Conservation and Development Approaches to Integrated Inventory and Monitoring for Adaptive Management

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Abstract—In 1996 the Smithsonian’s Monitoring and Assessment of Biodiversity Program (SI/MAB) and Shell Prospecting and Development B.V. Peru, in cooperation with Peruvian and international organizations launched a multi-disciplinary assessment and monitoring program for the Camisea region of Peru. The area is located east of the Andes along the Urubamba River. Located northwest of the Manu National Park, the area is considered one of the most species rich regions of the world. One of the largest gas reservoirs for South America is located in this biologically and culturally sensitive area.

The project was designed to evaluate the impact of development on biodiversity following an adaptive management process—setting objectives, carrying out an assessment and monitoring plan for forest biodiversity, evaluation, and decisionmaking. The cyclical nature of the process was maintained through refining the objectives and management decisions based on the results. Thus, adaptive management gives managers the flexibility to adjust on-the-ground practices. This scheme of cooperation allowed more sound development decisions including the decision to avoid the creation of permanent roads, locating the gas processing plant in a biologically less sensitive area, the revegetation of disturbed sites with native species, and the use of underground pipelines.

Six biological components (vegetation, mammals, arthropods, amphibian and reptiles, birds and aquatic systems) were inventoried in the initial assessment phase. The sites were selected to provide information on areas that would be potentially impacted by development. In addition, a strong local community program was established, and two workshops resulted in the implementation of a training program to build in-country capacity for biodiversity monitoring. A conceptual multi-disciplinary model for monitoring was developed to assess the impact of gas extraction, processing, and transport on the local biodiversity.

The Camisea project is now coming to an end due to the Peruvian Government and Shell being unable to agree on the natural gas distribution, and subsequent monitoring phases will not continue. Nevertheless, we have had the opportunity to forge a relationship with industry that was beneficial for conservation. In addition, we feel that Shell’s approach has now created a precedent that may well be incorporated into the industry by other companies. As conservation biologists we must be prepared to seek and forge other similar relationships that can benefit our natural environment.

Natural influences and human actions continually bring about changes in ecosystems. Examples of such natural events at large scales include hurricanes and typhoons, extended out-of-season droughts, and volcanic eruptions. Human-induced effects comprise a large and varied spectrum—from acid rain or dust deposition and the introduction of exotic species to rapid landscape alterations caused by development. It is becoming increasingly clear that species are less able to adapt to natural changes at local and regional scales when those changes are compounded by human-caused alterations (UNEP 1995).

Appropriate management of forest ecosystems requires the ability to measure the impact of such changes, but this information is not easily obtained. Monitoring can aid in evaluating existing management approaches and their impacts on forest ecosystems, providing data needed to ensure that the effects of management are within a previously defined range. The value of the information is enhanced through monitoring programs that cover large spatial and temporal scales. As a minimum requirement, properly designed monitoring should discriminate between changes induced by human and natural phenomena to pinpoint the most effective management choices.

Monitoring programs, even when initially supported by considerable financial and personnel investments may be of little value if the results are not analyzed and put to use. This is often related to a lack of well-defined program objectives and/or insufficient long-term support. A clear statement of goals, objectives, methodologies, and avenues of disseminating data are key to designing and implementing monitoring programs. This in turn will enable policymakers and resource managers to make more informed decisions about sustainable use and conservation of ecosystem resources.

Forest biodiversity monitoring is a science in the process of development. Most of the initial approaches were oriented to improving the prospects of intense logging in temperate forests. For the more complex tropical forest ecosystems, researchers continue to define the most appropriate methodologies for biodiversity sampling and monitoring.

In this paper, we describe the evolving framework initiated by the Smithsonian Institution’s Monitoring and Assessment of Biodiversity (SI/MAB) Program (formerly Man and the Biosphere Program) for multi-taxa forest biodiversity monitoring. The SI/MAB program operates through an international network of forest biodiversity monitoring plots. In particular, we address our experience of integrated science, conservation, and development in the Lower Urubamba Region, Peru, through a cooperative partnership.


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with Shell Prospecting and Development (Peru) B.V. (SPDP). This area is of particular interest being one of the most biodiverse regions in Amazonia, yet little prior information is available.

Si/Mab and the Monitoring Process

Si/MAB was created in 1986 to develop protocols for monitoring biodiversity in tropical areas. Since then, we have conducted extensive long-term forest biodiversity research and developed a model education and outreach effort for conservation biologists. Over the past three years, the program has developed guidelines for establishing monitoring in an adaptive management framework in order to provide decision-makers with quality information enabling them to make informed decisions concerning the impact of their activities on the natural environment.

Research

The program has developed a solid foundation based on the research activities that are aimed to (1) test and implement protocols for long-term multi-taxa monitoring in forested habitats; (2) provide a data management and analytical procedures that allow rapid assessment and dissemination of the information; and (3) coordinate the International Network of Biodiversity Monitoring sites (INBM) to facilitate information exchange, dissemination, and data quality standards. It is envisioned that the protocols will enable users to integrate scientific research methods and analysis with strategies for getting the resulting information into the hands of a wider range of users—in particular, decision-makers and resource managers involved with issues of sustainable use and conservation of natural resources.

Si/MAB staff, aided by researchers throughout the international network of forested sites, has developed vegetation protocols that have been adopted at nearly 300 research sites in 23 countries. These protocols facilitate the transfer of comparable data, and provide a framework for data analysis and dissemination (Dallmeier 1992; Dallmeier and Comiskey 1996; 1998b; 1998c). In addition, BioMon (Biodiversity Monitoring Database) has been developed to enable researchers to use consistent protocols for data management thus further facilitating data exchange and comparison (Comiskey 1995; Comiskey et al. 1994; Comiskey and Mosher 1999).

Education

The international network's success is due in part to Si/MAB's dedication to information dissemination on conservation biology. Over 50 workshops and training courses have been held since 1986, reaching over 1,300 people from more than 42 countries. Since 1993, we have hosted the five-week International Biodiversity Monitoring Course that provides participants with a solid framework for establishing long-term multi-taxa monitoring projects. Two additional training courses have been added to the curriculum in 1998 and 1999. The Smithsonian Environmental Leadership and Communication Course provides communication skills for effective conservation and development, and the Economic and Policy Solutions for Ecosystem Conservation, to be held for the first time in 1999, will focus primarily on policy issues in Latin America and the Caribbean. Si/MAB has also hosted numerous symposia in the United States, Taiwan, Peru, and Bolivia, enabling us to reach a wide range of researchers.

Adaptive Management and the Monitoring Process

In order to ensure that monitoring efforts succeed, it is important to provide the conservation community, decision-makers, and industry with high quality information on biodiversity to enable informed decision-making. An adaptive management cycle is used to set objectives, conduct assessment and monitoring, evaluate the results, and make decisions that affect the region (Fig. 1). This process is achieved when the information from one level in the cycle is fed to the next, thus influencing the decisions for future monitoring (Dallmeier 1996; Dallmeier and Comiskey 1998a). Thus, adaptive management enables managers to make informed on-the-ground decisions. Si/MAB has put this experience to the test in cooperation with Shell Prospecting and Development in the Lower Urubamba region of Peru. The remainder of this paper will review our experiences.

Urubamba/Camisea Project

Background

The discovery of natural gas and liquids reserves in the Lower Urubamba Region of Peru in the mid-1980s provided the country with an attractive prospect for converting its growing energy deficit into a positive balance. In addition to cleaner energy, the project afforded the opportunity to attract significant investment in new industries. Shell Prospecting and Development (Peru) B.V. (SPDP) in cooperation with its silent partner Mobil, entered a two year appraisal phase (May 1996 to May 1998). At the end of this phase, SPDP would decide whether to enter a field development phase estimated to last 40 years. SPDP plans included drilling four wells, completing a logistics base, establishment flow lines and a gas plant, and constructing a pipeline across the Andes to coastal facilities. Nevertheless, at the end of the two-year appraisal SPDP was unable to reach an agreement with the Peruvian government concerning the assurance of gas markets, and has since terminated their development plan.

In 1996, the Smithsonian Institution's Monitoring and Assessment of Biodiversity Program joined SPDP in a unique venture aimed at achieving environmentally sensitive development of natural gas and condensate resources. The biologically rich Amazonian lowlands of Peru represent an exciting opportunity to integrate science, conservation, and development through careful decision-making and management approaches. This approach, which includes adaptive management, allows for the integration of scientific research and decision-making in a way that ensures the best possible outcomes for the environment and society.
planning, assessment, monitoring, and decision-making. The Smithsonian's primary responsibilities were to: (1) enact a biodiversity assessment in the study area, (2) conduct long-term monitoring in the vicinities of the sites where SPDP and its partners were drilling gas wells, along the Urubamba and Camisea rivers, and along the proposed pipeline route, and (3) distribute the results in a timely fashion, providing information to assist in management decisions. The work was accomplished by multi-disciplinary teams of researchers under guidelines devised by SI/MA for long-term, multi-taxa forest biodiversity monitoring at permanent research sites.

**Site Description**

The area is located east of the Andes Mountains in the Urubamba valley northwest of the Manu National Park (Fig. 2). The area's lowlands, hills, and mountains vary in elevation, from less than 500 m (lowland rain forest) and 500 to 1,000 m (highland rain forest) with slopes ranging from 25% to 70%. Little is known about most of the plant and animal species that inhabit the lower Urubamba region. The study area encompasses many different climatic zones, soil types, and eco-geological patterns in a relatively small space, suggesting an ecosystem that is complex, and potentially rich in places. A factor that may contribute to high species diversity for both plants and animals in the Urubamba River valley is its status as a potential Pleistocene refuge (France 1982).

**Examples of decision-making process**

The objectives of the scientific portion of the project were to link vegetation information to data about other taxa to be assessed and monitored, and apply the results to decisions about management practices at the well sites and in the region. The assessments were targeted to six biologically diverse groups—vegetation (trees, shrubs, ferns); aquatic systems (water quality, invertebrates, fishes); invertebrates (insects, snails, spiders); amphibians and reptiles (frogs, salamanders, snakes, lizards); birds; and small, medium, and large mammals.

Six phases of the project were completed during SPDPs appraisal phase. Phase I involved a relatively quick assessment of the biological and cultural diversity in the Lower Urubamba region. The initial results revealed high levels of diversity in an area where few prior studies had been conducted, emphasizing the importance of linking conservation and development needs. This was followed by a workshop in September of 1996 to set the parameters for a biodiversity assessment and monitoring program. Participants included representatives of government institutions, non-governmental organizations, the scientific community, and local Native groups. A report on Phase I identified some of the initial findings and partner organizations (Udvardy and Sandoval 1997).

During Phase II researchers conducted biodiversity assessments and established several multi-scale and permanent biodiversity monitoring plots at two of the well sites, San Martin-3 and Cashiriari-2 (Dallmeier and Alonso 1997).
Assessment for five selected groups, vegetation, invertebrates, amphibians and reptiles, birds, and mammals, was completed in 1997. Based on this first field experience at the well sites, we were able to devise a plan for monitoring the impact of the well sites on the local biodiversity.

In Phase III, work was conducted at the Cashiriari-3 Well Site and at selected points along the Camisea and Urubamba Rivers. As in the preceding phase of the project, multidisciplinary research teams focused on the overall goal of linking vegetation information to data about other taxa that are being assessed and monitored (Alonso and Dallmeier 1998). Intensive training of young Peruvian scientists was conducted to augment in-country capacity for long-term biodiversity monitoring. Assessment of the riverine sites, and in particular the location of the proposed gas plant revealed a diverse flora and fauna for the studied groups. We recommended that local and regional biodiversity be monitored on a regular basis in the future to assess the impacts of developing the gas plant. The information from the assessments was provided to SPDP for incorporation into management decisions. Based on this information, SPDP made the final decision on the location of the gas plant.

We launched Phase IV in January 1998 with two workshops—one in Washington, D.C. and the other in Lima. The purposes of the workshops were to describe the integrated plan and scope of the monitoring program and define the sampling protocols and management approaches needed to carry out the project activities. More than 100 researchers and specialists attended the two workshops. Alonso and Dallmeier (1999) describe the standardized protocols for biodiversity assessment and monitoring that resulted from the workshops.

To address the immense task of assessing biodiversity at the well sites and along the proposed pipeline route, an intensive training program for young Peruvian biologists was planned for Phase IV at the Pagoreni well site. The initial training sessions were conducted under the direction of personnel from the Smithsonian's Institute for Conservation Biology and the SI/MAB Program. Smithsonian counterparts from Peruvian institutions and other international entities also participated as instructors. Fifty-five national and international biologists were involved in eight weeks of training.

Based on the levels of high biological diversity encountered in this and previous phases, and the likely physical impacts from road construction in the steep terrain of the Urubamba region, we suggested SPDP continue with their “off-shore” policy of helicopter use and no permanent roads. Recommendations were also made as to how to reduce the impact in the case that temporary roads were built. The information was presented to SPDP, who upon evaluation of the different alternatives decided to accept our recommendations, and to continue with their off-shore policy and not build any roads (Alonso and Dallmeier 1999).
During Phase V, the primary focus was aimed at assessing the diversity along the proposed pipeline route that would carry natural gas and condensates from the Lower Urubamba Region, over the Andes to a proposed processing plant at the Pacific coast. Ten sampling sites along the route were selected for assessment and long-term monitoring. The first two montane sites were sampled as SPDP and the Peruvian government decided not to proceed with full field development. One of the options considered by SPDP was the installation of an underground pipeline. Their major concern revolved upon the potential effects of tree roots, and the depth at which the pipeline should be buried. A special report was prepared by SI/MAB for the SPDP on the depth of plant roots (Mistry 1999). This information was then used by engineers to define the most appropriate course of action.

Phase VI arose from the need to finalize the project following SPDP's decision not to proceed with full field development. All of the well sites were visited by the field crews in order to obtain a second season assessment on the component taxa. This information will provide an initial baseline in the event that those companies in charge of future development continue to encourage biodiversity monitoring.

The Future

Our experience with SPDP has been extremely positive. We were able to conduct work in a pristine tropical forest that had received very little prior attention. More importantly, we were able to establish a high level of rapport with high level SPDP managers, and by providing them with information concerning the local biodiversity and their activities, we were able to influence the decision-making process and increase biodiversity conservation awareness. Now that the Urubamba project has come to an end, we feel that it is our responsibility to ensure that our experience is transmitted to other conservation biologists who in turn may be able to conduct similar projects. This will be achieved by disseminating the information in a timely fashion to as wide an audience as possible, including the lay public, development corporations, and other scientists. In the same way that Environmental Impact Assessments are required in most countries, we hope that in the future Biodiversity Assessment and Monitoring too will be required as part of any development project. We feel strongly that SPDP has made a big step in the right direction to creating a precedent that other companies may feel that have to follow. This can only be of benefit for the preservation of biodiversity for future generations.

Summary

Though conservation and development are often viewed as mutually exclusive, our experiences with SPDP state otherwise in the Lower Urubamba region. The growing human population continues to create pressure on the world's natural resources, and with it the need to find solutions that will help minimize the effect of development on biodiversity. It is our responsibility as conservation biologists to ensure that we are able to work with developers to minimize the potential impact on our natural environment by providing them with the information necessary to make informed decisions. Only through establishing these partnerships can we hope to improve the way that development proceeds in the pristine and remote regions of the world such as the Amazon rain forests of South America.

References


