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PEOPLE AND DECISIONS: MEETING THE INFORMATION NEEDS OF MANAGERS

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Abstract. The process of identifying management information needs, providing credible results, and incorporating those results into land management decisions has been essential for the effective conservation of avian communities. The Savannah River Institute funded 18 avian studies as part of a Biodiversity Program started in 1989. The factors that influenced the success of the management-research collaboration include an effort to understand the land manager's decision making environment, land use alternatives, and a close working relationship among scientists and managers that built trust and ownership in the projects. Broad research needs identified include ecological restoration, key species and resources, landscape patterns and processes, and monitoring. Individual research studies evaluated avian community responses to silvicultural manipulations, landscape vegetation patterns, and potential influence of key resources such as soft mast and coarse woody debris. Geographic Information Systems technology provided a means to develop two important decision support tools. The first was a quantitative assessment of community habitat models, and the second was the application of spatially explicit modeling of sensitive or endangered species.

Key Words: biodiversity, decision making, environmental assessments, geographic information systems, habitat modeling, land management.

In an early assessment of management information needs, Ackoff (1967) found that "most managers suffer from an over-abundance of irrelevant information." Yet, we find ourselves asking for more information to make decisions about the conservation and management of avian communities on public and private lands. Why does this apparent contradiction exist? A significant part of the problem results from the type of information that is being provided. People and organizations also have their own personalities and cultures that affect the utility of information. Given the concern for sustainable management of native communities and viable populations, it is important to refocus scientific efforts to generate information of greater utility. Management organizations also must provide a process for evaluating scientific information, and incorporating reliable results into land management decisions.

In 1989, the Manager of the Savannah River Institute (SRI) proposed a biodiversity research program at the Savannah River Site (SRS). The Institute management staff decided on a mission oriented, problem solving approach. It was evident to us that: (1) many land management paradigms in conservation are influenced directly or indirectly by the behavior of avian groups; (2) there had been few systematic observations of avian communities in forested areas at SRS since the 1950s; and (3) genuine concerns existed as to the impact of harvesting and silvicultural activities, land management policies, and facilities construction. Over the succeeding years, the Institute funded a total of 18 avian-related studies. This paper addresses general factors that influence the success of the management-research collaboration at SRI, how research needs at SRI were developed, and how the resulting information might affect changes in land management at SRS.

MANAGEMENT-RESEARCH COLLABORATION

THE DECISION MAKING ENVIRONMENT

The primary responsibility of the Institute's staff is to make land management decisions consistent with the objectives of the Department of Energy, and then to implement those decisions given the resources and technology available. A key to identifying useful information is understanding the decision making environment. Failure to appreciate this simple fact often results in scientific studies with little relevance to management issues, and in results that are ignored by practitioners.

Managers contribute to the problem by having objectives that are ill-defined, e.g., "enhance naturalness." We sometimes develop goals to manage and monitor species with little consideration of the metrics and costs involved. Our plans must be dynamic, but often are not, resulting in conflicts over time. Frequently, spatial scale is not appreciated. We have a difficult time articulating science questions beyond the classic "we need more information on . . . ," but offer no specifics. Rarely do we take a complex issue and break it into tractable questions that can be addressed through systematic studies. The important questions may include the need to test assumptions in existing relationships, or to establish the mechanistic bases for empirical observations. The need for the latter can be difficult for managers to appreciate. Scientists can help translate our information needs into research questions by using a parsimonious scientific approach.

From a manager's perspective, answers to science questions that do not distinguish among alternative land management activities will not be valued. If the alternatives are too politicized, good science is not likely to impact choices either. If the scientists fail to appreciate the larger context of the management problem, particularly other impacts that may result from the alternatives being considered, the information will be discounted. For example, social forces can significantly constrain alternatives. Serious health or liability problems may arise from ecological fire management strategies, or from restoring endangered species that impair adjacent landowner activities. It is technically difficult, particularly with biodiversity issues, to test alternative strategies directly, and to select a winner based upon a single variable. This requires that scientists often apply some mental gymnastics, involving consistency with other data, and a few assumptions, to extrapolate results to various management scenarios. However, the preference, when feasible, will be for more direct empirical tests contrasting alternative actions, and using simple metrics like richness, relative abundance, density, reproduction, or survival. The dilemma for scientists is the willingness to allocate time to improve communications and trust, and to develop the necessary perspective on decision making, including objectives, alternatives, technology, regulations, logistics, and costs.

As a starting point, scientists might ask themselves some simple questions. What decisions are being made by whom and at what level? Decision making authority often is delegated depending on perceived risks and technical demands. Decisions may be left to a committee whose members have competing agendas and little accountability. Some individuals are more adaptive to new information, others are not. What level of information is needed to distinguish among alternative actions? The purpose, in theory, of new information is to improve predictability by increasing precision or reducing bias in specific actions. Those actions may be broad land use decisions, or specific ones about whether, when, or how to harvest a single stand. What technology and resources are realistically available? Managers are frequently limited by regulations or budget authorizations with the consequence that the ability to implement certain alternatives is questionable. Are there regulatory requirements, such as an environmental impact statement or a forest plan, involved? When biological assessments are done at the SRS, regulators want data sets comparing impacted vs. un-impacted areas. How will information be used? It is important to anticipate whether results will contribute to a formal process such as a quantitative model, qualitative guidelines, or to convince one individual to change his or her mind.

MANAGERS AS PEOPLE

A few axioms about human nature and the process of change include: (a) that stress is an important factor in the process of innovation; (b) that you generally get what you reward and what is most important to an organization may have nothing whatsoever to do with resource management; and (c) individuals often see what they want to see, and hear what they want to hear. We all have our preconceived notions or favorite paradigms that are difficult to abandon in light of new information.

At the personal level, an essential step in identifying research needs is establishing a dialogue. Unfortunately, managers often see scientists as elitist and reluctant to treat them as equal partners in evaluating conservation strategies. Nevertheless, getting managers involved by defining their concerns, working together to establish the science questions, and in reviewing proposals is essential. The latter helps to build ownership in the results, and confidence that the scientists are largely free of bias associated with advocacy. This approach runs counter to the belief that collaboration with management will taint or compromise the science. Given the previous statements, effective communication may not be easy. For example, managers may be reluctant to criticize a scientific proposal, even one with obvious flaws, and they can be overwhelmed by unfamiliar literature and methodology.

Finally, many managers are not as analytical as scientists, and may not trust analytical-mechanistic models. Many multi-million dollar decisions are based upon a significant amount of intuitive gestalt. Some managers prefer the personal responsibility associated with using intuitive judgments, while others prefer to avoid rational analysis altogether. Government agencies like to institutionalize decision-making as standards and guidelines to avoid personal culpability, and to have something that will hold up in court.

IDENTIFYING RESEARCH NEEDS AT SRS

THE PROBLEM

When established in 1951, the SRS was a highly "domesticated" landscape dominated by farming, livestock, forestry, and hunting. Almost fifty years of federal management has transformed SRS from open habitats of agricultural fields and cut-over forests to a closed forest environment. Prescribed burning was aggressively re-introduced in 1977 to assist in the recovery of the Red-cockaded Woodpecker (*Picoides borealis*), and later to restore pre-settlement fire dependent communities. All these activities have without doubt altered vegetative conditions and wildlife populations to the extent that there are no truly un-impacted communities remaining. Despite past land use, the SRS currently supports a remarkably species-rich flora and fauna, although their relative abundance and distribution probably differs significantly from pre-settlement conditions.

The Atomic Energy Commission sponsored an inventory of the entire flora and fauna in the early 1950s, and subsequently supported research on ecological processes. Over the intervening decades, public values changed as evidenced by the amount of environmental legislation passed in the 1970s. People saw native plants, animals, and their communities as non-market "resources" that they wanted restored and sustained. What was once an innovative idea, i.e., inventory and monitoring, became an essential task. And whereas scientists historically set the direction of scientific studies, regulatory compliance demanded a more deliberate research agenda than just increasing our knowledge of ecological processes.

By 1989, the prospect of new legislation or directives aimed specifically at biodiversity and ecosystem management suggested the need to be proactive. However, the potential mandates were too subjective ("ecosystem management"), intangible ("naturalness"), unmeasurable ("integrity"), or unamenable to study (whole ecosystems) to adequately define research questions. In the simplest sense, we had to know what species were here in the past, what species could potentially be here based on range and habitats, and how to restore those species. It was important to establish which species were utilizing the site, and whether they were resident, summer migrant, winter migrants, or transients. We needed to develop long-term monitoring that provided accurate and unbiased estimates, and which was relatively easy and inexpensive to perform. We had to refine and test expected relationships between vegetation types, successional stages, landscape variables, structural variables, silvicultural activities, and species occurrence or abundance in order to predict possible impacts or benefits from manipulations. Were there source vs. sink habitats for sensitive species? Were there trends occurring over time and how were species distributed across SRS? We need to provide for all species, yet give particular attention to certain rare species, which incurs risks in that decisions are based on limited information about a few.

THE SOLUTION

The strategic solution was to target simple measurable objectives that could be more directly related to the public's perception of the issues. After some struggle, a document evolved that defined the biodiversity objective for SRS as "sustaining and restoring native species in structurally and functionally desirable communities" (SROO 1993). The definition recognized the long history of human influence at SRS, the need to minimize the amount of technology involved in sustaining and restoring species, and that goals would be determined by human perceptions of a diverse landscape, not just technical indices.

The SRI research program was delineated into broad themes: ecological restoration studies, key species and resources, landscape patterns and processes, and monitoring. Ad hoc groups of managers and scientists met formally and informally to develop and delineate specific research questions. Within the broad areas, major questions were identified that addressed areas of "tension" between alternative competing hypothesis. Some of these questions had implications for establishing the pattern and distribution of potential vegetation types across the SRS landscape, such as pre-settlement vegetation, land use history, and ordination of remnant natural communities. Others were targeted at the effects of specific silvicultural manipulations and their effects on community richness and abundance. Development of restoration strategies obviously was important given past land use, but also important were answers to questions about key resources, such as soft fruit or large woody debris, and their influence on the viability and distribution of native species. Research on landscape patterns and processes tested landscape and population processes that might significantly improve more traditional wildlife habitat models. The latter included a large experimental study of corridors.

Under these broad themes, a number of avian studies were initiated. In many research projects, the avian community was seen as a response variable to various large scale experimental treatments, such as creation of bottomland hardwood canopy gaps, removal of large woody debris, tree thinning, and site preparation. One study was directed at the importance of soft fruit to fall and winter migrants. The variation in community and species characteristics also were measured along gradients of successional stage, clear-cut size, hardwood patch size in agricultural and forested landscapes, and patch isolation. More intensive individual species studies were implemented only when a species could serve as a model for a process or mechanism (predation, dispersal, etc.), or was sufficiently rare or sensitive to justify more detailed studies of population behavior. The SRI developed an avian monitoring effort using breeding bird census methodologies across the site during the nesting season to complement the Christmas bird count data collected during winter. Finally, several modeling projects were supported. In all, these have generated a considerable understanding of the avian community at SRS.

EFFECTING CHANGES IN SRS LAND MANAGEMENT

THE PROCESS

The process for effecting change is an evolving one. To begin with, a series of seminars for the SRI staff was implemented at their request. Reports, theses, and papers submitted to journals by students and scientists were copied and distributed. These approaches affect mangers individually, that is, they can influence decisions made by each individual when and where they believe it is relevant. They work well with a stable staff, and when one is testing fundamentals (e.g., How do corridors influence population processes?), or when straightforward results to interpret an experiment are available (e.g., Does leaving woody debris affect density of certain species?). In these cases, it is frequently better if scientists do not make management recommendations per se, but make a clear convincing case, in light of all available research, that the science is sound. Let the managers determine the implications and the level of acceptable risk.

The more difficult problem is institutionalizing new information without precluding subsequent change. On federal lands, managers are obligated by law to address environmental impacts of their activities. Specifically, what will be the impact to flora and fauna from certain manipulations, and can we manipulate an area to improve conditions for a certain species without detrimentally affecting other species at a larger scale? Results from research at SRS that clearly relate to specific activities can be incorporated into an environmental impact statement or assessment. The results, along with other studies, can influence the preferred alternative. Research also can be incorporated into more detailed operational management guidelines. A habitat matrix, which is a simple tabular way of expressing the relationship between a species attribute (occurrence, nesting, foraging, etc.) and habitat attributes (type, age, stand size, snags, mast species, edge, distance to water), can be developed as a tool for analyzing impacts. However, the matrix rarely expresses the uncertainty in the relationships or weights variables quantitatively.

The advent of Geographic Information Systems (GIS) has provided a means for testing and using matrix relationships that includes uncertainty, quantitative parameters, variable scales, landscape attributes, and dynamic processes. The current status or future state in response to a specific alternative can be predicted on a "real" landscape. The SRS has been working with scientists to implement "spatially explicit" GIS modeling as a means for integrating research and institutionalizing results (Dunning et al. 1995). An approach underway is to test and refine the basic habitat matrix of Hamel (1992) using the SRS data sets (Kilgo 1996). Another approach for individual species is to construct dynamic meta-population models. The latter is being applied to the Red-cockaded Woodpecker, and "model" species, such as the Bachman's Sparrow (*Aimophila aestivalis*), where population parameters are available, and when a more detailed analysis is required.

WHAT CHANGES ARE OCCURRING?

It is difficult to determine the impact from the studies because we are at the stage where the information is used individually, although some results are making their way into formal biological assessments. The SRI is incorporating the results into a GIS habitat model, and we are continuing to develop spatially explicit models for a few species. There has been a realization of the enormous variability in existing habitat models as well as some counter-intuitive results, such as the occasional use of open habitat by forest interior birds. One side benefit has been a revision of the forest inventory system to emphasize structural measures of avian habitat. However, we still have not quantified winter migrant use, and we need to quantify reproduction and survival for various species in various habitats. It also is perplexing to try to obtain reliable data on rare species with low densities.

The primary tool for shaping habitat conditions for plant and animal communities has been and will continue to be manipulation of the structure, composition, and pattern of the vegetation through harvesting, silviculture and burning, and selective removal or re-introduction of species. Despite negative connotations, harvesting, silviculture, and burning (or lack thereof) are effective tools in sustaining and restoring some communities. It is not so much what is done, as how, when, and where it is done that can make the difference (snag and debris retention, choice of tree species, planting density, patch size, season of management activity, frequency, etc.). Ultimately, information from research will alter the extent to which we apply these tools, or alternatively, allow us to more precisely understand their impacts.

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