ERA OF LAND MANAGEMENT PLANNING AND RESOURCE MODELING: CHANGING TIMES FOR HABITAT MANAGERS

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Abstract: America was brought into the modern conservation era by Theodore Roosevelt and Gifford Pinchot at the turn of the century. The public was taught that resources on this land taken in their entirety were great but not limitless and that the strength and well-being of the country required careful resource preservation and multi-purpose development and use. Fazio and Gilbert (1981) documented the evolution of resource management in America by five discernible stages: Era of Abundance (Nation's beginning to 1850), Era of Exploitation (1850-1930); Era of Habitat and Harvest (1930-1970); Era of People and Environment (1970-present). It is my contention that the Era of People and Environment ended in 1980 and in 1981 resource management in the United States entered a new era. I call this era the Era of Land Management Planning and Resource Modeling. This era brings with it new social demands, new tools for natural resource managers and the mandate to keep ecological stability in focus in all land management and species population decisions. Habitat managers no longer have the freedom or choice to practice what R.W. Behan (1986) calls "single-product myopia."

At this gathering of wildlife biologists and resource managers who are here for the explicit purpose of discussing the moose, albeit harvest, population models, habitat models, changes in herd composition, etc., I encourage the efforts you are making on behalf of this magnificent animal; certainly keynoters ought to do no less. But I also challenge you to understand the role and leadership that you must display in an era when land management planning is demanded and habitat modeling is a pass into the arena. In this keynote address I have drawn heavily on my experience and the laws affecting land management planning within the United States. For the Canadian and other international biologists in attendance I believe you will note similarities in the progression of land management planning and resource modeling within your own countries and provinces. Let us now for a moment look back at the history of resource management in the United States to help gain a perspective of where we are today in the management of our natural resources.

America contains a fixed amount of land which is being subjected to increasing demands of more and more people. The onrushing technological revolution, greater consumption, more leisure time and the new age of transportation are placing enormous burdens on the bounty of the land and sharpening competition and controversy over its control and use. Every day, one can glimpse bits and pieces of the problem: the urban center that rises in aluminum and glass splendor; the water source running chocolate brown with topsoil washed off a suburban housing development or from farms being mined by the new generation of corporate sodbusters; the farmland and woodland sliced up by freeways; and out in the country, the desolation and poverty of cutover timberland and ruin that remains in the wake of unreclaimed strip mining.

From colonial days to the space age, control and use of the land have been issues that have molded the lives of generations of Americans. The Republic in its infancy was precariously situated between the Atlantic and Allegheníes, looking westward across a vast continent that national imperatives demanded to be taken and subdued. By 1900, the axe had cleared more than 300 million acres of virgin forests and the plow had ripped open nearly 300 million acres of grasslands. The rich store of metals and minerals was being exploited to provide the raw material for an urbanizing industrial society. The myth of inexhaustible resources was dying. The realities of unchecked exploitation shook the people. Timber and grasslands had been ruthlessly exploited. Wasteful mining had gutted huge areas. Whole species of wildlife had been wiped out or were in danger of extinction.

By 1870, the voices and writings of such men as George Marsh, John Burroughs and George Bird Grinnell began sensitizing the public for the need of land stewardship. They paved the way for America to be brought into the modern conservation era by Theodore Roosevelt and Gifford Pinchot at the turn of the century. The public was then

taught that resources on this land taken in their entirety were great but not limitless and that the strength and well-being of the country required careful resource preservation and multi-purpose development and use.

The role of Government, both Federal and State, was also being sharply redefined. No longer was Government to be a passive instrument for giving away the public domain, but the principal planner, investor, steward, researcher, and regulator. The public policy guidelines that followed was that all possible benefits stemming from the use of the land be attained and shared by all the people. This concept grew out of Pinchot's insight that all separate resource questions were merely parts of
". . . the one great central problem of the use of the earth for the good of man" (Pinchot 1947).

RESOURCE MANAGEMENT HISTORY

Fazio and Gilbert (1981) documented the evolution of resource management in America by five discernible stages: Era of Abundance (Nations beginning to 1850); Era of Exploitation (1850-1890); Era of Preservation and Production (1890-1930); Era of Habitat and Harvest (1930-1970); Era of People and Environment (1970-Present). It is my contention that the Era of People and Environment ended in

1980 and in 1981 resource management in the United States entered a new era. Briefly let us review some of the major historical facts that led Fazio and Gilbert to separate these eras.

The Era of Abundance describes our nation's beginnings, a time when the wealth of resources was great and a time when the conquest of the wilderness was a national challenge. Through this period the naturalist explorers such as Mark Caterby, the Bartrams, Lewis and Clark, Alexander Wilson and others wandered, recorded, mapped, and laid way for settlement of the vast new continent. By the 1830's, a few great visionaries began voicing a need for the preservations of wild places. These names we all know: George Catlin, Henry David Thoreau, and John James Audubon.

By 1850, a new era had begun to emerge, the Era of Exploitation. The railroad pushed its way west, population centers expanded, homesteading was popularized, industrialization began, and destruction of vast areas of forest and grasslands occurred. Fire and erosion followed the logging and lands that had been grazed or farmed and then abandoned. Concerned scientists, writers and philosophers began to sound the alarm. George Marsh (1864) published his book Man and Nature which shook the conscience of many Americans by detailing the destruction of watersheds. The writings of John Burroughts and George Bird Grinnell began sensitizing the public, influencing legislators, and rallied outdoorsmen to the cause of wildlife protection. Out of this

period came the park movement with Yosemite, Niagara Falls, Yellowstone, and Adirondacks being claimed from the path of exploitation.

Passage of the Forest Reserve Act in 1891 began the Era of Preservation and Production. This Act provided the President with the authority to set aside forested areas of the public domain. This was the period where President Roosevelt created the U.S. Forest Service and Gifford Pinchot became its Chief and the history of multiple-use management began. This is also the period of history where Fazio and Gilbert (1981) note that the "great dichotomy" in philosophical thought about managing public land began. The split between conservationists who followed the teachings of Pinchot and preservationists who followed the call of John Muir, Enos A. Mills, and Stephen Mather is noted and remains today.

The preservationists argued for parks and a different management approach than was used on National Forests. These voices of preservation were heard and the National Park Service was established in 1916. Significant strides were also made in areas of wildlife management. The Lacey Act was passed regulating market hunting and the import of exotic species. Migratory birds became a national charge with the passage of the Migratory Birds Convention

Act of 1916. Buck laws became the order of the day and wildlife research programs concentrated on life history studies and population management of game species.

Nineteen-thirty gave rise to the Era of Habitat and Harvest, and publication of Aldo Leopold's (1933) book Game Management altered the course of game management and wildlife conservation. Leopold's writings and teaching on a land ethic during this period influenced and was to be encompassed in much of the environmental legislation of the Seventies. Research and management concentrated on habitat manipulation and either sex seasons began to be used to keep population in balance with the habitat. Other significant events of this period include the establishment of the Civilian Conservation Corp, the Soil Conservation Service, and the Bureau of Land Management. Major legislation passed during this era included the Pittman-Robertson Act (1937), Dingell-Johnson Act (1950), the Land and Water Conservation Act (1964), and the Wilderness Act (1964).

On Earth Day - April 22, 1970 - the Era of People and the Environment began. An entire nation focused its attention on the environment. Citizens were worried and discussions centered on insecticides, water pollution, air pollution, and population growth. The names of Rachel Carson, Paul Erlich, and Berry Commoners became well known. Citizens and legislators took the leadership of resource conservation away from trained managers.

The National Environmental Policy Act (NEPA) of 1969 captured the spirit of this era - "one of public awareness and insistence on having a stronger voice in decisions affecting the environment" (Fazio and Gilbert 1981).

The later legislation of this era added increased strength to public involvement in resource decisions and further underscored the message that planning and management for any single resource must include consideration and adjustment for associated resources. The legislation that emerged from this period and that has made resource integration a binding management strategy today includes: the Endangered Species Act of 1973, the Forest and Rangeland Renewable Resources Planning Act of 1974, the National Forest Management Act of 1976, the Federal Land Policy and Management Act of 1976, the Public Rangelands Improvement Act of 1978, and the Fish and Wildlife Conservation Act of 1980.

A NEW ERA - LAND MANAGEMENT PLANNING AND RESOURCE MODELING

The voice of the people in the 1970's was heard and translated into legislation, as we have seen, that demanded harmony between man and the land. A land ethic emerged from the legislation that required us to constantly keep ecological stability in focus and insure the right of all species of plants and animals to coexist with man.

The mandate of the people moved from paper to the land in the late seventies and early eighties.

City, county, state, and federal land management planning became the order of the day. Many of these land management plans have been in the development stages for years and are just coming on line. The State of Oregon, for example, in 1973 passed Senate Bill 100 (Oregon's Land Use Act) creating the Land Conservation and Development Commission (LCDC) and its administrative arm, the Department of Land Conservation and Development. The Act requires that each city and county develop coordinated comprehensive plans, zoning and subdivision ordinances which are in conformance with the adopted goals of the commission. The LCDC goals establish the principle that "the long-term benefits from proper management and use of renewable resources will greatly exceed the short-term gain from consumptive use of non-renewable resources" (Brauner 1976). Oregon counties and cities began their land use plans in 1974 and the last of the 36 county plans and 241 city plans were approved in 1986 (Rohse 1987).

The U.S. Forest Service began its forest land and resource management planning process in approximately 1980. As of February 12, 1987, 113 of the 123 national forests had completed their plans. These Forest Service land and resource management plans affect about 188 million acres, but have been called the 50 percent plans by the Forest Service Chief F. Dale Robertson. He

sites that although they affect about 8 percent of the land base of the United States they affect aobut 50 percent of our deer, elk, cold water and anadromous fisheries and timber resources.

In the early 80's, statements were being made in the press that the environmental movement of the 70's was dead and the public was not interested in the land management planning process. Let me illustrate to you how wrong those reports were. The Forest Service has received as of February 12, 1987, 346 appeals on the 113 Forest Plans that have been completed. The public and its many interest groups have followed this process with great interest. They have demanded to be heard, have challenged the results, and required that data and tools used to assist in the decision making process be well documented and defendable. The Siuslaw National Forest where I worked as a fisheries biologist from 1978 to 1983 had separate appeals filed against 79 of 333 timber sales offered to the public. Every timber sale we offered was carefully reviewed by interest groups, and sales were appealed for threatened, endangered, and sensitive plant and animal considerations, anadromous fisheries concerns, elk management, spotted owl and old-growth management, visual considerations, roadless and wilderness concerns, and herbicide use. The public cares and is concerned about how we are managing our public lands.

Jack Ward Thomas at the "Wildlife 2000" conference in 1984 made some acute observations. He stated: "The Forest and Rangeland

Renewable Resource--Planning Act of 1974 and the National Forest Management Act of 1976 marked the confluence of biological and political streams. As these streams intermingled, platitudes and assumptions began to give way to coldblooded analysis. It became increasingly obvious that, indeed, there was no free lunch. 'Trade-off' emerged as the buzzword of the day." From legislation passed in the seventies there are numerous laws and regulations that direct what must be considered in the planning process. I have picked out those requirements within the Code of Federal Regulations (CFR) which I believe have had the greatest impact on the wildlife and fisheries profession in the land management process and have forced trade-off analysis. These requirements have caused personal anquish to team members working on integrated resource management plans and at the same time pushed wildlife and fisheries professions to the cutting edge of resource management today.

These requirements have had dramatic effects on management of forest resources. They are:

1. Analytical Process - Planning regulations 36 CFR 219.12(e) and (f) require the use of an analytical process to determine minimum and maximum resource production levels and economic consequences.

2. Fish and Wildlife - "Fish and wildlife habitats shall be managed to maintain viable populations of existing native and desired nonnative vertebrate species in the planning area...In order to insure that viable populations will be maintained, habitat must be provided to support, at least, minimum numbers of reproductive individuals and that habitat must be well-distributed so that those individuals can interact with others in the planning area." (36 CFR 219.19)

3. Water Quality - "Forest planning shall provide for compliance with the requirements of the Clean Water Act, Safe Drinking Water Act, and all substantive and procedural requirements of federal, state, and local governmental bodies with respect to the provision of public water systems and the disposal of waste water." (36 CFR 219.23(d))

4. Timber Harvest Dispersion - "When openings are created by the application of even-aged silviculture, individual cuts shall conform to the Regional Guide direction on the dispersion of openings and maximum size limits for areas to be cut in one harvest operation (with some exceptions)." (36 CFR 219.23(d))

5. Riparian Areas - "Special attention will be given to land and vegetation for approximately 100 feet from the edges of all perennial streams, lakes, and other bodies of water... No

management practices causing detrimental changes in water temperatures or chemical composition, blockages of water courses, or deposits of sediments shall be permitted within these areas which seriously and adversely affect water conditions or fish habitat." (36 CFR 219.27 (e))

6. Cumulative Impact (Effect) - The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. (40 CFR 1508.7)

When considering how these requirements have so influenced our profession, it's important that we recognize that trade-off analysis has forced us to enter the world of quantifiable biology. The planning regulations require us explicitly to use an analytical process to determine minimum and maximum resource production levels and economic consequences. Out of this requirement has grown benchmark analyses. The major purpose of benchmark analyses is to determine the maximum amount of various resource outputs the Forest can produce, subject to legal requirements. These benchmarks provide information on the maximum biological potential of the forest whether its timber, non-game wildlife, fish, or recreation

and the economic implications of management. Thus, benchmark analyses results when compared define the decision space in which land management planning alternatives can be developed.

Wildlife and fisheries biologists, in order to participate and effectively represent their resource speciality in benchmark analysis, must be able to model wildlife and fish habitat relationships. Land use planning and allocation requires the expression of wildlife and fisheries values in terms that may be compared and analyzed. Since 1980, biologists have been working to meet this challenge. We now have habitat capability models, species occurrence models, and pattern recognition models, and cumulative effect models that are being used regularly.

In order to enter the analytical world of planners, automated data bases and information systems have been and are being developed. We are even seeing integrated inventories being developed between wildlife, fisheries, forestry and range. Astonishing isn't it, yet the simplest models for terrestrial wildlife relate to forest stands as defined by basic descriptions such as cover type, size class, and canopy cover. Inventory needs for fisheries modeling are analogous to those for terrestrial wildlife and fall into the categories of geomorphic and watershed, channel morphology and flow, instream and lake habitat, and chemical. Our disciplines of wildlife and fisheries must demand integrated inventories and must take better advantage of the opportunities for coordinating inventory among other resources.

These words "Fish and wildlife habitats shall be managed to maintain viable populations of existing native and desired nonnative vertebrate species in the planning area." from 36 CFR 219.19 have pushed the science of modeling wildlife-habitat relationships to the cutting edge. Researchers and management biologists have pursued the quantification of viable populations with a great deal of energy over the last 8 years. Issues of genetics, fragmented populations, biogeographic theory, dispersion capability and selection of indicator species have been raised, researched, and reported in the literature. Even with this progress many quesitons remain unanswered.

For fisheries biologists and hydrologists requirements in the Code of Federal Regulations 36 and 40 addressing water quality, riparian areas and cumulative effects analysis have been responsible for some of the best integrated cause and effect stream research conducted. For example, the effects of various levels of sediment on fish habitat and fish emergence are being researched, the role of large organic debris in supplying fish habitat is better understood, and new grazing systems that better protect riparian areas and fisheries habitat are being tested. Most recently limiting factor analysis is being applied to entire watersheds in

order to better understand fish life histories and habitat interactions.

Because of the acknowledged complexity of multiple resource planning and the need to track changes and effects over time, computer models are being used routinely. However, let us establish as a fact that we recognize models are useful, but they are paradigms and must not be viewed as permanent expressions of truth. That is why the NFMA act places such importance on monitoring and evaluation to validate or change the assumptions made during the planning phase. At the same time it is important to recognize the value of models to the biologist charged with giving expert input and to the resource manager who must make the decision to implement the action. Models are expressed as explicit hypotheses rather than implicit assumptions, and they aid the biologists in the synthesis of many parts into a whole (Salwasser 1986). In addition, they serve the resource manager as a "risk analysis" tool. The quantitative output can display trends over time and the likely "cost" to an affected resource from implementing a set of management actions. Biologists, managers, and interested publics must realize that models developed for management indicator species whose distribution or habitat requirement are not well understood have a high likelihood for error. These must be monitored closely to ensure a wrong decision has not been made during implementation of the plan.

A number of different types of models are being used, linked together, or being used iteratively. Assessment of cumulative effects on wildlife and fisheries requires a projection of the habitat changes that will occur. For forest management problems, this requires a model that is capable of tracking forest changes across a number of vegetative stands through several decades. Prime examples of this type called multi-stand simulation models are FORPLAN, DYNAST, and FSSIM. FORPLAN is the Forest Service's linear optimizing model for multi-stratum habitat capability analysis and is used for large area analysis. It produces an optimum solution based on constraints and objective functions that are defined (Holthausen 1986). DYNAST allows the user to formulate a system dynamics model using mathematical statements. The simulator allows for forest growth and regeneration under a clearcutting regime. The simulation is controlled by specifying rotation ages, time steps, opening sizes, and rates of conversion (Holthausen 1986). FSSIM is a simulation model written in BASIC on the Forest Service's Data General System. This model developed and described by Holthausen and Dobbs (1985) draws upon the strengths of the other systems but is completely interactive and can be run separately or linked with a habitat capability model.

Wildlife habitat capability models utilize the information from the stand simulation model for the needed input. For wildlife, a calculated habitat capability index incorporates the cover and feeding habitat that the species requires within a home range into

a single value. The model allows an individual to rate the habitat value of individual stands to, or sites to, an indicator species and then integrate these values across stands. Thus, one can look at cumulative effects on an appropriate area and track the consequences over time.

For fisheries the process also begins with the vegetative changes to the area being analyzed. The next step is to relate this vegetative change to an effect upon the stream system and then on to the individual indicator species or the habitat condition. Several relationships between vegetative changes and stream environments have obvious broad applications to National Forests and are the focus of most of the cumulative effects models being developed for fisheries. They are: (1) the effects of various levels of sediment on fish habitat or specific species, (2) the effects of various quantities of large organic debris on fish habitat, (3) the effects of various temperature changes on fish habitat due to canopy removal, and (4) the effects of various livestock grazing on fish habitat.

Modeling cumulative effects on fisheries requires a link to hydraulogic modeling. Soil scientists and hydrologists must predict, for example, sediment yields and water flows for the area of analysis before impacts to the fisheries can be predicted. Thus, modeling impacts to the fishery resource requires close cooperation between a number of disciplines.

Habitat capability models tied to a Geographic Information System (GIS) are the most recent addition in the cumulative effects analysis process. With the use of GIS software the complex question of spatial analysis can be tackled. The habitat capability can be composed of submodels such as habitat quality, displacement, and mortality. Although building the data base to run the GIS system is costly, it appears this is the system of the future for cumulative effects analysis modeling and plan implementation.

Indeed the era of land management planning and resource modeling which we are experiencing has affected each of us and our profession greatly.

SINGLE PRODUCT MYOPIA - AN ERROR TO AVOID

Natural resource managers did not do a good job in the sixties in anticipating the leadership role we needed to take in the seventies, and subsequently resource management was regulated by the courts. The publics that have followed the land management planning process are sophisticated. Our management planning and actions have been very visible to the public and our intentions clearly stated. We must ensure implementation is carried through and the models we have built are validated and operate at a

geographic scale that allows meaningful analysis of wildlife and fish habitat.

We also need to better anticipate the publics we serve. The Colorado Division of Wildlife (DOW) released a market research project report dated September, 1986. The study was conducted for DOW to help in both short and long-term decision making regarding issues affecting the users of wildlife and wildlife habitat. The sample population for the project was individuals selected from 1985 license applicants and "non-users" contacted by random digit dialing calls. Specifically, the sample numbered 1,400; 800 users-- 200 fishermen in-state, 200 fishermen out-of-state, 200 hunters in-state, 200 hunters out-of-state; and 600 "non-consumptive" individuals in-state. Data collection took the form of detailed telephone interviews over a period of 3 weeks. The response rate was 85 percent for the hunters and fishermen; and 77 percent for the nonconsumptive category. The confidence level of the survey was 95 percent.

The report is a fascinating document with many interesting findings. Here are a few that I have extracted:

1. The recreational experience in Colorado is clearly multidimensional for hunting and fishing as well as for the non-consumptive user. The importance of the overall experience cannot be denied. This does not say that

harvesting animals and those characteristics related to the act are not important. It does say that DOW must be concerned with a wide range of wildlife management issues and the relationship between characteristics as they relate to the Colorado experience. Overall, it appears that the hunting and fishing experience may be defined along four dimensions - environmental (e.g., beauty of surroundings), social (e.g., being with friends), process (e.g., easily understood licensing), and stock (e.g., availability of animals).

2. The product the DOW manages is more than the animals and fish. The overall environment and experience is key, and the common theme is the preservation and enhancement of wildlife and its habitat.

3. Demand for hunting appears flat from a user's perspective. Given shifting demographic populations, hunting might be considered in a mature or even early decline phase of its life cycle.

4. Demand for fishing appears to be at a healthier level than hunting. Fewer people feel the quality of the experience has decreased. Consequently, 42.4 percent expect the number of days they fish over the next 10 years to increase.

5. DOW is in the service business with all of its attendant marketing and operating difficulties.

Much can be learned from this report, and it reinforces concerns that R.W. Behan, the former Dean of the School of Forestry, at Northern Arizona University, raised in a keynote address to the Wildlife and Fish Ecology Working Group Technical Session at the 1985 Society of American Foresters Convention. In reflecting on multiple-use management of the U.S. Forest Service he highlighted the agencies "timber fixation" calling it a "single-product myopia" error. He went on to state "if wildlife and fisheries biologist are sympathetic to the criticism of single-product myopia on the part of us foresters, let's not perpetuate the error by simply switching the focus from timber to wild vertebrates, aquatic and terrestrial."

Dick is absolutely right; we wildlife and fisheries biologists cannot afford to advocate single-product fixations. We must recognize the philosophical significance of the legislation of the 70's that has redirected management by demanding that biotic diversity and ecological stability be maintained as the primary purpose of managing land and forest resources. Ecological stability which ensures sustainable supplies of multiple-resources is the heart of integrated resource management. This demand of biotic diversity and ecological stability in my mind has been reinforced by findings of the DOW study I have just reviewed with you. The hunter, the fisherman, and the non-consumptive user view the Department of Wildlife in Colorado as managing more than fish and wildlife. The product they manage is the environment, and the common theme is the preservation and enhancement of wildlife and its habitat. I am convinced this same finding would be concluded if the study were repeated within any State. This realization must lead us to the fact that biologists and foresters, regardless of agency affiliations, must work as a team and increase our sense of partnership. We must learn to plan habitat management proactively and help develop silvicultural prescriptions that address a richer set of purposes.

Don't misunderstand me. I'm not accusing moose biologists of practicing single-product myopia, but I am stressing the need for integrated management. We know animal populations can be influenced through their vegetative habitat, and we can in fact model the ability of the habitat to support numbers of animals based on food, cover, and space. Our analysis, however, must focus on the desired future condition with its goals and outputs that have been identified for that landscape. By focusing on the desired future condition and its resultant outputs, the publics understanding is greatly enhanced. Only through this type of analysis will the people, our customers, be able to fully visualize the landscape we are proposing with its biotic diversity. And only through this type of analysis will we biologists be able to avoid a single-product myopic error.

CHALLENGE TO MOOSE MANAGERS

The importance of the integration of natural resource knowledge and biological systems expertise in solving problems and decision making on a fixed land base and managed forest continues to increase. Land management planning documents developed by federal, state and county agencies are for the most part programmatic documents, and project execution will require more detailed site specific design. Computer-based technology with its attendent geographic information systems, habitat and population models, and data-handling capabilities is providing all resource specialists a common tool to confront the complexity of natural systems and to make great gains in implementing integrated resource management on the ground.

It is not my intention to iterate the virtues and follies of modeling and computer-based technology. Wildlife 2000: Modeling Habitat Relationships of Terrestrial Vertebrates edited by Verner, Morrison, and Ralph (1986) with its excellent collection of papers tackles the issues related to the development, testing and application of models. However, I do want to challenge you to a greater leadership role in the management of research, development, and technology transfer as it relates to moose habitat management.

Let us examine these three terms; research, development, and technology transfer. The National Science Foundation defines research as "systematic study directed toward fuller scientific knowledge or understanding," and development as the "systematic use of knowledge directed toward the production of useful materials, devices, systems or methods (Cobb 1986). Research and development are terms easily understood. Technology transfer is not as well understood. Technology transfer is not as well understood. Technology transfer has been defined as: "a process whereby research results are transferred and applied from lab to user" (Shaw & Borden 1980). I have found it to be more the bringing of abstractions to life. For example, concepts that we deal with such as cumulative effects analysis, viable populations, and indicator species all have to be brought to life to our users. These abstractions must be painted with words and illustrations.

A key ingredient to the success of moose managers in integrated resource management is how the transfer of technology is managed for newly developed tools. This Friday, Saturday, and Sunday a group of biologists from Minnesota, Michigan, Colorado, Alberta, and Ontario will participate in an intensive moose habitat modeling effort. The effort will produce a habitat suitability index model for moose. I have no doubt this distinguished group of experts will develop a very useable tool for management that will reflect biological accuracy. I am also confident that this exercise will help to focus on needed research to verify and improve the model. Building the model is the first step, but just as important is managing the technology transfer.

The job of managing technology transfer is every bit as much a manager's job as is managing a budget or marketing a plan. Managing technology transfer is complex, but effective management provides high potential for payoff, both for individual professional stature and for improved productivity and product quality. I suggest there are four major tasks that must be accomplished to ensure a reasonable success rate in transferring technology. They are:

1) Identification of the receiver
2) Documentation
3) Distribution and followup
4) Network management

A key ingredient to technology transfer is to bring the product to the attention of those who might use it, and then encourage trial and application. Bringing the product to the attention of someone implies that a receiver or group of receivers have been identified.

Documentation must be effectively done and understood by users other than research scientists to enhance the ease of movement of the technology to another person or organization. Documentation should take more than one form. In other words use a media such as video tapes, slide tapes, or movies to compliment written reports or technical notes.

It's important to manage distribution at least initially until the product has been accepted for its application and quality. Questions such as: "Where is the information?" "How and by whom is it received?" and "Is there follow-up?" must be answerable. This is the only way quality control of the transfer be maintained.

Network management is the mechanism by which the technology can be improved and barriers to its acceptance overcome. It is through a network of users that unbiased feedback is received. The network should include the full spectrum of users.

You have a unique opportunity to collectively influence the research, development, and technology transfer of tools to help manage the moose in integrated resource management. Research needs should be directed toward specific, clear and carefully designed applications. These applications are your development products. Management problems should be driving this research and product development. Research & development efforts must be more creative in developing relationships with State, Federal, and private organizations. Agressive leadership is needed to facilitate interagency coordination among moose researchers, silviculturists, and land management administrators. Technology transfer is critical to the success of perpetuating the climate in which critical research and development can occur. Administrators and publics who benefit from research and development efforts need to see and hear how they have benefitted from the dollars invested.

The North American Moose Conference and Workshop should be the forum from which research and development needs are coordinated and technology transfer efforts are monitored and critiqued. This forum needs to ensure that tools developed for moose management are being used correctly and that users are properly trained.

SUMMARY

In summary, we have taken a mental trip through the eras of the resource management, stopping long enough to see the peaks of accomplishment. We have embraced the fact that land management planning and trade-off analysis has forced us to enter the world of quantifiable biology. We have put to rest any doubt that the public is disinterested in the land management planning process. We have established that single-product myopia is a fixation that we must avoid and the public is demanding that we do. And you have been challenged to take a more aggressive leadership role to ensure the moose and its habitat needs are being fully met in integrated resource management today.

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