

A GUIDE TO MANAGING HUMAN ACTIVITIES
ON NATIONAL WILDLIFE REFUGES

by

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PREFACE

This report has been organized such that the logic and content build from one section to the next. Consequently, we advise that the sections be read in order so that the developmental sequence of material in the report is maintained. For example, skipping to the "manager's guide to information sources . . ." (Section VI) might lead to confusion regarding the organization of the guide.

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A GUIDE TO MANAGING HUMAN ACTIVITY ON NATIONAL WILDLIFE REFUGES

SECTION I: OVERVIEW, PURPOSE AND OBJECTIVES

The management of National Wildlife Refuges (NWRs) is a complex undertaking. It requires, among other things, maintaining a careful balance between public use and wildlife conservation considerations. Certain kinds of human activity on refuges can adversely affect wildlife and their habitat. Some negative impacts can be tolerated within certain levels, other impacts can not be tolerated at all. The difficulty lies in determining: (1) which activities will have particular kinds and levels of impacts, (2) which impacts and levels of impact can or cannot be tolerated for wildlife species of concern, (3) which impacts can be avoided or reduced through specific management practices (e.g., regulation, education, or partial exclusion) and (4) how to integrate this information into the management decision-making process for a particular refuge. To add to the complexity, this decision-making process must be consistent with and reflect broad NWR management policy. That policy emerges from a variety of sources, making its interpretation difficult for specific application on a particular refuge.

Many of the NWRs administered by the United States Fish and Wildlife Service (USFWS) in Region 5 are located near large concentrations of people (Fig. 1). These Refuges currently receive extensive public use and such use is expected to increase in the future (Kirby 1985). Refuge managers in Region 5 have the problem of simultaneously (a) meeting high public demand for opportunities to use wildlife and (b) avoiding unacceptable negative impacts on wildlife and wildlife habitats. The problem is complicated because public uses of the refuges may have multiple impacts associated with them. The situation is further complicated in this era of public participation in decision-making

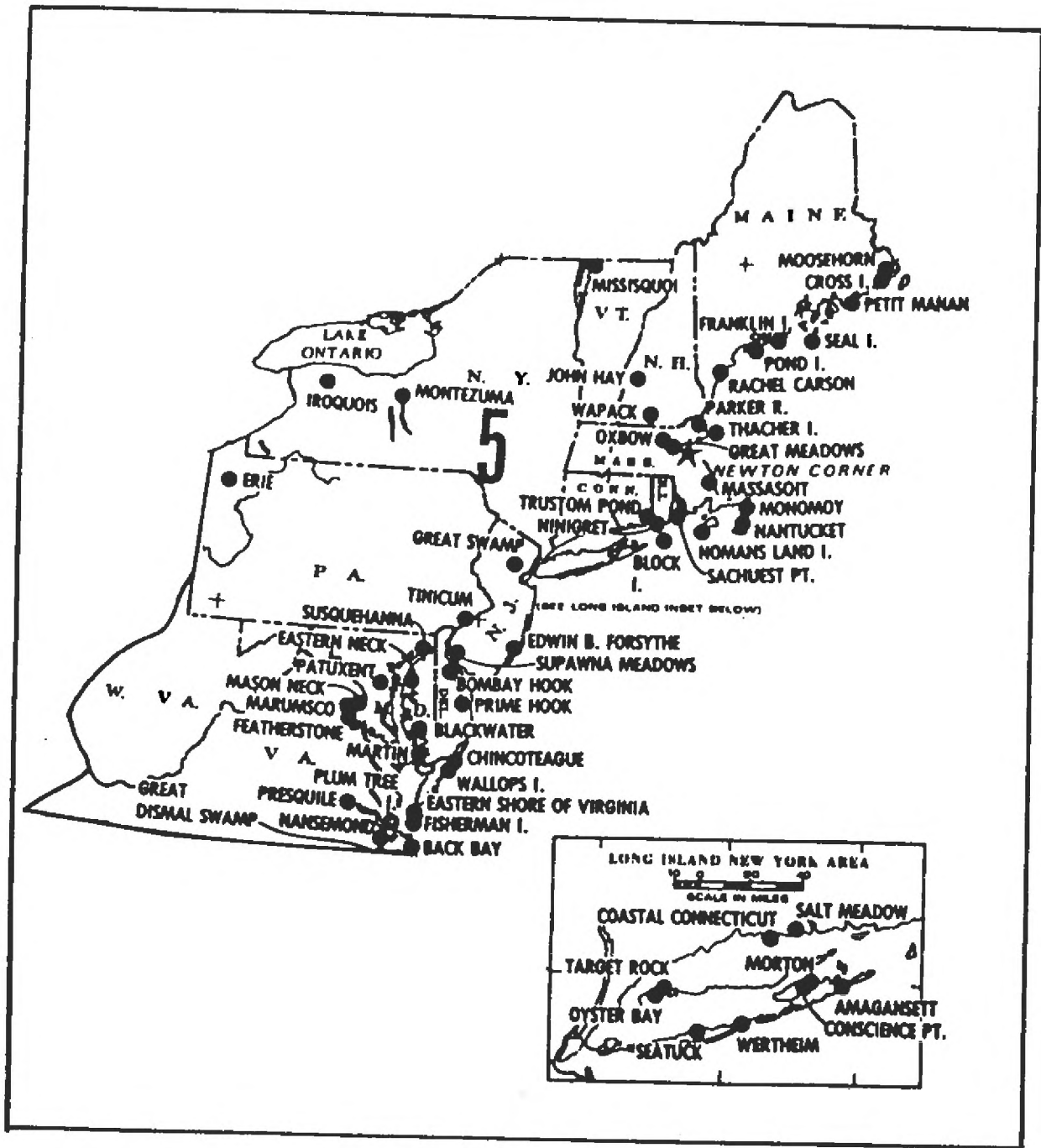


Figure 1. Locations of National Wildlife Refuges in Region 5.

because of a common and traditional public perception that impacts arising from consumptive-use activities (e.g., hunting, trapping, fishing) and nonconsumptive-use activities (e.g., birdwatching, wildlife photography) are entirely different, the former being more severe than the latter. Despite clear evidence that this distinction is not accurate, the dichotomy of consumptive vs. nonconsumptive uses has become a conventional way of conceptualizing wildlife use. Refuge managers have to deal with this conception as they explain their public-use decisions to interested and sometimes opposing publics.

The purpose of this guide is to provide a basic framework for understanding and possibly ameliorating problems of managing human activity on NWRs in Region 5. Specifically, the objectives of this project are to:

- a) Provide a synthesis of the "consumptive" vs. "nonconsumptive" argument as it applies to human use of National Wildlife Refuges in Region 5.
- b) Evaluate the charge of the Service to manage wildlife and wildlife habitat for the benefit of people with respect to the basic limitations of human activity that are needed to minimize human-wildlife interactions that are potentially detrimental to people or wildlife.
- c) For a list of important species in Region 5 (identified by NWR managers), provide a ranked list of human activities that addresses the effects of disturbance at various times of the year.
- d) For the same species, provide a list of means to minimize disturbance at critical times.
- e) Provide an assessment of means to obtain visitor cooperation in maintenance of high quality habitat.
- f) Provide a guide to the public-use activities of the National Wildlife Refuge System in a format that will permit NWR managers to obtain information on where to go for advice on the conduct of specific visitor activities.

The scope of this project was broad, but the time and funding involved were modest. Nevertheless, we have attempted to meet the above objectives by providing refuge managers with the following:

- a) a brief review and evaluation of policy relative to managing human activity on NWRs, emphasizing an apparent deficiency of that policy;
- b) a discussion of the consumptive-use/nonconsumptive-use dichotomy, including an argument to abandon that concept in favor of a more valid and useful conceptual framework for purposes of human-activity-management decisions by refuge managers;
- c) results of a survey of refuge managers in Region 5, reporting wildlife species of special concern in the region vis-a-vis human activity impacts and the nature of impacts, categorized using the conceptual framework developed specifically for this purpose;
- d) a guide to selected literature on mitigating impacts of human activity on wildlife and to solutions provided by Region 5 refuge managers, using a matrix key of "impact" by "activity," developed from the survey of Region 5 refuge managers and based upon the conceptual framework developed for this project.

SECTION II: A FRAMEWORK FOR CONSIDERING PUBLIC USE AND USE-IMPACT
MANAGEMENT ON NWRs

In this section we will initially discuss problems with the consumptive-use vs. nonconsumptive-use dichotomy from a very broad perspective then give specific examples. The consumptive-user vs. nonconsumptive-user dichotomy will also be discussed. An alternative classification system emphasizing impacts will be presented. This system was developed specifically for the project. It was incorporated into the mail survey of refuge managers and is used later in this guide as a key to the literature review and managers' solutions for impact mitigation.

Consumptive vs. Nonconsumptive Uses: A Faulty Dichotomy

The distinction of "consumptive" vs. "nonconsumptive"-wildlife-use activities has been questioned for more than a decade. Wilkes (1977) and Weeden (1976) were among the first to challenge the concept of nonconsumptive use and both referred to nonconsumptive use as a myth. Wilkes (1977:347) indicated that ". . . land use has implicit in it the idea of consumption To say 'nonconsumptive use' is actually to speak a contradiction." He pointed out that by their recreational visits to natural areas people consume space, habitat, and privacy. Wilkes (1977) classified the consumption of natural resources along the following dimensions: spatial (e.g., space for campsites, roads and facilities), visual (e.g., large numbers of people consume solitude and humans have a visual impact on wildlife), and physical (e.g., direct crushing of vegetation by trampling, soil compaction, etc. that can actually alter vegetation patterns and associations. Far from being unobtrusive, Wilkes claims that nonconsumptive recreationists have direct negative impacts on wildlife habitat and human satisfactions.

The consumption of wildlife habitat, however, does not require an actual site visit by an outdoor recreationist. Weeden (1975:15) points out that from a broader perspective, "We are all consumers of wildlife." He says,

I consume energy in flying to distant meetings and in heating my home, and that energy comes from strip mined lands or oilfields and pipelines. I wear clothes made from wool (which commits wild forage to domestic sheep), cotton (which replaces oak-pine woodlands of the South), or polyester (which comes from coal or oil). In short, every human, by existing, consumes or displaces wild things.

While Wilkes specifies the particular ways that people consume natural resources by their use of wildlands, Weeden presents a global view of humans as consumers of wildlife. Both emphasize the idea that the distinction between consumptive and nonconsumptive activities is misleading and should be discouraged.

The effects of the hunter are easily visualized. An animal killed is an animal consumed. The effects of the birdwatcher, on the other hand, are not easily perceived. Although the birder does not directly consume the object of observation, the disturbance of woodland vegetation and soil erosion (habitat "consumption"), and interference with nesting activities (future animal "consumption") are some of the common consequences of the activity (Boyle and Samson 1985, White and Bratton 1980). Consequently, the observer of wildlife may be as much a consumer of wildlife as the hunter. The major difference may lie more in the public's perception of the two kinds of activities than in actual impacts.

The impacts of human use of wildlands has been well documented. A 1978 symposium entitled "Recreational Impact on Wildlands" (Ittner et al. 1979) presented research on the physical effects of nonconsumptive recreational pursuits on vegetation, soils, water, wildlife, and human enjoyment. It examined, as well, the philosophical view of the appropriateness of recreation

on wildlands and, most importantly, presented management considerations in dealing with wildland use. Among the research findings, it was reported that: human trampling has detrimental effects on low-growing vegetation (Holmes 1979); backcountry recreationists produce stressful situations for wildlife (Ream 1979); and construction of roads in elk habitat effectively eliminated prime areas from elk production (Pedersen 1979).

Boyle and Samson (1983) compiled an annotated bibliography of human-wildlife interactions involving nonconsumptive outdoor recreation activities. Of the 536 references identified, 166 articles contained original data that reported the effects of nonconsumptive activities on wildlife (Boyle and Samson 1985). Boyle and Samson summarized the impacts to wildlife by type of recreational activity. They reported that mechanized forms of recreation had the greatest impact on wildlife, causing habitat disturbance, disruption of animal behavior, noise pollution, and even direct mortality. Professional resource managers surveyed by McReynolds and Radtke (1978) reported that several wildlife species (e.g., white-tailed deer) are intentionally harassed by snowmobiles. This intentional disturbance and indirect disturbance from noise increases physiological stress, causing extra energy expenditures and increased mortality.

Reports of the effects of hiking and camping indicated that these activities were responsible for many of the same impacts caused by mechanized recreation, as well as for displacement of animals, litter and dumps, and air and water pollution (Boyle and Samson 1985). Wildlife observers and photographers actively seek wildlife, making encounters more frequent and of longer duration. These visits, Boyle and Samson indicated, can lead to increased nest losses of passerines, waterfowl, and colonial nesting birds due to predation. Animals habituated to humans may become more vulnerable to

poaching. In addition, birds are disturbed through sight and sound by boaters and swimmers. Shorebird breeding is often disrupted, causing behavioral changes in waterfowl and forcing birds to less preferred habitats (Boyle and Samson 1985, Manuwal 1978). (Indeed, lowered nesting production due to trespass in or near nesting areas by refuge visitors was the human-use impact cited most frequently by Region 5 refuge managers [discussed in Section IV].) Visitors' actions contributed to the displacement of desirable wildlife by less desirable species (e.g., terns by gulls). The visitors who caused these disturbances most often were beach users, beach drivers, and general visitors. Wildlife observers and surf fishermen in off-road vehicles also were responsible, but to a lesser degree. White and Bratton (1980) indicated that it is not only the outdoor recreationist who impacts wildlands, but the scientist, educator, and school group as well.

Consumptive vs. Nonconsumptive Users: Another Dysfunctional Dichotomy

Like the distinctions in wildlife uses, separation of "consumptive" and "nonconsumptive" users as they have traditionally been classified is seldom an accurate classification of the individual. An analysis of the 1980 National Survey of Fishing, Hunting, and Wildlife-associated Recreation showed that 37% of all wildlife users participated in both "consumptive" and primary "nonconsumptive" wildlife recreation activities (Brown et al. 1984). Seventy-five percent of sportsmen ("consumptive" users) participated in at least one primary "nonconsumptive" activity and 42% of primary "nonconsumptive" users participated in either hunting or fishing in 1980. Involvement-level indices, which combined variables measuring direct participation, indirect participation, and expenditures, indicated greater interest and involvement in wildlife recreation by dual users than solely "consumptive" or "nonconsumptive" users (Connelly et al. 1985). This dual participation, Connelly et al.

suggest, makes the consumptive/nonconsumptive distinction a dysfunctional concept. Furthermore, Hay and McConnell (1982) found a positive relationship between hunting and wildlife observation. They noted that a decision to participate in one type of activity increased the likelihood of participation in the other.

Regional and national studies have indicated that not only is there an overlap in types of recreational pursuits between consumptive and nonconsumptive users, but the pursuit of game species (e.g., deer and bear) is about equal by both user groups (Fazio and Belli 1977, Lyons 1982, Shaw and Mangun 1984). Nonconsumptive users did not concentrate on nongame species as a focus of their attention any more than they did game species.

The types of wildlife that nonconsumptive users prefer to observe, however, are not always the ones actually seen. The most dominant factor in determining what kinds of wildlife habitats are visited is the availability of public lands, which does not necessarily correspond to the public's preference for specific habitats and associated species (Shaw and Mangun 1984).

Because availability of recreational sites has a greater influence on visitation destinations than preference for wildlife species and dual recreationists account for 37% of wildlife users, recreational sites and activities may be more substitutable than managers often believe. This is an important consideration for refuge managers because it implies that the exclusion of certain activities from refuges due to unacceptable impacts may not be detrimental to overall public-use benefits. Many recreationists may be able to obtain benefits from the wildlife resource by switching to another activity that is permitted or to a location where their original activity of choice is permitted.

Summary of Implications for NWR Management

The emerging pattern from analysis of data about the traditional dichotomy of consumptive and nonconsumptive wildlife recreation participation indicates that: (1) both consumptive and nonconsumptive wildlife recreational activities impact wildlife directly or indirectly; (2) a significant population of "dual" users exists (i.e., those who participate in both consumptive and nonconsumptive activities); (3) no unique relationship is apparent between nonconsumptive users and interest in nongame species--interest in game species is almost equal for both user groups; and (4) availability of public lands plays a dominant role in wildlife recreationists' destinations, regardless of their particular wildlife recreation preferences.

Whether to permit only nonconsumptive activities and restrict consumptive activities, given traditional meanings of these terms, may not be the appropriate concern for management of recreational use of NWR land. Rather, attention should be given to determining the kinds of impacts on wildlife or habitat that are of special concern on a particular refuge and which recreational activities are most or least likely to cause such impacts. With an understanding of this relationship, informed, defensible decisions can be made regarding which activities should be allowed on particular refuges, or portions thereof.

Lucas (1979:24) noted,

Any recreational use of wildlands will produce some environmental change. "No change" or "unmodified natural conditions" may sound noble but neither can be achieved in areas visited by recreationists and therefore both are unrealistic management objectives.

The problem that refuge managers are addressing is one of establishing acceptable impact levels. What may be acceptable at one site may be unacceptable at another. Refuge managers attempt to be sensitive both to the

needs of the particular resource they have the responsibility of conserving as well as to the public that would like to use that resource. These considerations may be situation specific. Consequently, there is a need for an overall policy guiding the management process that allows individual managers the flexibility to accommodate their particular situation while maintaining the overriding philosophy of the National Wildlife Refuge System.

Classification of Public-use Impacts

The usefulness of the consumptive/nonconsumptive dichotomous classification, with its implications that one of these general types of activity impacts the resource and the other does not, is misleading, considering the impact a broad spectrum of public-use activities can have on wildlife, habitat, and human satisfaction. A more realistic classification strategy, we suggest, is one that uses the type of impact as the basis of categorization. Impact categories that focus on the three elements mentioned above (wildlife, habitat, and people), would provide a comprehensive system of categorization. Examples of habitat impacts are trampled vegetation, soil erosion, and water pollution. Impacts on people include infringement on solitude, restrictions on resource use, and safety hazards. All of these impacts are important considerations in managing wildlands, but this report we will focus on impacts to wildlife and present an impact classification system that can be used in considering the effects of various uses of wildlife refuges.

We have classified the negative impacts to wildlife species that result from visitor activities into six categories (Table 1). There is not a one-to-one correlation of activities to impacts, nor does one type of impact necessarily exclude another. For instance, a birder hiking through prime nesting habitat of the piping plover may be causing stress to the bird, reduced

Table 1. Impacts to wildlife as a result of visitor activities.

<u>Category of Impact</u>	<u>Description of Impact</u>
Direct Mortality	Immediate, on-site death of an animal.
Indirect Mortality	Eventual, untimely death of an animal caused by an event or agent that predisposed animal to death.
Lowered Productivity	Reduced fecundity rate, nesting success, or reduced survival rate of young before dispersal from nest or birth site.
Reduced Use of Refuge	Wildlife not using refuge as frequently or in the manner they normally would in the absence of visitor activity.
Reduced Use of Preferred Habitat on Refuge	Wildlife use is relegated to less suitable habitat on the refuge due to visitor activity.
Aberrant Behavior/Stress	Wildlife demonstrating unusual behavior or signs of stress that are likely to result in reduced reproductive or survival rates.

use of the preferred habitat, and ultimately result in lowered productivity. Another example is the impacts caused by hunting. Although the obvious impact of hunting of a species is direct mortality of individuals of the species, the activity might also result in animals' reduced use of the refuge or reduced use of preferred habitat.

The point is that while a particular activity may have an immediate impact on wildlife or its habitat, the long-term effects of the activity must be considered as well. Although hunting may result in the immediate death of a game animal, indirect mortality from vehicle collisions by motorists driving through a refuge to observe wildlife or lowered productivity due to disturbance of nesting sites by hikers and photographers may similarly reduce the population. The issue of importance is not whether the intended outcome of an activity is considered to be consumptive or nonconsumptive of wildlife (or even that wildlife is considered the focus of the activity) but whether the level of impact of the activity on the wildlife resource is acceptable, or even recognized.

SECTION III: THE PUBLIC USE VS. WILDLIFE CONSERVATION DILEMMA:
A BRIEF EVALUATION OF POLICY IN NWR MANAGEMENT

The establishment of acceptable levels of impact for each category of impact in the classification schema presented earlier seems to be the key element in the rational and defensible administration of refuge management policy. If such levels of acceptable impact could be determined and agreed to for species or groups of species on a particular refuge, they could be used as criteria for decision making. Decisions about particular forms of public use that would be permissible on a refuge could be made based on estimated levels of impact expected from the uses under consideration, at various levels of participation, and with various levels of mitigation effort. Our evaluation of the various policies guiding refuge management indicates that this may be a valuable and needed link in management decision making.

The following review of relevant literature and documents regarding refuge management for public-use benefits indicates consistent reference to "compatibility" of such use with the primary purpose of the particular refuge. Furthermore, reference is made to the "compatibility test" when making decisions about permissible public use. Although such language implies that criteria exist for such a test, we did not uncover compatibility criteria. Consequently, the compatibility question is left to the individual refuge managers and regional directors. The flexibility this allows has advantages and disadvantages. The primary advantage is the opportunity to tailor decisions on compatibility to the individual refuge situation. The disadvantage is the lack of agency-accepted and, therefore, legitimized criteria for such decisions. This would seem to invite challenges to management decisions.

In the remainder of this section we will discuss the policy regarding public use of refuges, give two examples of where public-use decisions resulted

in public acceptability problems, suggest a general conceptual model for incorporating biological and sociological information into the management process, present the status of public-use policy statements for refuges in Region 5, and discuss how the public-use impact classification system presented in Section II can be used as an aid in establishing compatibility criteria for a refuge.

The Policy Context for NWR Management

The rubric guiding refuge management is established by the mission statement of the National Wildlife Refuge System (NWRS). The goal of the refuge system is:

to provide, preserve, restore, and to manage a national network of lands and waters sufficient in size, diversity, and location to meet society's need for areas where the widest possible spectrum of benefits associated with wildlife and wildlands is enhanced and made available. (USFWS Refuge Manual, 1.3)
(Audubon Society 1985:151)

According to the 1966 NWRS Administration Act, uses such as recreation are permissible on a refuge if the use is "compatible" with the basic purposes for which the refuge was established (Audubon Society 1985). The decision to allow recreational activities is made by the regional director with advice from the refuge manager, in consideration of the compatibility test. However, no criteria were given for this test, nor was a process for developing such criteria suggested. Consequently, refuges handled decisions on compatibility in their own particular way.

Public-use pressures on refuges continued to mount through the 1970s and early 1980s. Approximately 30 million people visited NWRs during 1983. This high visitation notwithstanding, the Director of the USFWS issued a memorandum in 1983 to the regional directors calling for increased use of refuges by the

general public for interpretation, wildlife observation, hunting, fishing, boating, hiking, and other activities. "This memorandum reflects a widespread feeling among supporters of the refuge system that it is not living up to its potential to provide these activities" (Audubon Society 1985:166). In 1984 the Public Use Requirements (USFWS 1984) document specified permissible public uses and encouraged public recreation and education. Thus, refuge managers experienced even greater pressure to provide for public use while insuring the integrity of the refuge for its primary purpose. But compatibility criteria or guidelines for developing such criteria were not established.

Funding for refuge lands comes from a variety of sources, including The Migratory Bird Conservation Act (Duck Stamp) and the Land and Water Conservation Fund (L&WCF). In using such funding, the NWRS must consider the purposes for which the funds were established. For example, up to 25% of any land acquired with duck stamp money can be set aside as wildlife management areas where hunting of resident and migratory game birds is allowed. Money from the L&WCF can be used to acquire refuge lands for endangered species conservation, interpretation, and recreation (Audubon Society 1985). Use of these funding sources for refuge lands influences what constitutes allowable activities on such lands.

The dilemma facing refuge managers and regional directors is one of conflict of purposes. The General Accounting Office recommended that the Secretary of the Interior resolve the conflicting goals of (1) promoting multiple-use of refuge lands and (2) resolving resource problems on refuges (Audubon Society 1985:175). However, it may not be possible to preserve the land and use it for public benefits at the same time. This problem is not unique to the NWRS. Many reserves are established with an inherent contradiction, trying both to protect natural areas and provide for public

recreation when direct and indirect human influences present the greatest threat to preservation goals (Stone 1965). Consequently, protection of wildlife and its habitat may require restrictions on public use that diminish the pool of recreational benefits.

The sometimes competing purposes of refuge lands require policymakers and managers to evaluate the goals of the NWRS carefully. The basic question of how much use is compatible with preservation goals needs to be addressed (White and Bratton 1980). A critical evaluation of the direct and indirect impacts of various uses and the benefits people derive from them is crucial to answer this question. It is important to consider the meaning of "society's need," a key phrase in the goal statement presented above. Are society's needs best served by wildlife refuges with limited public access that further species preservation? Or, is it more beneficial to society to have wildlife refuges with high public access that will satisfy recreational needs but often have correspondingly more negative impacts to the refuges' wildlife?

Integral to such an evaluative procedure is the recognition and consideration of public attitudes and values toward the wildlife resource. Recent conflicts regarding refuge use have pitted the USFWS against boaters, conservation groups, industry, and farmers. For example, in Nevada, wildlife conservationists claimed that extending the boating season at Ruby Lake National Wildlife Refuge would be incompatible with the primary purpose of Ruby Lake as a refuge and breeding ground for migratory birds and other wildlife. Boaters and fishermen, on the other hand, favored the boating season extension. The refuge manager, in the USFWS 1981 Threats and Conflicts study, stated "The most important threat to Ruby Lake National Wildlife Refuge is the Fish and Wildlife Service granting concessions to recreational interests detrimental to wildlife" (Audubon Society 1985:167). Following a suit filed by Defenders of Wildlife, the National Audubon Society and the Humane Society of the U.S., the USFWS rescinded the boating extension.

Another case of attempting to expand public use of refuges was the Department of Interior's decision in 1982 to permit deer hunting on Loxahatchee National Wildlife Refuge in Florida. Opponents to the hunt claimed that hunting was not compatible with the purposes for which Loxahatchee lands traditionally have been managed: to protect a fragile ecosystem that is home to a number of endangered and threatened species. Furthermore, they reasoned that the hunt was not necessary to control the deer herd and costs for the hunt to taxpayers greatly outweighed the limited benefits to hunters. As a result of the opposition the USFWS cancelled the hunt planned in 1982 as well as subsequent hunts proposed for 1983 and 1984 (Audubon Society 1985). Although we have no data on the specifics of how the original decision to hold a hunt was made, compatibility was the pivotal question in this instance as in many others. Had compatibility criteria been established beforehand for the refuge, based on an assessment of acceptable levels of various categories of impacts, and the anticipated levels of impacts from the proposed hunt been determined then compared against the criteria, the USFWS would have been in a more defensible position when faced with opposition to their decision to allow the hunt.

The above examples illustrate the problems that arise when the full spectrum of relevant public values are not factored into the decision-making process for wildlife management. They also demonstrate that the issue of public use of NWRs is not focused on consumptive versus nonconsumptive activities per se, but rather with the question of impacts associated with various uses. At the outset, a particular use of a refuge must be compatible with the purpose for which the refuge was created. Establishing impact criteria beforehand will help managers make the public-use decisions. However, if an activity or regulation meets with public disapproval, the most well-

developed management plan may be challenged. Nevertheless, refuge managers can maintain their credibility amid controversy if they have a defensible position, which we believe the establishment of impact criteria provides for the compatibility test.

Reconciling diverse refuge goals requires integration of biological and social values information. The decision-making process should have a feedback system built into it where management plans and rationale are communicated to the public and the public's views in turn are given careful consideration prior to implementation. This makes great sense, but we all recognize that it is difficult to operationalize in NWR management.

Recently, Krueger et al. (1986) proposed a comprehensive model of resource management that stressed integration of biological and sociological aspects of the management situation. Their view of management as a goal-oriented process, where goals emerge from broad policy statements, is relevant to the refuge management situation, as is their emphasis on criteria for establishing objectives. The model they proposed was dynamic in that it had an evaluation element that provided the feedback link to cause management to be an adaptive process that accommodates changing social and biological conditions. Krueger et al. (1986) assert that management decision making should be tied directly to such a process. We cannot go into the details of the model here, but recommend it for consideration by NWR managers (refer to Appendix A for a copy of the Krueger et al. paper). We believe that the adoption of a comprehensive resource management model like that proposed by Krueger et al. (1986) will be essential to managing public use on NWRs. Furthermore, the application of systematic decision-analysis procedures that explicate the public-use decision-making process will become increasingly critical to professional NWR management. Documentation of the rigor these procedures require will be needed

to defend public-use decisions that undoubtedly will come under increased public scrutiny as the polar factions of the public, such as animal rights advocates, become more active in a variety of public forums (e.g., media and courts).

Status of Wildlife-management and Public-use Policy Statements for Region 5 NWRs

As previously stated, individual managers and regional directors are given considerable flexibility in fulfilling the goal of the NWRs to both preserve wildlife and wildlife habitat and provide for public-use. As part of this project we wanted to determine the extent to which NWRs in Region 5 had policy statements to guide the development of wildlife-management and public-use objectives. NWR managers were asked whether they had such a policy statement and if the statement was a formal or informal policy (see Section IV for methodology used).

Table 2 summarizes the data from the managers of 21 refuges who fulfilled the request. Three managers indicated that they had no policy statements that specifically addressed wildlife-management and public-use, but rather they utilize the policies stated in the USFWS Refuge Manual (1985). No attempt was made to provide precise definitions of formal and informal policies. The terms were meant to imply a relative degree of officialism and flexibility in application and interpretation. Seven refuges utilize a formal policy and 14 utilize an informal policy. Refuges were included in the column categories of Table 2 according to the following criteria.

Species: Statement referred to the management of one or more wildlife species.

Wildlife group: Statement specifically referred to the management of one or more groups of wildlife such as migratory waterfowl, big game or small game.

Table 2. Wildlife-management and public-use policy statements of Region 5 National Wildlife Refuges.
(N = 21 Refuges)

Topics specifically addressed in the policy statement^a

	Species	Wildlife Group	Public Use	Public-use Compatibility
Formal	2	6	7	4
Informal	8	13	14	7
Total refuges	10	19	21	11

^aThree refuges utilize the policies stated in the USFWS Refuge Manual. These 3 were included in the totals for each topic except "species."

Public-use: Statement legitimized management of the refuge for some form of public-use such as education or recreation.

Public-use compatibility: Statement specifically stated that public uses of the refuge must be compatible with wildlife-use objectives.

All refuge statements included "public-use" as an objective of the refuge and nearly all included "wildlife group" management. Nearly half of the statements included management for one or more individual species as an objective of the refuge. Just over half of the statements mentioned that public uses must be compatible with wildlife-use objectives. Managers of three refuges indicated that policy statements on this issue were either needed or the current statements were in revision. No criteria for determining compatibility were identified.

Summary

The cursory evaluation of broad USFWS policy regarding NWR management relative to public use and our data from NWR managers in Region 5 indicate that a need exists for a process to determine criteria for making decisions about compatible public use on NWRs. We have indicated that the traditional consumptive/nonconsumptive use (user) dichotomy is dysfunctional for this purpose and have offered an alternative approach for assessing compatibility that is based on impacts of activities. We have also suggested that the decision-making process regarding public use of refuges (a) should occur in the larger context of a comprehensive resource management model for a refuge and (b) should employ decision-analysis procedures to document and improve the defensibility of decisions made; however, no details on operationalizing these two suggestions were presented.

The following sections will attempt to operationalize the impact classification system first by using it as the framework for analyzing and

reporting data from the survey of Region 5 NWR managers, then by using it in a guide to selected literature on mitigating impacts of human activity on wildlife and to solutions provided by Region 5 refuge managers.

SECTION IV. A SURVEY OF REFUGE MANAGERS: VISITOR ACTIVITIES AND IMPACTS ON SPECIES OF SPECIAL CONCERN

Survey Methodology

All Region 5 refuge managers were first contacted via letter in November, 1985 (Appendix B). This letter had the dual purpose of informing managers of the project and giving them the opportunity to consider questions to be addressed in an ensuing telephone survey.

The telephone survey (Appendix C), conducted in November, 1985, was designed to obtain a preliminary listing of species that were being negatively impacted by visitor activities, an assessment of the importance of the species on the refuge, the nature of the impact, season of impact, who the visitor publics were, and a ranking of importance of the impact. Data from the telephone interviews were then used to develop the 8 categories of questions for describing visitor-activity impacts in a self-administered mail questionnaire (Appendix D).

Next, the questionnaire was sent to Region 5 regional staff for review and approval. Upon receiving administrative approval, a final questionnaire mailing was prepared for refuge managers. The survey was implemented in July, 1986, and was preceded by a memo from Region 5 Assistant Director, Donald Young, requesting the cooperation of refuge managers.

Managers who had supplied information in the preliminary telephone survey received a form showing the information they had provided. They were asked to review the data and make corrections and/or additions as needed to describe the individual wildlife impact situations more accurately and completely. All managers (whether they had reported cases of visitor activity impacts on wildlife or not via the telephone survey) received a regionwide compilation of data obtained via the telephone survey. They were asked to review the

information and suggest potential solutions to any wildlife impact problems identified regionally with which they had experience. All managers received questionnaires requesting information regarding cases of visitor-related wildlife impacts that had occurred since the initial telephone interview. Furthermore, managers were asked to provide any policy statements regarding wildlife-management goals and public-use goals for their refuge and to indicate whether the statement was "formal" or "informal" (see Table 2, page 21).

Survey Response

As with the telephone survey, the managers were cooperative in the mail survey. Only one manager felt the questionnaire did not adequately address the unique problem on his refuge and he provided a letter explaining why it was inappropriate to complete the questionnaire.

Data on visitor activities and resultant impacts on species of special concern were provided by 16 of the 22 refuge managers in Region 5 (Table 3). A total of 148 separate impact situations involving 20 wildlife species were reported. Nine refuge managers made one or more suggestions for resolving specific impact situations. Twenty-one of the 22 managers provided policy statements for their refuges.

Data Analysis Procedures

As per the objectives of the study, analyses concentrated on species, activities, impacts, and importance of impacts. In-depth analysis was limited to these variables because they seemed to portray best the key nature of the interaction between the visiting publics and the impacted wildlife. For this report, data provided by the managers were structured to facilitate a complete, accurate, and analyzable set of responses. This structure was achieved by using the 8 categories of questions that appeared on the questionnaires to describe each wildlife impact situation.

Table 3. Percent of visitor-activity impact situations reported, by refuge.

<u>Refuge</u>	<u>%</u> <u>(n=148)</u>
Parker River	16.9
Rachel Carson	13.5
Back Bay	12.8
Edwin B. Forsythe	12.8
Wertheim	8.8
Ninigret	8.1
Chincoteague	7.4
Mason Neck	4.7
Great Meadows	2.7
Missisquoi	2.7
Prime Hook	2.7
Bombay Hook	2.0
Great Swamp	2.0
Presquile	1.4
Great Dismal Swamp	0.7
Iroquois	<u>0.7</u>
Total	100.0

The categories encouraged managers to examine critically several sides of an issue that may be important in its resolution, but might be easily overlooked. As a simple example, a cursory evaluation of a refuge wildlife impact problem might associate surf fishermen with nest disturbance of piping plovers. This analysis alone would suggest a need for a policy that would restrict surf fishing in the disturbance area. However, an examination of a manager's depiction of the problem using the questionnaire categories to describe the impact situation would reveal, more completely, that nest disturbance was caused by (1) surf fishermen driving to and from fishing sites, (2) pets and non-fishing guests of the fishermen exploring the beach and (3) fishermen picnicking on the beach. This examination reveals that the offending publics are off-road tourers, beachcombers, visitors' pets, and picnickers; the impacting activities are driving on beaches, exploring on foot, unrestrained pets, and picnicking, respectively. Analyzing the problem in this way would indicate that potential solutions might be (1) to simply inform fishermen how to get to fishing sites without driving through nesting areas, (2) to restrict guest and pet activities, and (3) to provide alternative areas away from nesting areas for picnicking. Thus, fishing itself would not appear to be a cause of negative impacts on wildlife of special concern and may be continued, with certain restrictions, as a compatible public use of the refuge.

Species and Impacts

In describing wildlife impact situations, Region 5 refuge managers identified a total of 20 individual wildlife species of special concern. Table 4 shows the frequency with which wildlife species were reported as being involved in impact situations. Piping plovers (24.3%) and least terns (19.6%) were those species most frequently cited as being impacted by human activities and, collectively, were involved in over two-fifths of all situations

Table 4. Distribution of species impacted by visitor activities in Region 5.

Individual Species	Percent (n=148)	Species Group
Piping plover	24.3	
Least tern	19.6	
Common tern	5.4	
Black skimmer	3.4	
Sanderling	2.7	
Sandpiper	2.7	
Roseate tern	0.7	
Great blue heron	0.7	
Shorebirds (general)	2.0	Shorebirds (61.5%)
Black duck	7.4	
Wood duck	4.7	
Goldeneye	1.7	
Canada goose	0.7	
Waterfowl (general)	2.7	Waterfowl (16.9%)
Bald eagle	4.1	
Osprey	4.1	
Northern harrier	2.7	
Cooper's hawk	1.4	
Peregrine falcon	0.7	Birds of Prey (12.8%)
White-tailed deer	5.4	Deer (5.4%)
Eastern bluebird	2.0	Bluebird (2.0%)
Loggerhead sea turtle	1.4	Sea Turtle (1.4%)
TOTAL	100.0%	

described. Black ducks accounted for about 7% of all reports of species impacted. Among other wildlife reported, no single species was the focus of more than about 5% of the impacts described. When classified according to groups of similar species, shorebirds clearly accounted for the majority (61.5%) of impacted species. Waterfowl (16.9%) and birds of prey (12.8%) were second and third, respectively.

Of all 148 impact situations described by managers, lowered productivity was cited in 61 situations (41.3%) as the effect of the impact on the species of interest (Table 5). Overall, similar percents of impact situations involved aberrant behavior/stress (16.2%), reduced use of habitat (13.5%), reduced use of refuge (12.8%), and direct mortality (11.5%). Indirect mortality was the least frequent (4.7%) impact reported.

Managers' evaluations of the importance of each impact situation indicated that nearly 60% were deemed to be of great importance; less severe evaluations of moderate and minor importance were associated with about 20% of all impacts described (Table 6). All impact situations involving sea turtles and nearly four-fifths of those impacts involving shorebirds were classified as being of great importance. Less than one-fourth each of the impacts on waterfowl, birds of prey, and white-tailed deer were considered of great importance. Of all species involved, impacts on birds of prey appeared to be of least concern as about 56% of the impacts described were perceived to be of only minor importance.

Activities and Impacts

Managers identified a total of 12 refuge visitor activities that had negative impacts on species of special concern. As shown in Table 7, two activities alone were involved in nearly 70% of all impact situations-- exploring on foot (48%) and driving on beaches (20.9%). Importantly, these

Table 5. Effects of visitor-activity impacts by wildlife species grouping.

Species Grouping	Percent by Impact Effect ^a						Totals	
	DM	IM	LP	RR	RH	AB	n	%
Shorebirds	11.0	1.1	39.5	14.3	14.3	19.8	91	100.0
Waterfowl	12.0	12.0	40.0	12.0	20.0	4.0	25	100.0
Birds of Prey	0.0	0.0	63.1	10.5	10.5	15.8	19	100.0
Deer	37.5	25.0	0.0	12.5	0.0	25.0	8	100.0
Bluebirds	33.3	0.0	66.6	0.0	0.0	0.0	3	100.0
Sea Turtles	0.0	50.0	50.0	0.0	0.0	0.0	2	100.0
% of all impacts	11.5	4.7	41.3	12.8	13.5	16.2	148	100.0

^aKey to Impacts:

DM = direct mortality

IM = indirect mortality

LP = lowered productivity

RR = reduced use of refuge

RH = reduced use of preferred refuge habitat

AB = aberrant behavior/stress

Table 6. Managers' perceptions of impact importance by species grouping.

Species Grouping	Percent by Importance of Impact			Totals	
	Minor	Moderate	Great	n	%
Shorebirds	8.2	13.7	78.1	73	100.0
Waterfowl	35.3	41.2	23.5	17	100.0
Birds of Prey	56.3	25.0	18.8	16	100.0
Deer	20.0	80.0	0.0	5	100.0
Eastern Bluebird ^a	--	--	--	--	--
Sea Turtle	0.0	0.0	100.0	2	100.0
% of all impacts	19.5	22.1	58.4	113	100.0

^aNo data were given for bluebirds.

Table 7. Ranking of refuge visitor activities by percent of reported occurrence in wildlife-impact situations.

Activity	Percent (n=148)
Exploring on foot	48.0
Driving on beaches	20.9
Harassing wildlife/vandalism	6.8
Boating	5.4
Wildlife observation on foot	4.7
Hunting	4.1
Feeding/petting wildlife	2.8
Collecting eggs	2.0
Driving on roads	1.4
Hiking/bicycling/jogging	1.4
Littering	1.4
Sunbathing/swimming	<u>1.4</u>
TOTAL	100.0

same activities were found to have the greatest range of impacts of all activities identified (Table 8). Lowered productivity was cited as an important impact attributed to nearly two-thirds of the activities. Activities involving use of land vehicles were commonly associated with direct mortality while, with few exceptions (e.g., hunting), other activities commonly impacted species of concern by lowered productivity. In view of the earlier discussion of the consumptive vs. nonconsumptive argument, it is of further value to note that the activity of hunting was far less pervasive in relation to the number of impact situations with which it was associated than were many other kinds of activities. Also, hunting accounted for only about 30% of all the problem situations described in which direct mortality was a result. Exploring on foot and driving on beaches, on the other hand, accounted for about 70% of the situations described resulting in that impact.

Table 9 shows the impacts reported by managers that were associated with visitor activities on the refuge and their effects on the groups of species of concern. As indicated, exploring on foot impacted nearly all groups of species identified and had a wide range of impacts. The table further shows that certain activities had varying impacts on wildlife species. Some activities had several impacts on a specific group of species (e.g., boating impacts to waterfowl) while other activities were associated with fewer impacts but affected numerous kinds of wildlife (e.g., wildlife observation on foot impacting shorebirds, waterfowl, and birds of prey).

It is also important to recognize the seasonal patterns of impacts from visitor activities that affect refuge wildlife. Table 10 shows the season(s) of the year reported by managers during which specific impacts occurred as a result of visitor activities. Most occur during the spring and summer, a popular time for most outdoor recreation activities. Associated wildlife

Table 8. Relationship of visitor activities to impacts on refuge wildlife.

Activity	Percent of Situations, by Impact ^a										Total n	%
	Direct Mortality	Indirect Mortality	Lowered Productivity	Reduced-use Refuge	Reduced-use Habitat	Aberrant Stress	Behavior	Total				
Exploring on foot	4	3	38	14	18	23	71	100				
Driving on beaches	26	6	26	19	13	10	31	100				
Harassing wildlife	0	0	100	0	0	0	10	100				
Boating	0	12	50	13	12	13	8	100				
Wildlife observation on foot	0	0	57	0	14	29	7	100				
Hunting	83	0	0	0	17	0	6	100				
Collecting eggs	0	0	100	0	0	0	3	100				
Driving on roads	50	0	50	0	0	0	2	100				
Feeding/petting wildlife	0	50	0	0	0	50	4	100				
Hiking/bicycling/ jogging	0	0	50	50	0	0	2	100				
Littering	0	0	100	0	0	0	2	100				
Sunbathing/swimming	0	0	50	50	0	0	2	100				
							<u>148</u>					

^aPercentages are rounded for data presentation.

Table 9. Refuge visitor activities and associated specific impacts on refuge wildlife.

Activity	Impacts by Species Group					
	Shorebirds	Waterfowl	Birds of Prey	Deer	Bluebird	Sea Turtle
Exploring on foot	DM, LP, RR, RH, AB	IM, LP, RR, RH	LP, RR, RH, AB	DM, RR	LP	
Driving on beaches	DM, IM, LP, RR, RH AB					IM, LP
Harassing wildlife/ vandalism	LP					
Boating		IM, LP, RR, RH, AB				
Wildlife observation on foot	LP, AB	LP, RH	LP, AB			
Hunting		DM	RH	DM		
Collecting eggs		LP			LP	
Driving on roads					DM	
Feeding/petting wildlife						
Hiking/bicycling/ jogging		LP, PR				
Littering	LP					
Sunbathing/swimming	RR					

Key to Impacts

- DM = direct mortality
- IM = indirect mortality
- LP = lowered productivity
- RR = reduced use of refuge
- RH = reduced use of preferred habitat
- AB = aberrant behavior/stress

Table 10. Seasonal patterns of visitor-activity impacts on refuge wildlife.

Activity	Impact						Aberrant/Behavior Stress
	Direct Mortality	Indirect Mortality	Lowered Productivity	Reduced-use Refuge	Reduced-use Habitat		
Exploring on foot	SS ^a (2) ^b YR(1)	FSP(2)	SS(16) SP(4) SU(3) SSF(3) WSP(1)	SS(5) SU(3) F(1) FSP(1)	SS(7) SP(3) SU(2) SSF(1)	SS(15) F(1)	
Driving on beaches	SS(7) SU(1)	SU(1) SS(1)	SU(4) SS(3) YR(1) SS(10)	SU(3) SS(3)	SS(2) SU(1) YR(1)	SS(3)	
Harassing wildlife							
Boating		FW(1)	SP(3) SSF(1)	FW(1)	W(1)	FW(1)	
Wildlife observation on foot			SS(2) SP(1) WSP(1)		SP(1)	SS(1)	
Hunting	FW(4) F(1)				F(1)		
Collecting eggs			SP(2) SS(1)				
Driving on roads	YR(1)		SSF(1)				
Feeding/petting wildlife	W(2)						
Hiking/bicycling/jogging							
Littering			SU(1)	SU(1)		W(2)	
Sunbathing/swimming			SS(2)				
			SS(1)	SU(1)			

^aKey for Seasons

- SP = spring
- SU = summer
- F = fall
- W = winter
- FW = fall/winter
- WSP = winter/spring
- SS = spring/summer
- FSP = fall/spring
- SSF = spring/summer/fall
- YR = year round

^bNumber of cases

impacts thus occur predominately during the same seasons. The data demonstrate, however, that managers must also be aware of potential impacts at other times of the year. The frequencies of seasons during which specific impacts were reported for visitor activities should provide a basis for temporal regulation of certain activities.

SECTION V: METHODS OF CONTROLLING VISITOR-RELATED IMPACTS ON REFUGE WILDLIFE

After identifying the activities engaged in by particular visitor publics that cause negative impacts on wildlife, the manager can decide what measures, if any, need to be taken to control those impacts. This section reviews four major categories of methods to control visitor impacts on wildlife in Region 5 refuges. These categories, visitor education, zoning, restrictions on visitor activities, and law enforcement, were developed from solutions to impact situations provided by refuge managers and from a synthesis of literature relating to management of visitor impacts (e.g., Hendee et al. 1978). The methods represent both indirect (e.g., visitor education) and direct (e.g., law enforcement) types of control. The brief discussions of each category presented below are based on a review of the literature. Relevant literature was obtained by searching three sources: (1) a computer-assisted search of six literature data bases, (2) review of "A Bibliography of Human/Animal Relations" (Kellert and Berry 1985), and (3) a review of "Nonconsumptive Outdoor Recreation: An Annotated Bibliography of Human-Wildlife Interactions" (Boyle and Samson 1983). References herein are listed by number (shown in parentheses); their full citation can be found at the end of Section VI.

Visitor Education

Education of the public about the values of wildlife is essential for the protection and wise use of wildlife (8). Visitors are entitled to wildlife viewing experiences, but must be educated about wildlife behavior and the need to maintain respect for wild animals (6, 23, 40). Of course, a potential problem with such education is that in some situations, increased public education and awareness may increase interest and demand for the resource, thus leading to increased disturbances of wildlife (37). However, education is

often the least offensive method of control available to managers because it preserves visitors' freedom of choice.

One area where education may be useful in alleviating adverse impacts is in hunter education programs (50). Such programs may clarify rules of special hunts or increase hunter proficiency to minimize inappropriate hunter behavior or misidentification of wildlife of special concern to refuges. Another area where the positive effects of education have been observed is in reduction of wildlife harassment. Information disseminated at access points can be effective if it is presented in a positive context and promotes separation of people from sensitive areas of wildlife use (43).

Methods of education include lectures and tours, leaflets, exhibits, signs, and press releases (16). Information and exhibits can be located at visitor centers or near access points for an area in need of protection. For refuges near large urban areas, bilingual signs may be important to place at access points (1). A detailed discussion of educational considerations for protection of colonially nesting waterbirds is provided in reference 16.

Zoning

Zoning is the act of identifying a spatial zone in which the elimination or restriction of certain types of use is necessary to protect wildlife of special concern. It is frequently used to delimit visitor activities that are compatible with wildlife uses at specific refuge sites. Zoning of an area includes an assessment of each use interest (human and wildlife) and the selection of a "prime user" for each area. All other human use interests are not necessarily barred, but they must be compatible with, and secondary to the "prime user" (3).

Examples of zoning as solutions for alleviating potential wildlife impacts are:

- 1) seasonal closures of critical wildlife areas (e.g., nesting areas) from off-road vehicle use, boating, wading fishermen, and other human activities (2, 15, 18, 21, 40).
- 2) zones closed to hunting around nature trails to assure visitor safety and reduce disturbance to wildlife (50).
- 3) designating special retrieval zones around waterfowl hunting areas that enables hunters to retrieve fallen game and thus reduce crippling losses (50).

Zoning a previously unrestricted area may result in vandalism of signs delimiting the area. However, persistence by the manager in replacing vandalized signs may lead to reduced vandalism and eventual effectiveness of the signing strategy (19).

Specific techniques used for zoning include: (a) developing small, high-use areas by providing for numerous visitor needs (e.g., parking, picnicking, toilets, water) at one site (51), (b) creating a vegetative buffer zone for protecting birds in nesting areas (5, 46), and (c) restricting off-road vehicles to carefully marked tracks during critical periods (16). For more specific information on zoning techniques and their implementation refer to references 13 and 16.

Restrictions on Activities

Restriction of activities is often used in conjunction with zoning as a means of controlling human impacts on wildlife. A restriction can occur for all or part of the year depending on the situation (17), and is frequently accompanied by positively-worded educational statements of the wildlife impact problem (16). For example, visitors might not be permitted near nesting

shorebird colonies because their presence leaves a scent trail which is followed by predators (4).

A commonly cited case that used various types of restrictions was the conflict between recreational use and waterfowl protection at Ruby Lake National Wildlife Refuge. The restrictions used included prohibiting motorboat use in nesting areas and limiting the horsepower of motorboats (10, 36).

Restrictions are often placed on hunters such as limiting the number of shells a hunter may carry to reduce "sky busting", as well as other shooting with low probabilities for a clean kill, and requiring the use of nontoxic shot (7, 50).

Law Enforcement

Law enforcement is the most direct method of control and should be used in conjunction with other methods or when other methods fail to control the problem. Examples of situations where enforcement personnel may be necessary include those where stringent control of area access is required (2, 32), preventing off-road vehicles from driving through nesting bird colonies (25), enforcing regulations against photography where it may disturb nesting birds (23), and minimizing intentional killing of nongame animals (50).

An instance where law enforcement was used with limited success was in Back Bay National Wildlife Refuge to protect sea turtles and sanderlings from human harassment. Initial efforts of enforcement personnel were not successful because the regulations themselves were not sufficient to prevent the impacting beach-use activities. When stricter regulations were imposed, law enforcement met with increased success (22).

SECTION VI. GUIDE TO INFORMATION SOURCES FOR MITIGATING VISITOR-RELATED IMPACTS ON REFUGE WILDLIFE

Table 11 (see page 45) has been constructed as a guide to provide managers with information sources pertaining to mitigation of specific visitor activity impacts on refuge wildlife species. In this guide, visitor activities and their possible impacts are used to identify potential problems relating to interactions between visitors and wildlife. For each activity and impact identified, up to 3 sources of information (as referenced in column 2 of the table) are included to permit refuge managers to obtain advice on the mitigation of visitor activity impacts. Information sources referred to in Table 11 are:

- R - Lists the refuges that reported wildlife impact situations occurring due to refuge visitor activities. Many solutions to problems may be generated through consultation among refuge managers. The numbers 1 through 16 refer to refuges listed in Table 11-1.
- M - Lists the methods for mitigating visitor activity impacts offered by managers that have experienced similar problems. These methods are not offered as comprehensive answers, but rather as opinions or suggestions. The letter prefix of E, Z, R, L, and RE designates a specific mitigation category as defined in Table 11-2.
- L - Lists literature that has been reviewed and chosen based on applicability to the activities and impacts identified. References are coded by number and appear in Table 11-3. References selected for use in Table 11 specifically address the activity and impact identified and offer potential mitigation measures.

How to Use the Guide

Use of the guide can best be illustrated with the following example. A manager has determined that his/her refuge is not satisfactorily fulfilling its potential as a breeding sanctuary for ospreys. Upon analyzing the interactions at the refuge between visitor activities and ospreys, the manager suspects that the activity of "wildlife observation on foot" may be an important contributor to "lowered productivity" of ospreys using the refuge.

Using the guide in Table 11, the manager may observe that refuges 2, 4, and 16 have reported similar problems. Referring to Table 11-1, these numbers correspond to Bombay Hook, Edwin B. Forsythe and Wertheim National Wildlife Refuges. It is important to note that the situations reported by these other refuges may be quite different than those involving this osprey case. Nevertheless, the situations do have activity and impact in common and consultation with the other managers may lead to viable solutions.

Table 11 also provides the manager with reference to 2 methods, Z-2 and E-3, as suggestions by other refuge managers for mitigating situations involving "wildlife observation on foot" and "lowered productivity". Referring to Table 11-2, Z-2 is a potential method involving the closure of areas during critical seasons. Reference E-3 pertains to a mitigation technique involving the use of interpretive displays.

Table 11 also references 9 individual literature sources that specifically address impact situations involving "wildlife observation on foot" and "lowered productivity" and that suggest a mitigation technique. The literature reference numbers listed in Table 11 refer to the full citations in Table 11-2.

Additional literature cited in Table 11-3 do not appear in the Table 11 guide. These additional citations are included because they contain pertinent

information on an activity, impact, or mitigation technique, but not all 3. These publications have been cited in the discussion on mitigation techniques in Section V.

Some cells within the matrix of the Table 11 guide lack entries. For example, 2 refuges (11 and 14) reported impact situations involving the activity of "exploring on foot" and the impact of "direct mortality", but no methods for mitigation were offered by managers nor did our literature search identify any references that pertained to that situation. In such instances, we suggest that managers use the guide to investigate other information that may be referenced for activities and/or impacts that are similar to those of primary concern.

Table 11. A guide for Region 5 Refuge Managers for mitigating visitor-activity impacts on wildlife.

Activities	*	Impacts						Aberrant Behavior/ Stress
		Direct Mortality	Indirect Mortality	Lowered Productivity	Reduced Use of Refuge	Reduced Use of Preferred Habitat on Refuge		
Exploring on foot	R	11,14	9	1,2,4,7,9,11,15,16	1,4,13,15	3,4,6,15	1,11,12,15,16	
	M			E-2,E-3,Z-1,Z-2,Z-3	E-3,Z-3	E-3	E-1,E-3,Z-1,Z-2,Z-3	
	L		9,16	13,16,29,30,38,43	E-3,Z-3	16	13,15,29,35,38,42,45	
Off-road driving (beaches)	R	3,4,12	1,3	1,4	1,4	3,4	12	
	M	E-1,Z-1,Z-3	E-3	E-1,E-3,Z-1,Z-2,Z-3,R-4	E-3,Z-1		E-1,Z-1,Z-3	
	L	16,47	16,17	14,16,17,22,41,47	41	16,17,22,41	14,16,33,47	
Harassing wildlife	R			12,15				
	M			Z-1			Z-1	
	L		34	22,24,34,38	16	22,24	34,38,42	
Boating	R		16	6,10,14	16	5	16	
	M		Z-2,Z-5,R-3	E-2		E-5	Z-2	
	L		10,17,20	10,13,17,36,38		5,17	13,36,38,48	
Wildlife observation on foot	R			2,4,16		4	16	
	M			E-2,E-3			Z-2,E-3	
	L		2,4,39	2,23,24,26,28,32,39,44,49		24	39,44	
Hunting	R	2,9,14,15						
	M	E-3,E-4,E-6,L-2						
	L	7,13,30	50			8		
Collecting eggs	R			7,10				
	M			Z-4,L-1				
	L	16		24				
On-road driving (refuge roads)	R	7		9				
	M	Z-1,L-3						
	L	25,45	4	28			33,45	
Feeding and petting wildlife	R		12				12	
	M		E-1,R-2				E-1,R-2	
	L							
Hiking/bicycling/ Jogging	R			1	1			
	M			E-3,Z-2	E-3		E-1,E-3,Z-2,Z-3	
	L	25		18			18,35	
Littering	R			11				
	M			RE-1				
	L			24		24		
Sunbathing/swimming	R			16				
	M			Z-2				
	L				1	24		

*R = Refuges reporting activity-related impact (see Table 11-1).
M = Methods recommended by refuge managers (see Table 11-2).
L = Reference literature (see Table 11-3).

Table 11-1. Addresses and telephone numbers of Region 5 National Wildlife Refuges.

**Refuges reporting visitor-activity impacts on refuge wildlife:

- | | |
|--|--|
| 1. Back Bay Nat. Wildl. Ref.
287 Pembroke Office Park
Pembroke #2, Suite 218
Virginia Beach, VA 23462
ph. (804) 490-0505 | 9. Mason Neck Nat. Wildl. Ref.
Jefferson Davis Highway
Suite 20A
Woodbridge, VA 22191
ph. (703) 690-1297 |
| 2. Bombay Hook Nat. Wildl. Ref.
Route 1, Box 147
Smyrna, DE 19977
ph. (302) 653-9345 | 10. Mississquoi Nat. Wildl. Ref.
Rt. 2
Swanton, VT 05488
ph. (802) 868-4781 |
| 3. Chincoteague Nat. Wildl. Ref.
Box 62
Chincoteague, VA 23336
ph. (804) 336-6122 | 11. Ningret Nat. Wildl. Ref.
Box 307
Charlestown, RI 02813
ph. (401) 364-3106 |
| 4. Edwin B. Forsythe Nat. Wildl. Ref.
Great Creek Road, Box 72
Oceanville, NJ 08231
ph. (609) 625-1665 | 12. Parker River Nat. Wildl. Ref.
Northern Blvd., Plum Island
Newburyport, MA 01950
ph. (617) 465-5753 |
| 5. Great Dismal Swamp Nat. Wildl. Ref.
3216 Desert Rd., P.O. Box 349
Suffolk, VA 23434
ph. (804) 986-3705 | 13. Presquile Nat. Wildl. Ref.
Box 620
Hopewell, VA 23860
ph. (804) 458-7541 |
| 6. Great Meadows Nat. Wildl. Ref.
Weir Hill Road
Sudbury, MA 01776
ph. (617) 443-4661 | 14. Prime Hook Nat. Wildl. Ref.
Route 1, Box 195
Milton, DE 19968
ph. (302) 684-8419 |
| 7. Great Swamp Nat. Wildl. Ref.
Pleasant Plains Rd., RD 1, Box 152
Basking Ridge, NJ 07920
ph. (201) 647-1222 | 15. Rachel Carson Nat. Wildl. Ref.
Rte. 2, Box 98
Wells, ME 04090
ph. (207) 646-9226 |
| 8. Iroquois Nat. Wildl. Ref.
P.O. Box 517, Casey Rd.
Alabama, NY 14003
ph. (716) 948-9154 | 16. Wertheim Nat. Wildl. Ref.
P.O. Box 21
Shirley, NY 11967
ph. (516) 286-0485 |

Table 11-1. Continued.

** Other refuges in Region 5:

Blackwater Nat. Wildl. Ref.
Rt. 1, Box 121
Cambridge, MD 21613
ph. (301) 228-2677

Montezuma Nat. Wildl. Ref.
3395 Route 5/20 East
Seneca Falls, NY 13148
ph. (315) 568-5987

Eastern Neck Nat. Wildl. Ref.
Rt. 2, Box 225
Rock Hall, MD 21661
ph. (301) 639-7056

Moosehorn Nat. Wildl. Ref.
Box X
Calais, ME 04619
ph. (207) 454-3521

Erie Nat. Wildl. Ref.
RD 1, Wood Duck Ln.
Guy Mills, PA 16327
ph. (814) 789-3585

Tinicum Nat. Environmental Ctr.
Suite 104, Scott Plaza 2
Philadelphia, PA 19113
ph. (215) 521-0662

Table 11-2. Methods suggested by Region 5 refuge managers for mitigating visitor-activity impacts on wildlife.

VISITOR EDUCATION

- E-1. Educate about the human impact (no specific method given) and general environmental education programs about wildlife.
- E-2. Informational brochures, leaflets, and news releases which build public awareness of impact.
- E-3. Interpretive displays. Examples include: Black duck identification panels in parking lots and panels that cite the need to reduce public disturbances.
- E-4. Hunter education (of special concern in black duck identification).
- E-5. Place weatherproof cards on nest boxes to explain their purpose.
- E-6. Require hunters to take a waterfowl identification exam.

ZONING

- Z-1. Close critical areas year round.
- Z-2. Close areas during critical seasons. Examples include: close nesting areas during nesting season, close areas during breeding season, close river to boaters in the winter (critical time for waterfowl).
- Z-3. Use zoning techniques such as effective signing and snow fencing to demarcate closed areas.
- Z-4. Locate nest boxes in areas not easily accessible to the public.
- Z-5. Cooperate with state government to get regulations implemented in area surrounding the refuge similar to those that currently exist within the refuge.

RESTRICTIONS ON ACTIVITIES

- R-1. Restrict sunbathing and swimming to 1 area.
- R-2. Restrict against feeding wildlife.
- R-3. Permit only nonmotorized or electric-powered watercraft.
- R-4. Prohibit driving between midnight and 5 AM.

Table 11-2. Continued.

LAW ENFORCEMENT

- L-1. More frequent patrols, especially during critical periods such as nesting seasons.
- L-2. Loss of hunting license for 1 year for hunters apprehended in an illegal activity.
- L-3. Enforce auto speed limits and/or lower speed limit in critical areas.

ADDITIONAL RESEARCH

- RE-1. Implement studies to determine impacts of avian/mammalian predation due to human disturbance (littering).
-

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4. Bart, J. 1977. Impact of human visitations on avian nesting success. *Living Bird* 16:186-192. (WILDLIFE OBSERVATION, DRIVING ON ROAD, LP, E, R, BIRDS)
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6. Bell, J.N. 1963. Wild animals are wild. *Natl. Wildl.* 1(5):34-36. (E)
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Legend to Keywords:

Impacts: DM - direct mortality
IM - indirect mortality
LP - lowered productivity
RR - reduced use of refuge
RH - reduced use of preferred habitat
AB - aberrant behavior/stress

Methods of Control:

E - visitor education
Z - zoning
R - restriction of activities
L - law enforcement

Species Groups:

shorebirds
waterfowl
birds of prey
deer
sea turtles

SECTION VII: CONCLUSIONS AND RECOMMENDATIONS

Current USFWS refuge-use policy statements regarding visitor use at the regional and refuge levels clearly state that such use must be compatible with the wildlife-use interests of Region 5 Refuges. Criteria for determining this compatibility, however, have not been established. This suggests that compatibility criteria guidelines should be developed at the regional level and that individual refuges be encouraged to develop specific policy statements appropriate to their particular needs while incorporating the structure offered at the regional level. Without such policy, managers will continue to be in a difficult position when making decisions to ameliorate public-use and wildlife-use conflicts. In addition, refuge policy should be formulated such that decision analysis procedures can be applied when management options are being considered to reflect changing refuge use conditions; this approach will lead to documentable and more defensible decisions regarding management.

Because of the complex nature of the situations of public-use impacts on wildlife at NWRs, it is important that a comprehensive and systematic framework be adopted to assess these situations accurately. The impact categorization framework employed in this study presents 1 such possibility. In use, it was well received by refuge managers, was effective in eliciting the salient factors involved in specific impact situations, and allowed a quantitative assessment of each situation. However, no formal evaluation of the impact categorization methodology was conducted in this study; consequently, we recommend that managers fully evaluate the methodology before it is reapplied.

During this study, the lack of literature dealing with mitigation measures for ameliorating visitor-use impacts on wildlife became apparent. Much of the literature investigated for this study provided only brief and often untested recommendations for mitigation measures. Thus, we suggest that the efficacy of

mitigation measures used by managers be carefully evaluated. Furthermore, numerous refuge managers had experience using many methods discussed herein, making them a valuable information base for assessments of mitigation measure efficacy. Additional pools of experienced professionals such as state and private wildlife management area managers may be valuable sources of information.

Further research is needed to determine elements critical to the successful use of various mitigation approaches. Research should address the process of establishing compatibility criteria, how such criteria influence the choice of mitigation techniques, and the degree to which refuge staff should actively direct public use. The consequences of zoning and restricting activities on public support of the refuge system, increased congestion in delimited refuge areas, and the substitutibility of public-use activities on refuges should be examined, as well.

The "Managers' Guide to Information Sources..." presented in this report was based on a conceptual framework for evaluating ways to mitigate visitor activity impacts on refuge wildlife. The utility of this framework will be determined by the degree to which refuge managers find it appropriate for their impact assessment needs. We recommend that the guide be further reviewed, tested, and evaluated by Region 5 administrative staff and by selected refuge managers over a reasonable time period. Following any necessary modifications of content and format, we suggest that a condensed version of the guide be prepared and distributed to all Region 5 refuge managers.

To facilitate use of the guide by managers, it would be highly desirable to have one or more complete reference libraries of the publications cited in this guide available to managers on a loan basis. To account for new literature pertaining to investigations of public-use impacts on wildlife, a

system should be devised for review and inclusion of new publications into the guide. Furthermore, refuge managers should be resurveyed every 2-3 years in order to update the status of visitor activity problems as well as managers' experiences in finding solutions to those problems; the guide should be revised to reflect new situations and experiences.

Finally, based on an evaluation and refinement of the methodology used in this study and associated guide, a similar approach may be desired for implementation in other USFWS Regions. Many refuges could benefit from such a concerted effort to address potential problems related to visitor activity impacts on refuge wildlife.

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APPENDIX A - Krueger, C.C., D.J. Decker, and T.A. Gavin. 1986. A concept of natural resource management: an application to unicorns. Trans. N.E. Fish and Wildl. Conf. (In press)

A CONCEPT OF NATURAL RESOURCE MANAGEMENT: AN APPLICATION TO UNICORNS

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Abstract: Natural resource management is a dynamic, goal-oriented process that functions within a management environment and is guided by a team that represent many disciplines. The management environment is a combination of cultural, economic, political, and ecological components. The management team includes individuals who represent disciplines such as ecology, sociology, economics, administration, political science, educational communication, law enforcement, and management science. The management process is described in terms of six interactive elements that are set within the management environment. Goals (1) are broad statements of intent about the purpose of management. Objectives (2) provide a measureable definition of the goal that is expected by a specified date. Problem identification (3) determines what prevents achievement of objectives. Actions (4) are implemented to solve the problems that are identified. Evaluation (5) measures the response of the management environment to the actions in terms of the parameters stated in the objectives, and provides redirection to the management process. This latter step is essential if goals and objectives are to be revised, new problems identified, and alternate actions implemented. Evaluation provides the feedback link to cause management to be an adaptive process. These five elements cycle around and interact with an information base (6) that includes published information and the collective experience of the management team.

INTRODUCTION

Management of natural resources is a complex process that involves management professionals and, increasingly, the interested public. Effective decision-making can be hindered by the different concepts of the management process that occur among resource managers, and between managers and the public. In the authors' experience in Great Lakes fishery management (CCK) and management of white-tailed deer (Odocoileus virginianus) on Long Island, New York (DJD and TAG) and in Washington (TAG), resource managers and the public will often interact with each other about management solutions without a common agreement on goals, objectives, or problems. Without agreement on these issues, the result can be ineffective management that does not meet the needs of the public, that may be to the detriment of the resource, and that wastes available funds and human resources.

Resource managers could better guide the management process, especially when the public is directly involved, if they agreed to similar concepts about how management should be approached. Such a conceptual model must be rational and logical in sequence and yet be sufficiently robust to accommodate initial errors in decisions. The model must be self-correcting and adaptive to social and biological changes over time, and thus encourage proactive as opposed to reactive management.

In this paper, we define the environment within which management must function, discuss who the resource manager is, and propose a simplified, idealized conceptual model for resource management. Parts of the model are similar to descriptions of comprehensive and strategic planning for natural resource management (Rieck 1971, Phenicie and Lyons 1973, Matthews 1976:10, Anderson and Hurley 1980:460, Crowe 1983:7) and descriptions of business management (e.g., Kast and Rosenzweig 1970:456, Buchele 1977:275, Odiorne 1979, Christopher 1980:23, Wren and Voich 1984:8). The purpose of this paper is to broaden the concept of resource management by discarding the common notion that management consists solely of techniques such as regulations and stocking.

We gratefully acknowledge the many helpful discussions provided over several years by our colleagues in state natural resource agencies and at Cornell University. In particular, we thank S. P. Gloss, R. J. McNeil, R. T. Oglesby, and B. T. Wilkins for their comments on early drafts of this manuscript.

MANAGEMENT ENVIRONMENT

The management environment can be described as a composite of cultural, economic, political, and ecological components within which resource agencies must function. The cultural component includes the traditions, religions, and philosophies of the general public and resource managers. This component contributes most to the establishment of values by society for natural resources. These values provide the principal motivation for resource management. Management is conducted because the end products of the process are believed to have value to part or all of society.

The economic component includes all the processes of the marketplace that can influence decisions about resource management. The economic component can influence management of the resources related to commercial fisheries and timber production for example, and has become an important consideration in management of recreational resources such as Pacific salmon (Oncorhynchus sp.) in the Great Lakes. The economic impact that results from management contributes to the societal perception of the value of management, and thus helps to define societal values.

The political component may be divided into two aspects: first, the laws of government, and second the personal values of the individuals who enact, enforce, or interpret laws and policies. The first aspect is clearly defined by the legislative statutes that give agencies the responsibility for management. The second aspect is poorly defined because the biases of government officials are dynamic and undocumented. Before a resource manager proposes a new program, the manager should determine if the agency has legislative authority for management, and whether the political "climate" is right for the new proposal.

The ecological component includes the ecosystem where populations of interest live, grow, reproduce, and die. Management programs that intentionally impact a particular species will often perturb indirectly both abiotic and biotic parts of the ecosystem. The ecological component defines the upper boundaries to what management can expect to achieve in terms of resource production rates. This component exerts control over the annual production of management products, such as number of white-tailed deer, board feet of timber, and pounds of bluefin tuna (Thunnus thynnus).

Natural resource managers must consider simultaneously the cultural, economic, political, and ecological components of the management environment because of the interactive nature of these elements. Historically, resource agencies have focused most attention on the ecological component; it is now apparent, however, that the other elements must be given greater attention. In some cases, resource management has been driven principally by components other than the

ecology of the system being managed (e.g. Fraidenburg and Lincoln 1985).

THE RESOURCE MANAGER

Operating within the management environment described is the resource manager, who is trained traditionally in applied biology. These individuals often find themselves forced to function within cultural, economic, and political arenas as opposed to the biological focus of their education. The frequent interaction of the local manager with these other subject areas emphasizes the need for the inclusion of social sciences, communication sciences, and the humanities in the college curricula for natural resources.

Resource management at a regional or district level (e.g. Region Six) or for a large geographical areas (e.g. Catskill Mountains or Lake Ontario) becomes exceedingly complex due to the extensive nature of the resources and the diversity of users. In this situation, it is unlikely that one person could conduct successful management, or that universities could purport to prepare a single person to do so. At this scale, the concept of the "manager" should instead be changed to that of a "management team" that is comprised of several individuals who represent disciplines such as ecology, sociology, economics, administration, political science, educational communication, law enforcement, and management science. This team could also be used by local managers for help in interpretation of components of the management environment in smaller areas.

DESCRIPTION OF A CONCEPTUAL MODEL FOR RESOURCE MANAGEMENT

The model that we propose has six basic elements: goals, objectives, problem identification, actions, evaluation, and an information base (Fig. 1). Goals, objectives, problem identification, management actions, and evaluation are linked to each other sequentially in a cyclic manner that provides feedback to the management process to cause self-correction and adaptation. These five elements are linked to and cycle around an information base that helps guide the process. These six elements are connected and occur within the multidimensional management environment described above.

Below we define the six elements further and illustrate these definitions through an application of the model to unicorn (Unicorn unicornensis) management. We chose unicorn management as an example because of their considerable scientific interest (e.g., Cole 1957) and the lack of managers knowledgeable about this species. We anticipate, as a result, that readers of this paper will be able to

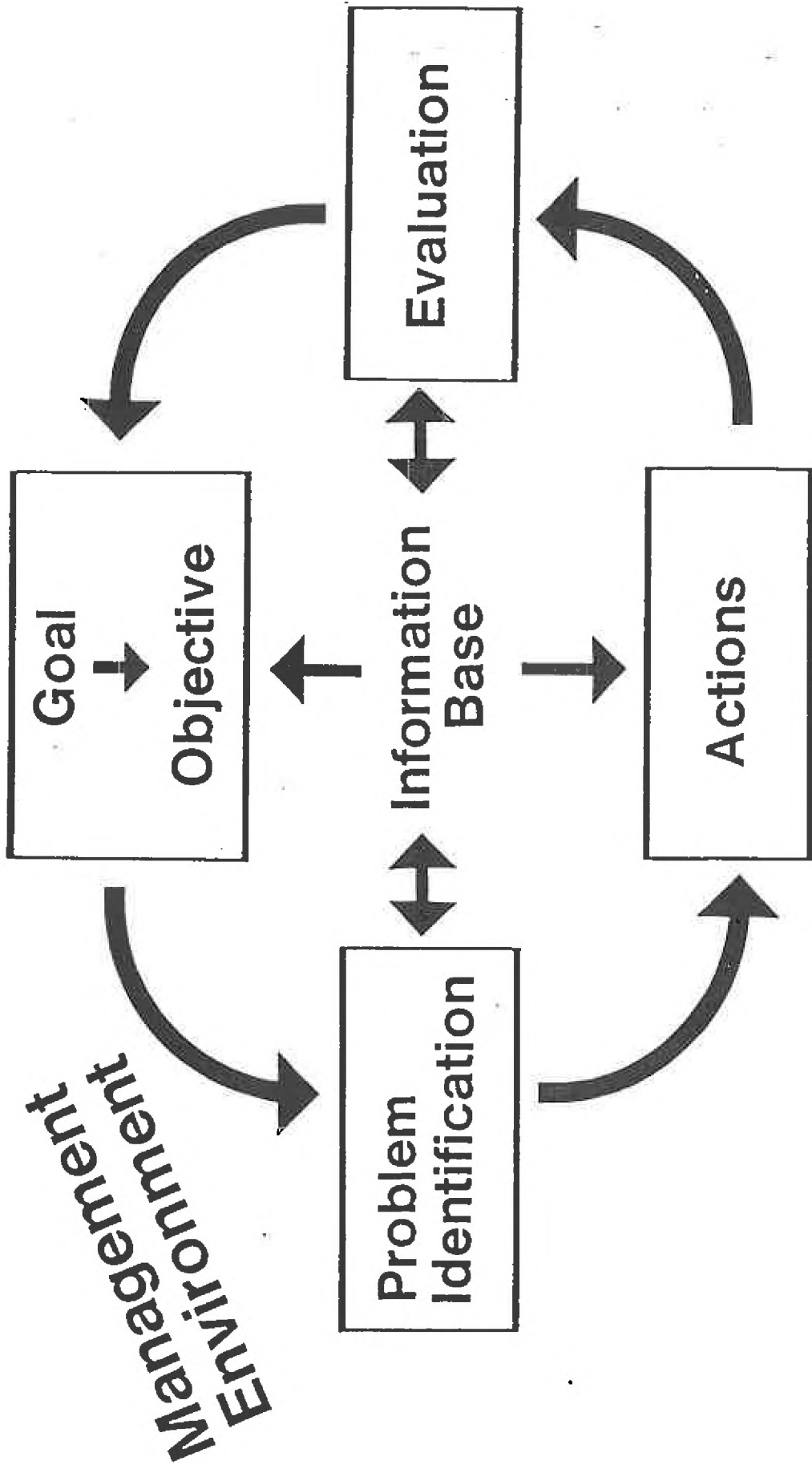


Fig. 1. Resource management displayed as a cyclic process set within an environment that has cultural, economic, political, and ecological components.

concentrate on the concepts of the model's elements rather than on the details of the examples.

Goals

Goal definition is the first and most important step in the management process (Fig. 1). Goal statements describe the purpose of management. Goals are long-term, broad statements of intent about management. Goals explain why we manage natural resources. Goals set the entire frame of reference in which objectives are established, problems are identified, management actions are implemented, and evaluation is conducted to redirect management. The selection of goals is a difficult task. The values of various segments of society must be weighted then balanced against the well-being of the resource and a concern for resource use by future generations. We are not aware of any formal decision process that can easily accommodate these values and concerns, and therefore urge that the goal-selection process be of top priority for study by those interested in natural resource management. Senior level administrators, planner analysts, regional or district managers/biologists, and public representatives are some of the individuals that should be involved in choice of goals. A philosopher or an individual interested in environmental ethics would also be helpful for the analysis of societal values.

Resource agencies often have several goals which are organized hierarchically. For example, state statutes often define a broad goal statement for an agency. Such goals are often termed "mission statements" by the agencies. These statements give authority and direction to an agency but are of limited assistance to the definition of goals lower in the hierarchy. Under these broad statements are program-level goals that may focus on a specific resource (such as unicorns). The model description and examples used in this paper address resource management at this program level only; however, we believe the concepts to be useful at the higher levels of agency management as well.

The unicorn management goal is based on the information that society values unicorns as oddities of the animal kingdom. Although rarely seen, great pleasure is derived by those lucky individuals who can observe a unicorn in its natural habitat (typically adjacent to watering holes). Published studies indicate that unicorns are extremely rare and in danger of extinction. Thus, agencies must manage unicorns due to the societal values reflected in the Endangered Species Act. The information described above (from the information base) provides the basis for establishment of a management goal:

To restore populations of unicorns in the northeastern

United States, to ensure preservation of the species and to provide the opportunity for observation by humans.

This goal clearly states the purpose (restore populations), outcome (preservation of the species), and product of management (opportunity for observation). In addition, the goal provides a spatial definition (northeastern United States) for this new management program.

Objectives

Objective statements explicitly define measurable characteristics of the resource, users, and/or resource utilization that will occur during the process of goal achievement (Fig. 1). Objectives provide the criteria by which we measure our progress towards goals. Objectives are measurable and should contain parameters related to the products of management. Objectives also must contain an explicit time frame that specifies when the objectives will be accomplished. Current measurements of a parameter must exist (from the information base) in order for future levels of a parameter to be specified in an objective. In addition, as parameters are chosen for objectives, this selection must be considered as a commitment by the agency to their future measurement. The levels of parameters specified in objectives need not always increase over the time of the management program but could be chosen to be stable or decrease from current levels. Often multiple objectives will be required to quantify the achievement of a single goal. Choice of objectives requires participation from several types of professionals, such as: program administrators, local managers/biologists, planners and budget analysts, and in some cases individuals external to the agency who can provide specialized sociological, economic, political, and ecological information.

The choice of objectives for unicorn management is governed by the information available about unicorn population ecology and the public demand to observe unicorns. For example, unicorn populations elsewhere in the world are stable and reproductively self-sustaining where they occur at densities of 20 breeding pairs per square mile. However, minimum herd size under such conditions is approximately 80 breeding pairs, which means that a minimum of four contiguous square miles is required to achieve population restoration where ideal habitat occurs (much of the Northeast). A recent preliminary habitat survey suggests that six populations could easily be supported. There now exist three extant but rapidly declining populations of unicorns. Due to the large human population in the Northeast, demand for unicorn observation is estimated to be approximately 44,000 day trips annually.

With this information, the unicorn management objectives were established as follows:

1. To secure permanent protection for unicorn habitat at six sites in the northeastern United States, each with a minimum of four square miles, by 1988.
 - A. Three areas are to be within or adjacent to the habitat used by the extant populations.
 - B. Three areas are to contain suitable habitat where unicorns may be reintroduced.
2. To maintain population densities at an average of 20 breeding pairs per square mile in each of the three extant populations by 1994.
3. To establish three new populations of unicorns in secured habitat areas by 1994 and to maintain these populations at 20 breeding pairs per square mile by the year 2000.
4. To provide facilities for public access at the six habitat sites, which can accommodate an average of 20 visitors per day per site by the year 2000, and with full use expected by the year 2005.

The objectives above provide quantifiable endpoints for management of unicorns. These objectives quantifiably and temporally describe successful progress toward the unicorn management goal.

Problem Identification

The next step in the management process is to determine what problems prevent achievement of the objectives (Fig. 1). This step is essential if the appropriate management actions are to be chosen. Often management personnel and the public skip this step and assume agreement on problems, which is rarely true. If this happens, selection of actions becomes a chaotic process that can result in contradictory actions being implemented. As with the other elements of the management model, the process of problem identification is dependent on the information base. The local manager/biologist who has experience with the resource, and scientists who study the resource are examples of individuals that can help in the transfer of information and with the identification of problems. In some cases, the major problem identified may be a lack of information, and thus studies may be initiated to aid the definition of problems. In other cases, the management team may conclude that the problems related to achievement of objectives are insurmountable, and therefore return to redefine the goals and objectives.

As would be expected, the problems associated with unicorn management are related to land ownership (objective 1), control of mortality (objective 2), stocking techniques (objective 3), and facility development and public information (objective 4). The unicorn management objectives and goal cannot be achieved unless these problems are solved. The specific problems identified are as follows:

1. All available unicorn habitat is currently in private ownership and threatened by urban development.
2. Mortality among adult males is excessive, largely due to illegal harvest by market hunters selling horns for medicinal purposes.
3. Techniques for capturing and transporting unicorns efficiently have not been developed.
4. Architectural designs of public facilities have not been developed to allow observation of unicorns without serious disturbance to populations.
5. The public will be unaware of new opportunities to observe unicorns which will be available in the year 2000.

Actions

The fourth step in the management process is the selection and execution of actions to solve the problems that prevent achievement of the objectives and goals (Fig. 1). Actions or tactics represent what is traditionally thought of as "natural resource management" and have comprised the focus of college courses and texts in resource management. Actions include college regulation, stocking, population control, habitat management, and public education. More broadly, actions may be classified as sociological, economic, political or legislative, and ecological, which follows the components of the management environment. Implementation of tactics requires the allocation of money and human resources from agency budgets. As a result, the control of the implementation of actions is usually linked to agency budget planning and is often termed tactical or operational planning.

The choice of actions should involve the local managers/biologists responsible for implementation. Law enforcement personnel should be included whenever regulations are considered as an action. Simulation modelers can be helpful by developing models to assess the probable responses of the management environment to different sets of actions. Agency personnel responsible for budget planning should also be included since actions cost money.

Implementation of actions most often will include the local managers/biologists, technicians, and other agency personnel. In some cases, volunteer help from the public may also be used.

In the unicorn example, actions must be chosen to solve the problem of the development of privately-owned habitat (problem 1). One tactic to solve this problem is as follows:

1. To purchase habitat in contiguous parcels until four square miles are secure at six locations.
 - A. To inventory areas of suitable habitat.
 - B. To select the most suitable locations for purchase that are consistent with the population rehabilitation and human observation objectives.
 - C. To promulgate legislation to obtain the budget appropriation required to purchase habitat.
 - D. To assess properties, contact landowners, and buy land.

This action includes steps that are ecological (inventory of unicorn habitat), legislative (legislation for budget appropriation), and sociological (contact landowners). The contact of landowners would require that attention be given to education of the public in order that landowners would understand their role in the management program. This educational aspect may require the development of an array of educational materials and use of a variety of media that explain the program.

Evaluation

Evaluation determines the response of the management environment to the actions implemented and compares these measurements to the parameters stated in the objectives (Fig. 1). Evaluation is the last step in the management process and includes four parts: parameter measurement, comparison to objectives, assessment of the comparison, and management revision. First, the parameters stated in the objectives are measured as response variables to the management environment. Next, the comparison process determines whether the objectives have been achieved. Third, assessment follows to determine the probable causes for (or the lack of) achievement of objectives. Fourth, the management program is revised based on the results of assessment. Measurement of parameters may involve statisticians, agency research personnel, private consulting firms, and university scientists. The comparison and assessment parts of evaluation would include the above individuals plus the agency's program administrators. The

individuals who would be involved in management revision would depend on the management step being revised.

The evaluation step allows the management process to cycle to the next appropriate step to revise goals, modify objectives, identify new problems, and select new management actions. Evaluation is essential if management is to be self-correcting to earlier errors and adaptive to a changing management environment. Unfortunately, in many agencies this step has been neglected entirely.

Evaluation of the unicorn management program would be designed around the parameters specified in the objectives. For example, the number of habitat areas, their size, and their location would be determined administratively (objective 1). Ecological studies would be conducted on both the extant and introduced populations (objectives 2 and 3). The existence of public access facilities would be determined administratively, and a study of public use of those facilities would ascertain whether full use had occurred (objective 4). Minimally, these determinations must occur in the years specified by the objectives. Preferably, the measurement of parameters would be ongoing prior to these dates so that interim evaluation would permit quicker program revision, if necessary. Parameter measurement and program assessment contribute directly to the information base (Fig. 1).

The results of parameter measurement about unicorn management would then be compared to the parameter levels specified in the objectives. For example, the size of the habitat areas would be compared to the four square miles specified in objective 1. Assessment would then follow this comparison. If the size of some habitat areas purchased was smaller than specified by the objectives then the reasons for this deficiency should be determined. Were landowners uncooperative in selling land because they did not understand its future use? Were land prices higher than anticipated and the budget allotment was spent quickly? Did the habitat inventories fail to identify six habitat areas of the size specified? Redirection of the management program might include more intensive public education about the benefits of unicorn management, to increase budget allotments for land acquisition, and to revise objective 1 to specify fewer than six habitat areas. If an objective is not met, then the time frames of that objective, and usually other objectives, must be revised to later dates. If habitat is not acquired (objective 1), then it will be difficult to increase extant populations and to establish new populations (objectives 2 and 3).

Information Base

As described above, each management step interacts with the information base (Fig. 1). The information base is used to guide the decision processes within each step. The information base includes published results of sociological, economic, political, and ecological studies as well as the collective experience of the management personnel involved. A conscious effort must be made to use both types of information. Use of this management model will cause the information base to grow, primarily due to the evaluation step. Thus if the management environment does not substantially change, management should improve over time since the probability of correct decisions will increase.

Several types of information were used in the unicorn management program. The goal was set based on the knowledge that society values unicorns. Objectives were set based on ecological information about the reproductive requirements of unicorns in terms of habitat requirements and population densities. Sociological information about the lack of public awareness of the unicorn management program was useful in the problem identification step. Information about the habitat requirements of unicorns was needed to guide the purchase of proper habitat as an action. The results of the evaluation step contributed to the information base.

DISCUSSION

The management process as described cycles within and responds to the management environment (Fig. 1). Cultural, economic, political, and ecological components may change individually or in synchrony and thus require that management programs adapt if they are to remain effective. The effects of natural resource management must be recognized as one source of change in this environment. For example, management that influences resource utilization may alter what users expect to receive from a resource. Thus, values related to user satisfaction may change and affect the future demands placed on a resource and on management agencies. A better understanding of societal values and the forces that change values is required if natural resource management is to serve the public effectively.

The responsibility to ensure that management follows a rational, directed approach rests with the personnel involved in natural resource management. As described earlier, contributions from many types of people are required to conduct effective resource management, from philosophers to ecologists and from agency administrators to technicians. A key to management success is for each individual to understand their role in the management process and how they can contribute cooperatively to the

efforts of the management team. Bureau and regional chiefs or directors should focus most closely on the selection of program goals and the process of management, and not get "bogged down" in the fine details of actions. Local managers/biologists must help set goals and objectives so they can later choose and implement effective actions. University personnel should contribute research results to the information base, help evaluate actions, and provide agencies with unbiased advice. They should conduct research that provides the information anticipated by the agency to be important for future management decisions. If the management team understands the dynamic process of management and works cooperatively, natural resource management will successfully meet the challenges of the future.

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APPENDIX B - Research Introduction Letter sent to Region 5
Refuge Managers

November 11, 1985

Dear Refuge Manager:

This letter has the two-fold purpose of informing you of a research effort being undertaken by the Human Dimensions Research Unit, Department of Natural Resources, Cornell University and to ask for your assistance with the project. The project is sponsored by the Office of Information Transfer, Research and Development, U.S. Fish and Wildlife Service and is being conducted under the auspices of the N.Y. Cooperative Fish and Wildlife Research Unit.

The purpose of the study is to identify specific interactions and subsequent impacts that human visitation and use has upon the wildlife or wildlife habitat of Region 5 National Wildlife Refuges. Then, using these findings to focus our efforts, we will prepare a guide or bibliography which summarizes the interactions and lists reference sources or specific practices that will be of use to the Region's refuge managers in dealing with these problems.

We are requesting the assistance of all Region 5 National Wildlife Refuge managers to provide the initial input essential for this undertaking. This informational letter is the first of three contacts we would like to have with you. The second contact will be a phone call, scheduled before 27 November 1985, through which we wish to have you identify, describe, and rank visitor/wildlife problems you may have on your refuge. The third contact, scheduled before 1 February 1986, will be the mailing of the list of concerns generated through the phone calls. We would like to have you review that preliminary list and make suggestions for additions or deletions. At that time we would also like to document any suggestions you have on how to alleviate some of the problems identified. The final report will be published in a format to facilitate your use in refuge management.

Please look over the enclosed survey form and prepare your responses for the forthcoming phone interview. Either myself or Laura Mattei will be in touch sometime between 15 and 27 November. The interview should take about 15 minutes, depending on the number of interactions identified. If you would like to have us call you on a specific day or at a specific time please leave a message with our secretary, Judy (607-256-2114).

Thank you very much for your time and assistance!

Sincerely,

Gary R. Goff
Extension Associate

GRG:ecb
Enclosure

APPENDIX C - Instrument Used in Preliminary Telephone
Interviews with Refuge Managers

INTERVIEW FORMAT

Please familiarize yourself with this questionnaire and jot down a few notes before we call you, sometime between 15 and 27 November. Questions 2 through 5 should be answered separately for each species named in Question 1. If you have any questions please give us a call at 607/256-2114.

QUESTION 1

- a) Please name a wildlife species which frequents your refuge and is negatively impacted in some manner by human visitation or use of the refuge.

_____ (Can include waterfowl, song birds, wading birds, small game, big game, amphibians, reptiles -- any species you deem of special importance and is significantly influenced by human visitation.)

- b) Why is this species of special importance?

QUESTION 2

- a) What is the nature of the interactions between visitors and the species or its habitat?

There could be several interactions for each species. For example, visitors could be disturbing nesting shore birds (negatively impacting the wildlife) and also trampling turf grass (negatively impacting habitat).

- b) Also identify the season or time frame of the interaction.

QUESTION 3

What impact(s) or effect(s) does the specific interaction(s) listed above have on the species or its habitat?

For example, the interaction of "trampling turf grass" may have reduced nesting habitat by 50% and resulted in higher predation rate on eggs and nestlings.

QUESTION 4

Please categorize the specific visitor public(s) responsible for the interaction(s). For example; joggers, boaters, hunters, fishermen, youth groups.

QUESTION 5

Once the above listing is complete, please rank the top 3 problems by the answer to Question 2, "Nature of Interaction" and give associated wildlife species. For example trampling nesting habitat of least tern might be ranked No. 1, followed by feeding bread to mallards as No. 2 concern.

Thank you for your help!

