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Needs For and Approaches To Wildlife Habitat Assessment

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The 1970s—A Time of Revolution

The period, 1969–1980, brought a dramatic change in how Americans view wildlife and its management. The change, a revolution in perception, was simply the recognition that *all* wildlife are important in and of themselves and as part of a larger functioning whole—an ecosystem. This perceptual revolution in concept is now fixed firmly in law, but its impacts are only gradually working their way into full-scale application by governmental agencies at both state and federal levels.

For many years prior to 1969, wildlife was essentially defined, in the practice of governmental bodies, as those species hunted for sport, trapped for furs, controlled to accomplish human objectives, or of particular aesthetic value. Governmental management of these species was based on funding obtained from or supported largely by clearly identified constituencies.

Universities evolved specialized programs in wildlife biology and management to produce the knowledge and trained professionals to meet these needs. Many such programs were oriented to training in zoology which emphasized the animal and populations while paying less attention to habitat.

As a result, most wildlife research was focused on a few species, and was directed to their taxonomy, population level and dynamics, life history, behavior, distribution, and food habits. Comparatively little effort was spent on defining habitat requirements of even these select species. And, little attention was given to the study, welfare, and management of other species.

For many decades preceding the revolution, scientists expanded the science of ecology. They taught principles of ecological management to generations of wildlife managers and researchers. Those students went to work in mission-oriented organizations that served well-defined constituencies such as graziers, hunters and fishermen, and the wood-products industry. Simultaneously, these ideas about a holistic management philosophy were reaching thousands of other people. New interest groups formed around wildlife for reasons other than or in addition to sport hunting, trapping, nuisance wildlife control, etc.

Suddenly, as if a dam had broken, there was a flood of state and federal legislation that mandated these revolutionary perceptions into actions that instructed those who serve in government agencies on how wildlife would be considered and managed. To many practicing wildlife professionals this has caused wrenching adjustments to new realities.

The seminal piece of legislation that stirred this revolution in concept was the

[1]This paper, in a very similar format, was first prepared (Thomas 1982) for inclusion in a book prepared by the U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency. William T. Mason, Jr., Editor, has given permission for the use of that material.

National Environment Policy Act of 1969 or NEPA (U.S. Laws, Statutes, etc., Public Law 91-190). NEPA required that the environmental consequences, including impacts on wildlife, of any activity involving federal funds be described prior to action on the project. This made it necessary for wildlife to be much more broadly defined but also *understood and described in relationship to alterations in habitat.* Other pieces of legislation emerged in 1969 and the 1970s that also mandated better and broader consideration of wildlife. These included the National Forest Management Act of 1976 (U.S. Laws, Statutes, etc., Public Law 94-588), the Endangered Species Conservation Act of 1969 (U.S. Laws, Statutes, etc., Public Law 91-135), the Endangered Species Act of 1973 (U.S. Laws, Statutes, etc., Public Law 93-205), and the Forest and Rangeland Renewable Resources Planning Act of 1974 (U.S. Laws, Statutes, etc., Public Law 93-378). Still, the National Environmental Policy Act of 1969 set the stage in terms of what had to be described and considered in order to be responsive to the new legislative mandates.

That revolutionary concept, now embodied in law and associated regulations and tested in the courts, makes it essential that biologists be able to relate all species to habitat conditions and be able to predict species response to habitat alterations. The task is enormous and perhaps one of the most challenging ever to face professionals in wildlife biology and other areas of applied ecology.

Management Needs and the Data Base

Sufficient data to accomplish this task are available for relatively few of the vertebrate species in the United States. Research data on the relationships of species to habitat continues to emerge, mostly in bits and pieces, and seemingly at an increasing rate. But it will be many decades, if ever, before a data base totally derived from well-designed site-specific research is available in a form that is readily adaptable to planning. This is further aggravated by the fact that existing information on species/habitat relationships is scattered throughout the literature and is not consistent in terms of research approach, analysis, or reporting. Existing and emerging research data on species/habitat relationships can be generally categorized as fragments of information of varying quality from many locations that contribute, like pieces of a jig-saw puzzle, to some useful understanding of species/habitat relationships.

In short, it has become increasingly obvious that biologists should try to put existing knowledge and theory into a framework that can be utilized in land-use planning and in helping meet legal mandates. That process requires innovative use of basic ecological principles in formulating systems for analyzing and interpreting existing data. When statistically sound results from replicated scientific studies are not available, the opinions of "qualified experts" will have to serve until the gaps in scientific knowledge, identified through planning and evaluation process, are filled. Efforts to develop procedures to investigate the relationship between land-use and wildlife abundance have been thoroughly reviewed elsewhere (New England Research, Inc. 1980).

Wildlife Management Strategies

The scientifically based art of wildlife population and habitat management is usually considered in one of three ways: (1) featured species management (Holbrook 1974), (2) species richness management (Siderits and Radtke 1977), or (3) some combination of the two (Figure 1). In featured species management, the objective is production of selected species in desired numbers in specified places. With species richness management, the aim is to insure that a broad spectrum of species is maintained within a geographic area of concern (Figure 2).

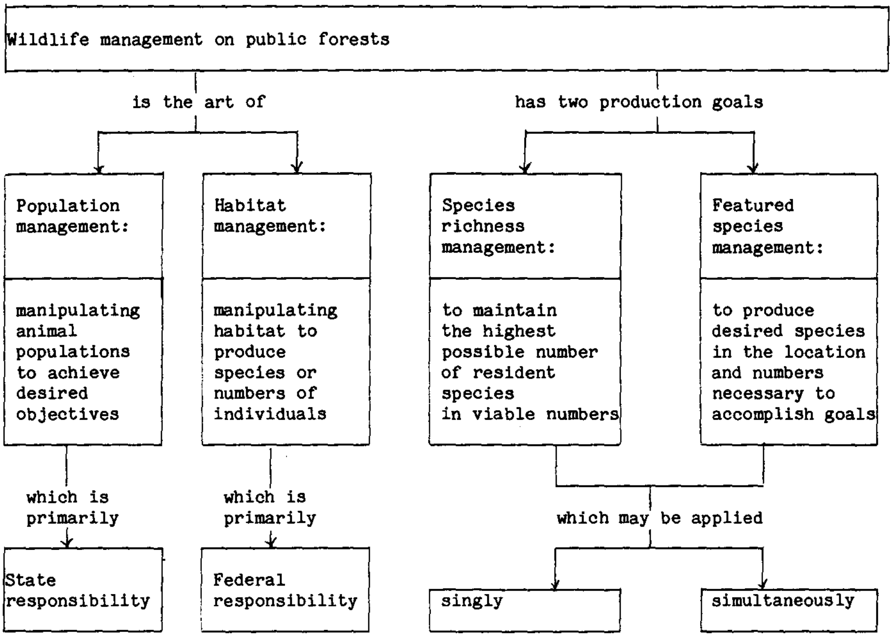

Figure 1. The arts and goals of wildlife management on public lands (after Thomas 1979a).

Production goal	Management for species richness	Featured species management
Objective	Insure that all resident species exist in viable numbers. All species are important.	Produce selected species in desired numbers in designated locations. Production of selected species is of prime importance.
Process	Manipulate vegetation so that characteristic stages of each plant community are represented in the vegetative mosaic.	Manipulate vegetation so that limiting factors are made less limiting.

Figure 2. Production goals, objectives, and processes for wildlife habitat management on public lands (after Thomas 1979a).

Featured species management has been the most common type of management pursued by state and federal agencies. The information needed to carry out the habitat manipulation aspects was accomplished by determining the habitat requirements of the featured species. As a result, much of the research on species/habitat relationships has been focused on comparatively few species. This information was usually gathered by studying how a species was related to its habitat in a particular place.

Species richness management came more into vogue with both state and federal land management agencies with the advent of increasing environmental awareness and the resultant federal legislation. The vast number of wildlife species present, or potentially present, in any area makes it impractical to study, individually, the relationship of each species to its habitat. There are probable advantages, in terms of costs and time, to be gained by describing habitats by categories such as plant communities and successional stages or structural conditions and, then, by relating the species present to those habitats (Thomas 1979b).

Habitat Analysis—Habitat Evaluation Procedures (HEP)

Two predominant approaches evolved to answer the demands of the law and challenges of the "environmental 70s" for information on species/habitat relationships. The U.S. Fish and Wildlife Service sponsored the development of a process or technique to evaluate habitat suitability for individual species called Habitat Evaluation Procedure (HEP) (Flood et al. 1977, U.S. Fish and Wildlife Service 1980). The procedure is particularly well-adapted to evaluating habitat suitability or judging habitat manipulation responses for individual (featured) species. This and similar procedures (McCuen and Whitaker 1975, Willis 1975, Whitaker and McCuen 1976, Whitaker et al. 1976, Nichols et al. 1977, Williams et al. 1978, Russell et al. 1980) are numerical rating schemes in which key habitat factors are described and rated, the scores weighted appropriately, and a final value calculated. The overall suitability of the habitat is estimated. Habitat deficiencies or limiting factors that can be altered to benefit the species in question can be identified.

A somewhat similar system was developed by USDA Forest Service research scientists in modeling impacts of management alternatives to achieve multiple-use forest management in the eastern United States (Boyce 1977). In this approach, the consequences of manipulating key habitat characters, such as the proportion of the area in identifiable structural states, frequency of openings or the basal area of trees, were evaluated for selected wildlife species and other multiple-use products.

Such systems have the advantage of being largely objective and usable by different observers. The question, of course, is how well the developers of the particular species rating system or species/habitat model identify the truly significant habitat variables to be evaluated and how appropriately they are valued or weighted in the mathematical rating scheme. Ideally, each HEP for each species in each ecologically distinct area would be tested repeatedly and "fine-tuned" accordingly. In practice this has seldom been the case because of the large research investment required.

HEP can be adapted to guide efforts in species richness evaluation and management, preparation of environmental impact statements, and generalized wildlife habitat evaluation. This is done by preparing a HEP for a species that serves as an indicator of certain habitat conditions or, conversely, stands as a surrogate for a group of species that requires the same or very similar habitats. This is, for example, in keeping with the regulations issued pursuant to the National Forest Management Act of 1976 (U.S. Laws, Statutes, etc., Public Law 94-588) that requires the inventory of "indicator species" as a means of determining if wildlife planning objectives are being met.

Habitat Analysis—Wildlife and Fish Habitat Relationships (WFHR)

A quite different approach was independently developed by David R. Patton of the USDA Forest Service (Patton 1978) in the southwestern United States and by a team of 16 contributors from the USDA Forest Service, the Bureau of Land Management, and the Oregon Department of Fish and Wildlife for the Blue Mountains of Oregon and Washington (Thomas et al. 1976, Thomas 1979b). These systems use habitat as the key to analysis. Habitats are classified or categorized and the wildlife associated with these conditions identified. The earlier work of Reynolds and Johnson (1964), though confined to one small study area, was much the same in approach.

These efforts (Patton 1978, Thomas 1979b), though regional in scope, presented principles, concepts, and techniques that were found to be adaptable to other areas. These efforts provided the seminal direction and framework for the development of species/habitat information systems and models that are underway or planned for most of the USDA Forest Service's nine regions (Nelson and Salwasser 1982). This approach to systematic consideration of species/habitat information has become known in the USDA Forest Service as the Wildlife and Fish Habitat Relationships (WFHR) system, although considerations of fish life are just now being developed.

Salwasser et al. (1980) said that:

> Wildlife and Fish Habitat Relationships is a relatively new term—it is not a new philosophy or approach to resource management. It is simply the comprehensive organization of the vast array of existing information in a format that is useful in managing animals through managing their corresponding habitats. The philosophical basis of WFHR dates back to Joseph Grinnel and Aldo Leopold. Intertwined is the current state-of-the-art of ecosystem approaches to natural resource management; in this case, an attempt to view wildlife habitat from the animal community as well as the single species perspective. The philosophy has been incorporated in the . . . [environmental legislation of the 1970s that was mentioned earlier].

The WFHR system has already been adapted for use in other areas of the west (Wischnofske 1977, Verner and Boss 1980, Capp et al. n.d., and others). The system, originally applied to forest lands, is being adapted for rangelands of the Great Basin in southeastern Oregon in order to demonstrate applicability to rangeland conditions. Six of 14 planned "chapters" of this effort have been printed (Bowers et al. 1979, Maser et al. 1979a, Maser et al. 1979b, Thomas et al. 1979a, Thomas et al. 1979b, Dealy et al. 1981).

The WFHR system divides habitat considerations for terrestrial wildlife into three general parts: (1) the habitat (described by plant community and structural condition) association of each species for feeding, reproduction, and resting; (2) the value of special habitat elements (such as snags, edges, dead and down woody material, riparian zones, cliffs, caves, and talus) to associated species; and (3) development of more elaborate habitat capability models for selected or featured species (Patton 1978, Thomas 1979b, Verner and Boss 1980). The information on species relationships to habitat is readily put into a form suitable for computer manipulation for use in long-range planning or in analyzing impacts, across the species spectrum, of management alternatives that involve manipulation of vegetation. There have been several successful computer programs developed to handle various kinds and varieties of WFHR data bases. Successful computer application has included both mini-computers and standard computers. By far the best known of these systems for storage and recall of data has been Patton's (1978) RUN WILD system and modifications thereof such as the "Procedure" for Pennsylvania (Thomas 1982). Other systems of analysis, similar in terms of predicting generalized wildlife responses to alterations in habitat have been developed for such purposes as evaluating impacts of water development (Daniel and Lamaire 1974, Golet 1976, Larson 1976), transportation systems (Smith 1974, Herin 1977), forest management (Buckner and Perkins 1974), or the general evaluation of wildlife habitat (Graber and Graber 1976, Brabander and Barclay 1977).

Habitat Management and Indicator Species

Thomas et al. (1979c) grouped species into "life forms" that showed affinity to similar habitat. This concept was expanded from that proposed by Haapanen (1966) for birds in the Finnish forest. Previous systematic groupings of species have been largely morphological in nature. Such "life form" groupings are flexible. Analysis can create as many as make biological sense in terms of habitat use in a localized area. Some workers (Hal Salwasser, USDA Forest Service, pers. comm.) believe that ecological guilds (Severinghaus 1981) may have more flexibility than life forms for the purposes described above. The important thing is that it probably will be necessary to group species in some manner that accounts for reaction to habitat.

These groupings were developed in anticipation of the regulations issued pursuant to the National Forest Management Act of 1976 that specified monitoring "indicator species" in National Forest System management. Indicator species, theoretically, represent or reflect the welfare of a larger group of species. The regulations call for a description of just what changes in the status of the chosen indicator species do indeed indicate. Once appropriate life forms are created for local situations, the welfare of the species that occur within that life form within a plant community and successional stage can, again theoretically, be represented by the status of an indicator species chosen from within that group. Some have tried to expand the use of the life form concept beyond the specific area for which the information was developed; it works poorly in such cases.

The appropriateness of using indicator species to reflect changes in habitat suitability or condition is a subject of debate. Sampling of indicator species (of which there may be several) over vast areas of National Forests will be costly in time and money. Sampling must be intense enough to discern statistical differences in populations between areas within sampling periods and between sampling periods within areas. Then the population or occurrence changes must be carefully interpreted to assure that they reflect changes in habitat conditions rather than normal perturbations in population levels. The description of just what an indicator species indicates must be described as accepted for the short term and somehow tested over the long term. Some fear that such an approach will be very, perhaps prohibitively so, expensive to carry out. And, there is concern that such activities will divert scarce professional wildlife personnel and funds from more important duties.

Monitoring Habitat Conditions

It seems much easier to inventory habitats, as categorized by plant communities and successional stage or other acceptable descriptors, and relate these inventories to species. Such information might be obtained by relatively minor changes in the routine information collected in standard forest survey efforts. These approaches are already being tested by USDA Forest Service forest inventory personnel in the Pacific Northwest and in the South (McClure et al. 1979). This approach has the advantage of being capable of "piggy backing" onto existing comparatively well-financed and well-established efforts for many forest and rangeland areas already being regularly and systematically collected by the Bureau of Land Management and the USDA Forest Service.

The data so collected can be manipulated in or used in conjunction with existing linear programming models for considering alternatives for manipulation or allocation of timber and range resources. The USDA Forest Service's Timber RAM (resource allocation model) is an example of such a linear programming model (Navon 1971).

Monitoring of Indicator Species

The regulations issued pursuant to the National Forest Management Act of 1976 clearly require use of the indicator species approach in monitoring wildlife activities for National Forests. It is likely, though, that habitat inventory and analysis based on species/habitat relationships will be an additional means through which the welfare of the entire spectrum of vertebrate wildlife species is considered in Forest Service planning. Indicator species will probably be chosen primarily, as directed by the National Forest Management Act of 1976 regulations, from those species that are taken for food, sport, or hides and those that are threatened or endangered. The status of such species will probably indicate little beyond their own numbers. So, when such species are chosen as indicators, they are likely to be the same as the "featured" (Thomas 1979a) or "selected" (Salwasser et al. 1980, Verner and Boss 1980) species already provided for in the WFHR process.

Land-Use Planning

Land-use plans and environmental impact statements prepared using the WFHR approach have been evaluated by some experienced reviewers as more comprehensive, better formulated, and more responsive to intent of the law than those prepared before this planning tool became available (William Morse, Wildlife Management Institute, pers. comm.). The system has weaknesses, however. The information in the data base ranges from the thorough, sound, well-documented, and site-specific to speculations of knowledgeable biologists. To many, if not most, managers who deal continually with decision making under conditions of uncertainty this seems quite acceptable. Some scientists, on the other hand, are appalled.

Land-use planning is presently based on interpretation and extrapolation of existing theory and data. Such an approach, obviously, has an inherent danger of human error. The entire WFHR system has been called "a working hypothesis" (Thomas 1979c). Research is already underway to test critical hypotheses and to improve the data base by providing additional or site specific data or both.

Most importantly, a system or framework for analysis exists that is acceptable to most of the concerned publics and state and federal agencies. Any such system must meet that bio-political test of acceptability if it is to be used successfully in land-use planning and preparation of environmental impact statements. This does not imply that arguments about resource allocations or management prescriptions are resolved by the existence of an acceptable system for data organization and analysis.

The development of a generally acceptable system, however, has provided a gaming board on which defined pieces may be manipulated in a game of problem resolutions involving economics, politics, law, ecology, aesthetics, and philosophy. Until the advent of such procedures as HEP and WFHR in the 1970s, those interested in wildlife seemingly could not participate as effectively as other interest groups in the land-use planning process. With the development of such procedures, it has been easier for land-use planners to consider wildlife values.

HEP or WFHR Approaches—Which Is Best?

Which of these two general approaches to species/habitat relationships analysis is best depends on the type of analysis required and the objectives of management. Close examination of the two approaches shows that they are not radically different in concept or development. They are really two ways to achieve the same goal—improved ability to predict wildlife response to potential alterations in habitat.

The HEP type approaches begin with the analysis of habitat for a single species. These species may be the featured or indicator species described earlier. Species can be selected, however, that might serve in land-use planning or the analysis of alternative management actions as the indicator of the welfare of other species.

The WFHR system starts with a data base that describes the general habitat requirements of all resident species; then, in one case (Thomas et al. 1979c), combines those into groups based on similar habitat responses. This makes it possible to more rationally select an indicator species for the group. Once an indicator species is selected it is necessary to develop a special and much more detailed write-up of how the habitat of this species can be measured in land-use planning and subsequent management.

Existing examples of this type of treatment for a featured or selected species include Rocky Mountain mule deer (*Odocoileus hemionus hemionus*) and Rocky Mountain elk (*Cervus elaphus nelsoni*) in the Blue Mountains of Oregon and Washington (Thomas et al. 1979d) and native trout (*Salmo* sp.) in the Great Basin of southeastern Oregon (Bowers et al. 1979). If the status of the featured species is an "indicator" of management success, it is then necessary to adequately census the species on a periodic basis.

HEP could be used to provide the habitat analysis mechanism when it is deemed necessary to fully describe habitat relationships for a featured species. In fact, species featured under a WFHR system must have a special document prepared describing habitat requirements for the species and a process for their evaluation by procedures that have been very similar, conceptually if not yet procedurally, to the habitat suitability indices produced by the HEP procedure.

WFHR and HEP were originally developed to serve different needs. Experience has shown that managers and analysts end up needing and using both systems. So, WFHR and HEP, used in conjunction, play different but synergistic roles.

Both approaches (HEP and WFHR) to meeting the demands for wildlife considerations in planning and action mandated by the environmental laws of the 1970s have been praised by some managers and practitioners. Others, primarily researchers, have criticized the "stretching" of available knowledge and ecological theory required to produce such operational systems. Those concerns are certainly valid. However, agencies are making and will continue strong attempts to meet requirements of the law. Moreover, HEP and WFHR programs have directed the attention of the wildlife research community to some of the major problems that must be resolved. Likewise, information required to improve the data base and the theoretical foundation of these presently operational systems has been identified.

Management Decisions Made Under Uncertainty

The dilemma has been described this way:

> The knowledge necessary to make a perfect analysis of the impacts of potential courses of . . . management action on wildlife habitat does not exist. It probably never will. But more knowledge is available than has yet been brought to bear on the subject. To be useful, that knowledge must be organized so it makes sense. . . .
>
> Perhaps the greatest challenge that faces professionals engaged in . . . research and management is the organization of knowledge and insights into forms that can be readily applied. To say we don't know enough is to take refuge behind a half-truth and ignore the fact that decisions will be made regardless of the amount of information available . . . it is far better to examine available knowledge, combine it with expert opinion on how the system operates, and make predictions about the consequences of alternative management actions [Thomas 1979c].

The 1970s—Just the Beginning

It seems likely that these two basic approaches, HEP and WFHR, will continue parallel evolution. Eventually, they may be melded into a single system. Indeed, Nelson and Salwasser (1982) show that the Forest Service's WFHR program now incorporates habitat suitability index type models to meet special analysis needs. They almost certainly will become more quantitative and more reliable as better data become available (Salwasser et al. 1980). There have also been efforts, in many ways parallel, to develop a national data base and a national application of species/habitat relationships data (Schweitzer and Cushwa 1978, Schweitzer et al. 1978).

Each successful effort should produce a better, more reliable and sophisticated product. The initial efforts should be quickly outdated and outmoded. The important thing is that the first steps on a long journey have been taken. There is, in my opinion, no turning back.

There *was* a revolution in the 1970s in the way we view and consider wildlife in planning and management. The National Environmental Policy Act of 1969 was the beginning. *Planning, execution,* and *accountability* will be bywords for those concerned with land-use planning and wildlife management in the 1980s. And, today's wildlife biologists are much better able to participate effectively in land-use planning than they were in 1970. *Planning, execution,* and *accountability* will become bywords for those concerned with land-use planning and wildlife management in the future. Improvements in those abilities will continue and accelerate in the 1980s.

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