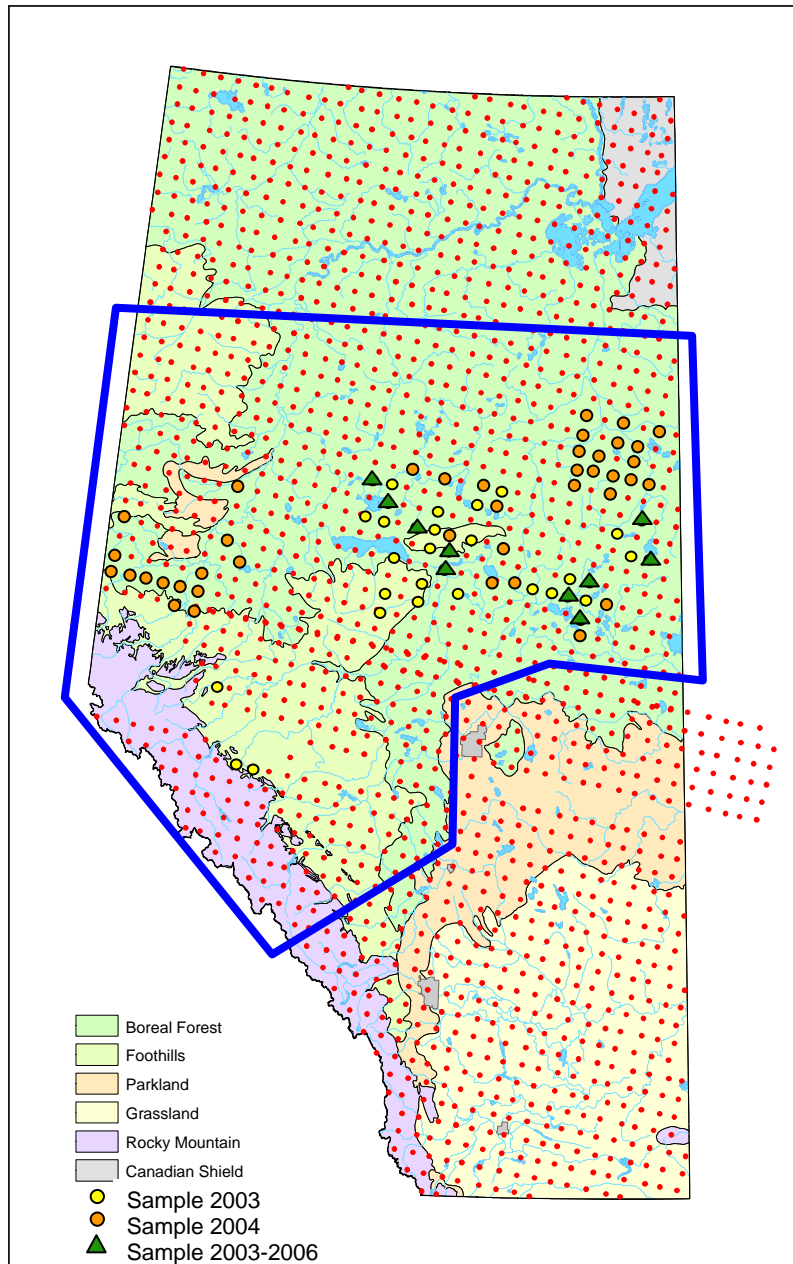


Figure 1: Sites for the ABMP occur throughout Alberta at 20 km spacing. The area in blue indicates the location of ABMP Prototype with the sites that have been surveyed during 2003 and 2004 indicated.

Complete Development of the Aquatic, Fungi, and Arthropod Protocols

At the end of Phase I, a few of the field protocols were not finalized. Based on a field trial of the proposed aquatic protocols, concerns remained with finding appropriate sites. The proposed arthropod protocols were too costly and the species composition data were too variable to detect the required level of changes. Finally, fungi protocols had not been

developed. Thus, during the Prototype Phase, scientific experts are building on the development that has already occurred (see Chapters 10, 11, 14, and 15 at <http://www.abmp.arc.ab.ca/Documents.htm>) to develop/refine these protocols so that they are effective for the ABMP.

During 2004, Dr Brian Eaton suggested revisions to the aquatic protocols and field-tested the protocols in lakes and streams. Revisions and field-testing will continue during 2005. During 2003/04, Dr. Jeff Battigelli, suggested revisions to the arthropod protocols. His suggestions were peer reviewed and field tests of the suggested protocols are planned for 2005. During 2004, Drs. Jogeir Stokland and Anna-Liisa Sippola suggested protocols for surveying fungi in the ABMP. Their suggested protocols are being peer reviewed and field-tests will be conducted during 2005.

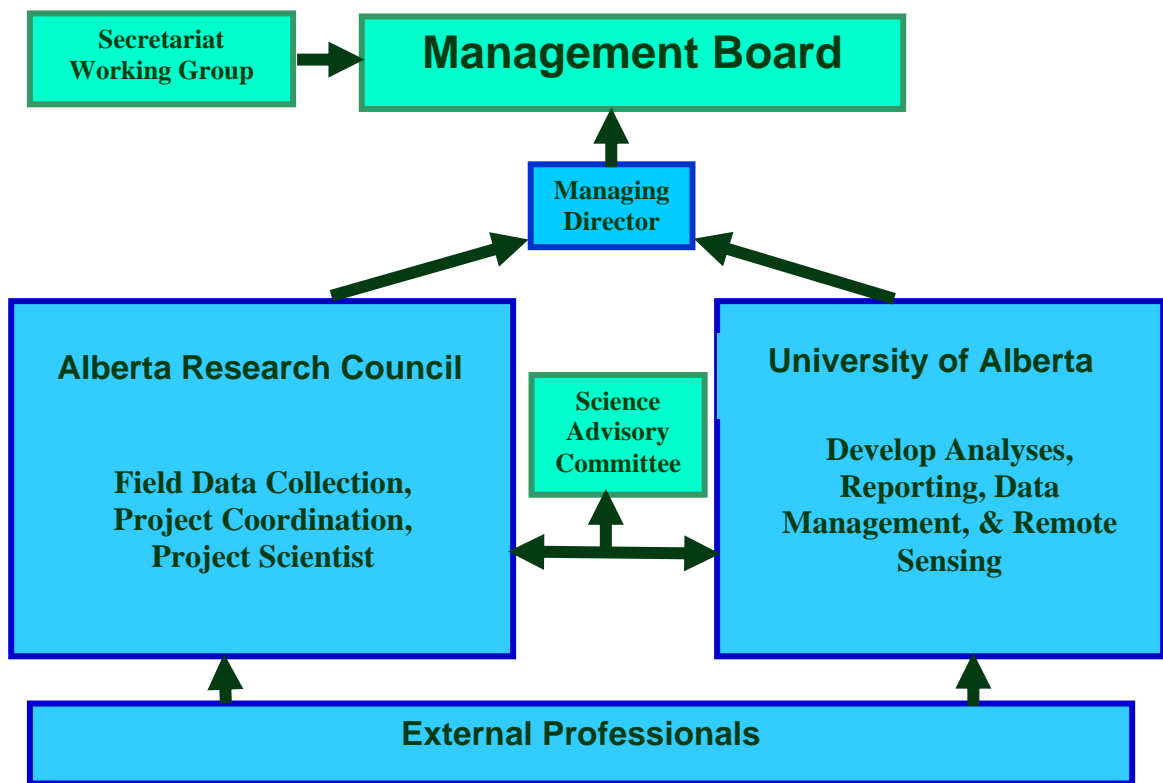


Figure 2: Governance and management structure for the ABMP Prototype.

Complete Development of the Remote Sensing Protocols

Significant research has been done to develop remote sensing protocols for the ABMP (see Chapters 7, 8, and 9 at <http://www.abmp.arc.ab.ca/Documents.htm>). However, at present there are no reliable, automated remote sensing feature extraction and labeling algorithms for use in land cover classification of remotely sensed images, that are applicable for the large datasets that will be acquired by the ABMP. Thus, algorithms for the labeling (classification) of remote sensed imagery (Quickbird and Landsat Thematic

Mapper 7) will be evaluated to determine their accuracy at identifying selected land cover types (e.g., deciduous, white/black spruce, mixed woods, shrub lands, meadows, bare ground, marshes, bogs, fens, etc.), as well as how different compositions of canopy trees and forest ages relate to LAI and canopy closure.

During 2004, activities were conducted on two initiatives. First, Dr Arturo Sanchez developed a manual that documents how Thematic Mapper 7 images will be processed for the ABMP to create coarse resolution “wall-to-wall” vegetation coverage for Alberta. During 2004, he processed Alberta Ground Cover Classification data for approximately 100 ABMP sites. During 2005, Dr. Sanchez will process the remaining ABMP sites in the forested zone of Alberta. An initiative to create coarse resolution vegetation polygons outside the forest will be developed. As an interim measure, we are using Alberta Vegetation Inventory data around each of the ABMP sites to determine fine resolution vegetation polygons. However, AVI is hand interpreted and as such, Kyung-Kuk Kang, is evaluating whether Quickbird images can be used to replace AVI. Kang’s research will be continued during 2005.

Field Data Collection

During the Prototype, all field protocols used for the ABMP will be field tested to ensure that they can be completed efficiently and effectively. Field sampling focuses in the Boreal Natural Region of Alberta. However, to ensure that protocols are effective in all habitats, protocols will be tested in other regions also. The data collected during the field tests is being used to develop biodiversity multi-metrics and to test the statistical power of detecting change. Developing and testing the biodiversity metrics is limited to the taxonomic groups where protocols have been finalized.

During 2003 and 2004, Curtis Stambaugh coordinated data collection at 73 ABMP sites; 63 of these sites were surveyed during one year, and 10 sites were surveyed during both years (Figure 1). Data collected included physical site characteristics, breeding birds, forest structure (trees, snags, shrubs, downed wood), vascular plants, lichens, mosses/liverworts, and high profile animal species. All unknown specimens that were collected in the field were sent to experts for identification. Refinements to the terrestrial protocols, with the exception of arthropods (see above), are essentially complete. Detailed protocols and data collection techniques can be found on the ABMP web site (<http://www.abmp.arc.ab.ca/FieldProtocols.pdf>, <http://www.abmp.arc.ab.ca/FieldDataSheets.pdf>). Data will be collected at approximately 50 more ABMP sites (and re-collected at the 10 repeat sites) during the next two years of the Prototype to aid development of biodiversity metrics and to calculate statistical power for the ABMP (see below).

Test the Statistical Adequacy of ABMP Protocols

ABMP information will be of value to land managers and other end-users only if the signal (ie. real change in biodiversity over time, or difference in biodiversity among regions), can be separated from the noise (ie. variation caused by measurement error and natural variation). Data collected during the ABMP Prototype will be used to evaluate sources of variation and the statistical power to detect changes in biodiversity metrics. Approximately 120 ABMP sites will be surveyed during the 4-year Prototype

with ten of these sites re-sampled in each of the 4 years. This two-pronged approach to data acquisition allows us to evaluate Within Site Variance, Between Site Variance, Between Year Variance in the data and to determine statistical power of the ABMP. In addition, we will determine whether vegetation structures at the ABMP sites, and landscape patterns around the sites, can be used as covariates to statistically account for some of the Between Site and Between Year Variance, and thus, increase the statistical power.

A preliminary analyses of statistical power will be conducted during the winter/spring of 2005 using data that has been collected during 2003 and 2004. Based on this analyses data collection during 2005 and 2006 will be targeted at specific habitats. Statistical power will be evaluated rigorously during the fall of 2006 once all the data has been collected. Preliminary analyses suggest that the protocols will be very effective. All common species in the taxa that were targeted for sampling were surveyed effectively. In addition, many of less common species were also detected and changes in the abundance of these less common species may be detectable at the provincial scale using ABMP data.

Develop Biodiversity Indices from ABMP Data

In the ABMP we have chosen to be consistent with the Convention of Biological Diversity and have defined biodiversity as “the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems”. Since there is no consensus within the Convention of Biological Diversity (or among other organizations) regarding how to measure changes in biodiversity, the ABMP has been developing a suite of effective and efficient indices. During Phase I of the ABMP, the Science and Technical Committee developed a suite of taxonomic groups and habitats to be included within the program. This suite includes approximately 1000 species from 14 taxonomic groups and approximately 100 habitat elements from 10 habitats groups (see description above, and <http://www.abmp.arc.ab.ca/ABMPSummary.pdf>). Changes in presence and abundance for this suite of species and habitats will be used to provide inferences about changes in biodiversity in general.

With many taxonomic and habitat groups being monitored, it is necessary to summarize the information so that the signal of biodiversity change is readily determined. Thus, during 2004, Drs. Jim Schieck, Stan Boutin, Erin Bayne, Chris Shank, and Dan Farr developed a framework for information pyramids that will be used to summarize biodiversity information. Three pyramids were developed; one for species/biotic information, one for information about natural habitats, and one for information about anthropogenic disturbances. During 2005 and 2006, Dr. Scott Nielsen and Jim Herbers will join the group of scientists, and help develop algorithms for calculating biodiversity at each level in the pyramids. In addition, this group of scientists will develop algorithms to compare information among pyramids, and to evaluate whether changes in biodiversity are associated with changes in natural or anthropogenic habitats. Information that is collected on vascular plants, mosses, lichens, birds, and mammals during the Prototype (see above) will be used to determine the statistical power of the biodiversity metrics.

Develop Analyses and Reports for the ABMP

To ensure that managers use information from the ABMP, the information produced must be translated into products and services that are valuable to these managers. These products/services need to provide analyses of past management practices, and point to areas of potential improvement. Development of such “value added” components will require a thorough understanding of the management systems presently being used, coupled with strong ecological understanding of land and biodiversity management issues.

During 2004, Jim Herbers, Kirk Andries, Dr. Stan Boutin, and Dr. Jim Schieck conducted workshops and follow-up discussions with 15 groups of stakeholders to ensure their needs were understood, and that products would be developed to address those needs. In addition, a review of policy and regulation in Alberta was conducted to determine the type of biodiversity management that was required. During 2005, a cost/benefit analyses will be conducted to highlight the savings that will be provided by having the ABMP, a high quality, integrated province-wide biodiversity monitoring program. In addition, during 2005 reporting templates will be developed and discussed with land use managers, to determine which biodiversity metrics and products they need, and how best to present this information so that it is used.

Develop a Data Management System for the ABMP

A large amount of field and remote sensing data will be gathered by the ABMP. This data must be managed in a secure environment and distributed in formats that can be used by many individuals and organizations. As such, an effective information management system must be designed to store and manage the ABMP data. In addition, a secure, internet-based, interactive interface, that allows external users to sort and access the pieces of ABMP data they require, must be designed and implemented.

During 2004 Qiongyan Fang reviewed the scientific literature, comparable data management systems on the internet, and existing data management systems that had been developed by provincial and federal governments. Based on this review, and using existing components from other systems where possible, Q. Fang has developed a basic data management system for the ABMP that is capable of delivering the raw ABMP data to users over the internet. This data management system ensures that the data is secure, yet readily available to everyone. During 2005 and 2006, Q. Fang will incorporate the analyses and summary algorithms that are being developed for biodiversity metrics into the data base, so that these metrics are updated automatically. In addition, data filtering tools will be incorporated into the system to allow users to search the complete ABMP database and export selected point and map data. Finally, increased functionality will be created to allow user to conduct simple analyses, and to evaluate change over time in biodiversity within regions.

Position the ABMP for Implementation

The ABMP Prototype will be completed by March 2007. A legal entity with a business plan, governance structure, and secure funding is needed at that time to implement the

program. All of these aspects require extensive development and negotiation. Thus, the major task of Kirk Andries (the Managing Director of the ABMP) during the Prototype is to insure that the ABMP is fully developed and positioned for implementation by March 2007.

During 2004, many workshops and discussions were held with stakeholders throughout Alberta to determine what was needed within the ABMP (see descriptions above). In addition, research continued on all science and technical aspects of the ABMP to have these completed by 2007 (see descriptions above). To complement this background research, an ABMP Board composed of senior industry and government personnel, was created to promote the ABMP. K. Andries and the ABMP Board have been meeting with senior industry and government managers to explore how to position the ABMP within existing management and regulatory frameworks. A preliminary “product and service” offering has been developed for the ABMP. In addition, draft governance principles and funding principles have been developed for the ABMP. During 2005 and 2006 situations where data and information from the ABMP can be used to fulfill regulatory requirements will be identified. In addition, cost/benefit analyses will be conducted to highlight the savings of having the ABMP, a high quality, integrated province-wide biodiversity monitoring program. Management and governance options will be explored with senior industry and government personnel to develop an appropriate mechanism for long-term support for the ABMP. In addition, K. Andries will work with the ABMP Board to develop a legal entity, create a business plan, finalize the governance, develop a funding mechanism, and finalize the product and service capabilities of the ABMP. The ABMP is being positioned to become a fully functional program in April 2007.

Benefits to Society

The pillars of Alberta’s economy are oil and gas, forestry, agriculture, and tourism – all of which depend on the abundant natural resources that are present in Alberta. To have secure markets for the goods and services produced by these resource-based industries, the general public within Alberta, and societies throughout the world, are demanding that industries demonstrate sustainable management of biodiversity and the natural environment. Consequently, both industries and government have made commitments to maintaining and managing biodiversity. Although the commitments were agreed upon during the past decades, there has been no process to evaluate whether human activities were affecting biodiversity. The ABMP was designed to fill that gap.

From its inception, the ABMP has been a multi-organization initiative involving industries, governments, non-government organizations, and academics. More than 20 scientists, in consultation with industry and government managers, developed survey protocols for a broad diversity of biota, habitat structures, and landscape metrics. These methods were reviewed by scientific peers, and integrated among taxonomic groups into a program that is statistically robust and cost effective. The integrated program was peer reviewed by international experts. A Management Board composed of very senior managers from industry and government was created to direct a cautious roll-out of the ABMP during Prototype.

ABMP data will be housed and managed by a single entity and will be freely available to everyone. In addition, data collection, analyses and reporting will be conducted in a transparent manner so that all Albertans can use them in an effective manner. This

rigorous, respected and fully functional biodiversity monitoring program will assist all levels of government by: i) allowing Canada and Alberta to meet stated commitments to conserving biodiversity; ii) helping ensure that development activities are sustainable for ecosystems, economics and people; iii) being a foundation for cumulative effects management; and iv) allowing Canada and Alberta to continue to access the increasingly consumer driven, ecologically sensitive market place that demands products be “certified” to demonstrate conservation of biodiversity.

Albertans also want to capitalize on the abundant natural resources this province has to offer, and want to develop those resources in responsible, productive ways. In that context, it is important that development capacity be maintained to allow for growth in our economy. A system that understands biodiversity status, trends, and associations, must be nimble enough to adjust management practices as concerns are identified. The ABMP is such a program and is envisioned to become an essential tool for managing biodiversity in Alberta’s robust economy. This program, and will allow Albertans to set an example for other jurisdictions to follow.

Conclusion

Unless biodiversity is properly managed it carries the risk of reduced access to resources by industries. The ABMP has made considerable strides to supporting biodiversity monitoring and management in Alberta, from its conceptual beginnings in 1998 to its current support from industry, government, and non-government organizations. Successful implementation of the ABMP in 2007 will highlight the importance of this world-class initiative. By having a consistent province-wide monitoring program, the ABMP will ensure that data are collected in a comparable manner among regions, reduce duplication that is presently occurring, and save costs to everyone, including the government and public, by having data collection and analyses conducted on a cost shared basis. In addition, the ABMP will provide early warning of species decline so that corrective actions can be implemented before expensive species recovery programs are needed. Finally, the ABMP will increase the quality of life for all Albertans by ensuring that biodiversity and the environment are managed in a sustainable manner for present and future generations.

The ABMP is a pro-active program that is designed to manage risks by producing information, analyses, and data that will be used:

- i) By industries to evaluate whether they are managing biodiversity in an effective and efficient manner;
- ii) By the government to assess whether companies have achieved biodiversity management as outlined in agreements;
- iii) By the general public to assess whether biodiversity is being managed in an effective and sustainable manner; and
- iv) By all parties to adjust management practices to meet desired results consistent with our commitment to adaptive management.

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