Wildlife Habitat Management on the Northern Prairie Landscape

Douglas H. Johnson[a], Susan D. Haseltine[b] and Lewis M. Cowardin[a]

[a] *US Fish and Wildlife Service, Northern Prairie Wildlife Research Center, Jamestown, ND 58401, USA*
[b] *US Fish and Wildlife Service, Refuges and Wildlife, Fort Snelling, MN 55111, USA*

Abstract: The northern prairie landscape has changed dramatically within the past century as a result of settlement by Europeans. Natural ecosystems have been disrupted and wildlife populations greatly altered. Natural resource agencies control only limited areas within the landscape, which they cannot manage independently of privately owned lands. Wildlife managers need first to set quantifiable objectives, based on the survival, reproduction, and distribution of wildlife. Second, they need to build public support and partnerships for meeting those objectives. Finally, they need to evaluate progress not only with respect to attitudes of the public and partners but, more importantly, of the wildlife response. This paper describes some useful tools for managing information at all phases of this process. We follow by discussing management options at a landscape level. Examples are given that involve agency lands as well as private lands, managed for biological resources and diversity as well as economic sustainability.

This resource is based on the following source (Northern Prairie Publication 0893):

Johnson, Douglas H., Susan D. Haseltine, and Lewis M. Cowardin. 1994. Wildlife habitat management on the northern prairie landscape. Landscape and Urban Planning 28:5-21.

Introduction

Before settlement by Europeans, the northern Great Plains of North America was a vast prairie grassland ecosystem, dominated by grazing bison (*Bison bison*) and fires set by nature or by native Americans. Settlement drastically changed the landscape; now the bison have virtually gone and the prairie has largely been converted to cropland. Ninety-six percent of the land is privately owned and managed for current income. The US Fish and Wildlife Service and other natural resource agencies own tracts of land, often small ones, that they manage to meet agency objectives. The current landscape is a mosaic of these public and private lands. Agencies cannot manage their holdings as islands unto themselves; wildlife rarely meet their life requisites within those boundaries, but move freely between public and private lands to meet their needs.

The purpose of this paper is to describe briefly the Prairie Pothole Region ecosystem and indicate how it has been altered, especially as a habitat for migratory birds. We then discuss objective setting for management, mention a few tools available at the landscape level, and discuss some examples of successful use of these tools in management efforts.

The Prairie Pothole Region

We focus on the Prairie Pothole Region of the United States (Fig. 1), although the majority of the region lies within Canada (Adams, 1988). The region is, or was, characterized by native grasslands and an abundance of wetlands situated in small depressions of glacial origin. Bounds of the region have not been precisely defined, but most authors have used or modified the bounds established by Mann (1974) as illustrated in Van der Valk (1989). Kantrud et al. (1989) presented more precise bounds for the region in North and South Dakota, based on geologic landform and density of wetland basins.

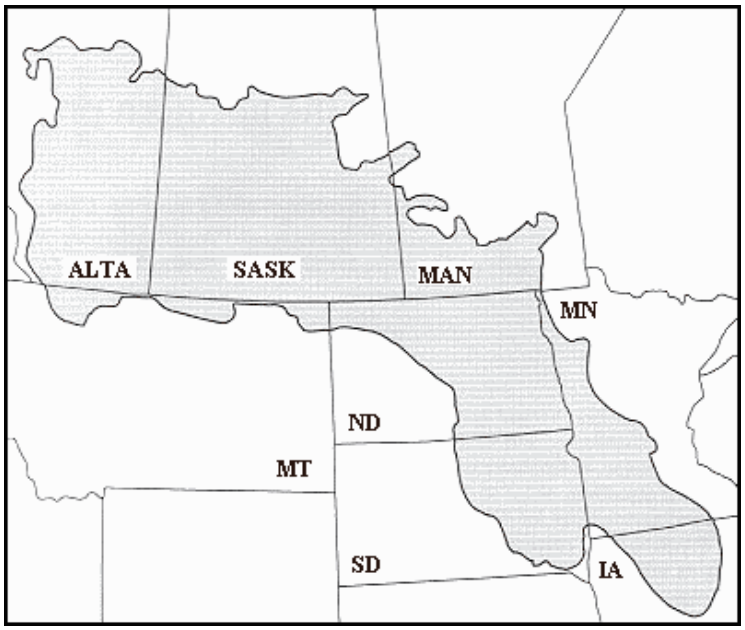

Fig. 1. The Prairie Pothole Region of North America (after Mann, 1974).

Understanding two characteristics of the region, spatial heterogeneity and temporal instability, is essential to sound habitat management. Actions that do not address the questions of where and when, as well as what and why, may yield disappointing results. Glaciation resulted in a collage of landscape features. At a distance, the most obvious features are glacial lake beds, till plains, and moraines (Stewart, 1975; Kantrud et al., 1989). Viewed from close up, even these features are highly heterogeneous. For example, the Missouri Coteau, a large morainal belt, contains various types of moraines, glacial outwash plains, and small lake beds, each possessing different topography, soil types, and vegetation. Temporally, the climate of the Prairie Pothole Region is characterized by instability and extremes. Droughts recur frequently and cause cyclic changes in the flora and fauna of the region. Also, there is a gradient in annual precipitation from wet in the east to dry in the west (Winter, 1989, pp. 24-28). Associated with this variation is a gradient in plant communities from bluestem prairie in the east, through the mixed prairie of wheatgrass, bluestem, and needlegrass, to wheatgrass and needlegrass in the west (Küchler, 1964).

Plant communities of the region, especially those in wetlands, have always been unstable. Cyclic weather patterns, grazing by huge herds of bison and other ungulates, and fires were integral to the landscape. Settlement of the region by Europeans resulted in massive changes to the prairie landscape. Tillage of natural grasslands not only caused the loss of much of the original prairie but fragmented the remaining grassland into small blocks surrounded by cropland. Free-ranging bison were nearly extirpated from the region and replaced by cattle. Eurasian plant species were introduced on purpose or by accident, and subsequently invaded the native grassland communities. Wildfires, essential to

maintaining native plant communities, were suppressed, which allowed invasion of the region by woody species. Droughts in the 1930s brought extreme soil erosion to the denuded lands. In response to the erosion problem, windbreaks were planted. Woody species introduced in these windbreaks, as well as around farmsteads, small towns, and cities, further changed and fragmented the landscape of the region.

Wetland ecosystems also were substantially altered. Many of the potholes were drained to create new lands for agriculture and to increase the efficiency of tillage operations. In Iowa and southern Minnesota, nearly all of the original wetlands were eliminated (Mann, 1974). From the 1780s to the 1980s, about 42%, 50%, 35%, and 26% of wetlands were lost in the states of Minnesota, North Dakota, South Dakota, and Montana, respectively (Dahl, 1992). Further, dams were constructed on most of the major river systems, inundating the natural riverine and riparian habitats.

Along with these habitat alterations came profound changes in the community of predators; this story has been nicely summarized by Sargeant et al. (1993). Before settlement, the top predators throughout most of the region were gray wolves (*Canis lupus*) and occasional grizzly bears (*Ursus arctos*). Populations of coyotes (*Canis latrans*) and red foxes (*Vulpes vulpes*) were low, while those of swift foxes (*Vulpes velox*) were high. The primary prey for wolves and bears were bison and other large ungulates.

Early settlers were intolerant of wolves and, by the early 1900s, virtually eliminated them from much of the region. In the absence of wolves, coyotes greatly increased in number. The favored natural prey of coyotes includes deer and smaller mammals. Coyotes also became targets of human dislike and were aggressively persecuted by hunting, trapping, and poisoning. When they were reduced, especially in the eastern part of the area, the numbers of red foxes began to explode. Among the preferred prey of foxes are ducks, especially nesting females, and their eggs. Predation by red foxes on ducks and other large ground-nesting birds is often severe; Sargeant and Raveling (1992) estimated that foxes take about 800,000 adult ducks in the Prairie Pothole Region during a typical breeding season.

Currently, restrictions on the use of poisons and aerial hunting—along with low fur prices, which reduces trapping pressure—are causing the numbers of coyotes to increase again, especially in the US portion of the region. This change is depressing densities of red foxes (A.B. Sargeant, US Fish and Wildlife Service, personal communication, 1992). Like so many other features of the prairie landscape, predator communities are dynamic and change in response to natural and, especially, human actions.

Because the Prairie Pothole Region can produce as much as 50% of the continental waterfowl population (Smith et al., 1964; Crissey, 1969) and host even more during migration, programs were designed to protect these birds and their habitats. Accordingly, wildlife refuges were established throughout the Region. Habitats protected by these refuges, however, are not typical of those in the Prairie Pothole Region. Rather, they usually contain one or more large lakes (often created by river impoundments), surrounded by various amounts of upland habitat.

Precipitous declines in waterfowl populations and continued loss of wetland habitat prompted the US Fish and Wildlife Service to initiate its Small Wetlands Acquisition Program in 1962 (Sidle, 1983). Under that program, the Service purchased wetlands and, more extensively, acquired easements that prevented landowners from draining, filling, or burning wetlands within easement tracts. Most tracts owned in fee title are small, often appearing as islands of grassland and wetland in a sea of tilled land.

Although these programs have been effective in preserving some of the wetland base, rarely have they maintained the integrity of the original prairie ecosystem.

Declining commodity prices owing to overproduction and an alarming loss of soil prompted the initiation of a number of programs designed to convert cropland to grass and legume cover over the past four decades. The Soil Bank Program, initiated in the 1950s, converted vast areas from cropland to grassland, but by the late 1960s these lands were returned to cultivation. The Water Bank Program of the 1970s restored grassland to some cropped areas. More recently, the Conservation Reserve Program has been successful in converting cropland to grassland on highly erodible soils.

In summary, natural variability and changing priorities for land management have created a mosaic of habitat types, each of which is in constant flux. It is impossible to return to the landscape that was present in pre-settlement times. Some species have been extirpated, certain habitats eliminated, and wetland hydrology irreversibly altered. The Prairie Pothole Region, although sparsely populated, is one of the most intensively managed landscapes in North America. It will remain so despite talk of the Buffalo Commons. The challenge for wildlife agencies is to manage those parts of the system they control and to influence management on those parts outside their jurisdiction. A landscape perspective facilitates this approach.

Setting Objectives for Wildlife Management

It is tacitly expected that wildlife management should benefit wildlife, but some management practices have unknown consequences. Direct benefits can arise only if the action changes the survival, reproduction, or distribution of animals in a desired way. Such biological benefits can be evaluated in a straightforward, if laborious, manner. More difficult to appraise are indirect benefits to wildlife; these usually involve influencing human actions or attitudes, and they may not pay off for years.

Ideally, we should have complete understanding of a system before we attempt to manage it. That is, we should know with some level of confidence what consequences will ensue from a specific action. We never have perfect knowledge, of course, so managers must act in the face of uncertainty. A reasonable question is: should the first course of action be gathering more information? That issue lies at the heart of many apparent conflicts between managers and researchers. Managers feel the need to act decisively to solve immediate and obvious problems involving wildlife populations. Researchers may believe that additional information could facilitate a better decision later. Without attempting to resolve that conflict here, let us agree that (1) any management action should be optimal according to some criterion in light of the available information, and (2) results of the actions should be monitored and assessed in relation to the objectives. The first guideline requires a statement of the objectives and restricts us to actions that most authorities would agree are warranted. The second stricture simply asks us how well we are doing and ultimately permits fine-tuning of the process.

This procedure requires, then, one or more defined objectives. These should be stated clearly, use easily understood terms, and be quantifiable, so that everyone can tell whether or not they have been met. For example, the North American Waterfowl Management Plan described below calls for restoring waterfowl populations to 1970s levels, or about 62 million breeding birds. This is a clear and quantifiable objective that can be related to a specific landscape area. From this statement of the objective, management options and their consequent effects can be assessed.

Once objectives are defined, procedures to accomplish them can be explored. Several options should be described, evaluated, and compared. Models can often serve a useful function here. As an example, the mallard (*Anas platyrhynchos*) productivity model (Johnson et al., 1987; Cowardin et al., 1988b) has been used to examine how specified combinations of management practices will address an objective on a specified landscape; this tool will be described later. It should be emphasized throughout, however, that direct benefits of management actions will result only by changing the survival, productivity, or (occasionally) the distribution of the animals. Activities that do not change one of these should be viewed cautiously. Outreach objectives that build public support and understanding must be factored into management schemes, but their outputs are hard to quantify.

Management options are often constrained by policies and politics. For example, acquiring habitat by purchase may be the best option for managing ducks in an area. If acquisition is against agency policy or lacking public support, alternatives must be sought. Likewise, if predator removal would cause a major increase in game bird populations, but is unacceptable because of public attitudes, alternatives must be explored. Politics has been called the art of the possible; by this definition, wildlife managers must sometimes become politicians.

Information Tools Available

Once objectives are established, the needed information can be considered. Today's migratory bird manager has an arsenal of information-management tools at his or her disposal not available to the manager of yesteryear. Many of these are products of new technology, but others simply package information in a more useful form. In this section, we examine some of these tools, which allow the quantification of landscape features and their utility to land managers.

GIS data bases

The term geographical information system (GIS) is currently in vogue, but the idea that spatial variation in the landscape is a key to informed management decisions has been around since 1969, when McHarg (1992) first published 'Design with Nature'. McHarg understood the complexity of landscapes and proposed a methodology, GIS, that had the potential to 'put Humpty Dumpty back together again' (American Society for Photogrammetry and Remote Sensing, 1988). The power of GIS has been greatly expanded by advances in remote sensing and computer technology. This tool is valuable for analyses of landscape ecology (e.g. Turner, 1989) and for monitoring natural resources. There have been numerous excellent applications of GIS as a tool in decision making, but many of these examples are from local areas. Unfortunately, there are few examples where the methodology has been used on a scale as large as the Prairie Pothole Region. The problem lies not with any shortcoming of GIS nor with the availability of hardware systems and GIS software. Rather, it results from a lack of appropriate data being available to the user. Data are the most important and most expensive components of a GIS.

The first step in developing a GIS is not acquiring hardware and software, but specifying the purpose for the GIS. Too often, agencies have acquired a GIS facility, only then to ask 'What do we do with it?' The questions to be answered with a GIS determine the type, quantity, and quality of the data required.

Data gathered by satellites such as the Landsats are generally available, but costs may be prohibitive for an area as large as the Prairie Pothole Region. Koeln et al. (1988) demonstrated that satellite data can be used as a planning tool in waterfowl management. Many habitat management questions for the Prairie Pothole Region involve wetlands and associated wildlife. Fortunately, detailed wetland mapping of the region by the US Fish and Wildlife Service's National Wetland Inventory is nearly complete (Wilen, 1990) . These maps are being converted to digital products, but the task is not yet finished. Digital data for political jurisdictions and cultural and hydrological features are available from the Earth Sciences Information Center of the US Geological Survey's National Mapping Program.

For many questions, interpretation may require data from one or more specific time periods. Obtaining data for the entire region may be impractical, but sampling can greatly reduce the need for data, with GIS applied to sample plots. Cowardin et al. (1988a) used GIS techniques applied to sample plots in conjunction with the mallard productivity model described below.

Gap analysis

Gap analysis is a tool developed by the US Fish and Wildlife Service and cooperators (Scott et al., 1993) . It is intended to determine how much biological diversity is in the current system of protected natural areas. Diversity is indicated indirectly by surrogates such as potential distributions of vegetation, vertebrates, and butterflies. Geographical information systems are used extensively to consolidate the information. Gaps are unprotected (privately owned) areas potentially rich in biological diversity. The premise behind gap analysis is that crises in populations, such as endangerment, can be avoided by proactive identification of areas most suitable for preservation. One deficiency of gap analysis is that, by virtue of its extensive nature, the results are too crude for use in local management decisions and do not provide an adequate measure of diversity for grassland habitat. It identifies areas of potential occupancy, rather than actual distributions of species. Also, it does not address the population viability of animals or plants that might be in an area. Its strength is in consolidating information and providing a vivid portrayal of areas bearing further scrutiny.

Habitat suitability index models

Habitat suitability index (HSI) models represent another effort by the US Fish and Wildlife Service to develop a tool for use by field managers. Wildlife managers often need to predict the impacts of human activities on certain animal populations. Typically such predictions are made subjectively. The Service attempted to develop methods for objective and quantitative assessment. This process, involving habitat evaluation procedures, used HSI models for certain 'indicator wildlife species' in affected habitats. The premise was that certain habitat features, which can be measured with relative ease, could be used to estimate the carrying capacity of the habitat for the species of interest (US Fish and Wildlife Service, 1980, 1981). Most HSI models were developed through the use of expert opinion. The few tests that have been conducted have found limited correspondence between predictions of the model and actual numbers of animals, especially for mobile species inhabiting complex habitats (e.g. Johnson et al., 1989 and references therein). Nonetheless, such models do provide objective criteria for assessing environmental impacts.

The mallard model

Simulation models are useful to aid decision-making in habitat management; some incorporate information on both landscape features and population dynamics. An example is the model of mallard productivity developed at the Northern Prairie Wildlife Research Center (Johnson et al., 1987). It is distinctive in that it links population processes to landscape attributes (Cowardin et al., 1988b) . It has aided management decisions in the US Fish and Wildlife Service's Regions 3 and 6 and in planning for the North American Waterfowl Management Plan in both the United States and Canada. A regression component predicts breeding population from the amount and type of wetland habitat available. Inputs to the productivity model include availability, attractiveness, and hatch rates of nests for classes of nesting habitat. These are combined to produce an estimate of the recruitment rate, which then can be applied to the breeding population to estimate the number of young produced. Various applications employed habitat data from a sample of more than 500 4-square-mile areas to predict the production of mallards for the entire Prairie Pothole Region. For site-specific applications, such as Hamden Slough

National Wildlife Refuge, a habitat inventory was completed to furnish the habitat availability data. The model can be manipulated to simulate various treatments and combinations of treatments. The model-based procedure gives managers some indication of the possible outcome of proposed management before actual application.

The use of such a model is not without hazard; results should not be blindly accepted. Models cannot tell you what to do, but they can be helpful in evaluating alternatives. Nor can models, by themselves, set priorities. Even though the predictions derived from the model may not represent exactly what will happen, they force some essential actions in habitat management: (1) assembling the best available data; (2) understanding where data are inadequate and acknowledging the importance of assumptions that must be made; (3) gaining insight into potential outcomes of a number of management scenarios prior to actual application; (4) evaluating the feasibility of objectives; (5) aiding the assignment of resources.

The approaches mentioned—gap analysis, HSI modeling, and the mallard productivity model—represent points along a continuum of biological detail and resolution. At one extreme, gap analysis provides a perspective of the potential habitat. In the middle, HSI and similar models offer an assessment of the actual habitat and potential population. At the other extreme, the mallard model estimates not only the actual population, but also its productivity.

Management by Habitat Acquisition

History

A traditional practice in wildlife management is purchasing habitat for protection and manipulation. The significance of the Prairie Pothole Region was recognized early, as was the necessity of protecting and managing migratory birds and their habitats there. Several refuges were established for migratory bird protection and management, mostly by designation of lands already in the public domain.

The drought of the 1930s heightened interest in additional habitat protection, and passage in 1934 of the Migratory Bird Hunting and Conservation Stamp Act, known as the 'Duck Stamp Act', provided a source of funds for federal acquisition of wetland habitat for migratory birds. Even while one federal agency was purchasing wetlands, however, another, the US Department of Agriculture, was sponsoring large-scale drainage projects. Wetlands had been drained in prime crop production areas of Minnesota and Iowa in the late 1800s and early 1900s. New programs expanded drainage into the more northerly and westerly prairie areas and threatened much of the entire region with subsidized drainage. In the late 1940s and 1950s, state and federal biologists raised serious alarm over the loss of prairie wetlands, and subsidized drainage was reduced. In the late 1980s, drainage was proscribed for farmers enrolled in US Department of Agriculture programs.

As wetlands were being lost, the emphasis on protecting habitat by land purchase increased. In the 1960s the Waterfowl Production Area acquisition program began and continues today, funded by annual duck stamp receipts.

Selection of lands

Lands for fee purchase or easement acquisition under the US Fish and Wildlife Service's Waterfowl Production Area Program are selected by wildlife biologists applying criteria designed to protect the best possible wetland complexes for waterfowl production. Wetland complexes should be between 32 and 400 ha, with 4 upland hectares for every hectare of wetland. There should be a scattering throughout the area of temporary and seasonal wetlands, which attract breeding pairs, and at least one semi-permanent and permanent marsh of significant size, which persists later in the summer and supports broods. Such wetland complexes help meet various life-cycle requirements of breeding waterfowl (Dwyer et al., 1979).

Easements prohibiting drainage, burning, and filling of wetlands are taken by the Service, especially near Waterfowl Production Areas, to extend habitat protection around the acquired complexes.

Ideally, the best wetland complexes in each township would be acquired, but this is not always possible. Funding is obviously a major constraint. Annual duck stamp receipts have limited the program. Another constraint is the availability of land for purchase. Waterfowl production areas are purchased only from willing sellers; condemnation has never been considered. The price paid for land generally is limited to the appraised market value of the property. That is, a marsh with high value for migratory birds is not given any additional consideration for that value unless it is recognized in the market as a whole.

Current status

About 2.3 million ha, or about 9% of the Prairie Pothole Region landscape, had been acquired or protected by federal, state, or private entities in 1988. Nearly half of that total is in the Department of Agriculture's Water Bank Program (130,000 ha) or its Conservation Reserve Program (1.1 million ha).

The North American Waterfowl Management Plan (described below) has a goal of securing 450,000 ha for protection and enhancement by the year 2000. This, added to the 2.3 million ha already protected, will bring the total land protected to 2.75 million ha, or 11% of the Prairie Pothole Region. As of September 1992, the US Fish and Wildlife Service had acquired 228,000 ha in fee title and 547,000 ha in easements under the Waterfowl Production Area Program. In addition, 177,000 ha in the Prairie Pothole Region are protected under the Service's National Wildlife Refuge System. A portion of that area was acquired by other federal agencies, such as the US Bureau of Reclamation, the US Army Corps of Engineers, and the US Department of Agriculture (primarily through the Resettlement Administration).

The public's views

Acquisition by federal and state conservation agencies is not unfettered. Although society generally looks kindly on protecting migratory bird habitat by acquisition, the process is often controversial at state and local levels. One reason for this is lingering resentment over the US Fish and Wildlife Service's role in reduced subsidies for farm drainage over the past 40 years. Also, the perception exists that government ownership of too much land threatens the traditional family farm and rural community. The fear that the federal government will use its power of condemnation to take lands can be a serious impediment to approval for larger projects. Expansion-minded neighbors may worry that federal acquisition will drive up land prices. Perhaps the greatest obstacle to acquisition in the Prairie Pothole Region is the frequent shortfall between payments made by the Service, as authorized by the Congress, in lieu of real estate taxes and what the real estate tax would be if the property were privately owned. Because purchase through the Migratory Bird Conservation Fund requires the Governor's approval of lands to be acquired, the element of foregone real estate taxes jeopardizes acquisition. For example, in Minnesota, which requires review and approval at the county level for both fee purchases and easements, several counties are avoided by the Service because of strong opposition to any acquisition of waterfowl production areas. Also, it is difficult to obtain approval for fee acquisition in North Dakota because of perceived concerns about the amount of land the Service already owns there. Generally, however, in South Dakota, Montana, and Iowa, no problems arise in getting necessary approval for acquisition.

Although easements solve some of the problems of fee acquisition, they are not a panacea. The purpose of a conservation easement is to acquire an enforceable interest in real estate to prevent habitat alteration. As time passes, and memories of the easements dim or the property changes ownership, the chance of violating the easement provisions increases, in part because economic pressures encourage more intensive agricultural use. The Service routinely informs landowners of easement provisions to prevent violations. On occasion, however, enforcement actions against easement violators must be carried out, even to the point of litigation.

Example: Hamden Slough National Wildlife Refuge

The Hamden Slough National Wildlife Refuge, in north-central Minnesota, serves as an example of an integrated approach to planning for acquisition and management of wildlife habitat (US Fish and Wildlife Service, 1988). The Service proposed the area as a national wildlife refuge in 1976. After a long and exhaustive planning process, the concept of a refuge, incorporating 2407 ha owned in fee title, was approved. The proposed method of habitat acquisition was different from other refuges because the refuge would include not only federal land but also private land, some of which would be under various easement arrangements to assure preservation and management toward refuge objectives. Not only was land ownership and land use stated in terms of area, but the sites were located in different parts of the refuge to allow a landscape evaluation of waterfowl production potential. The purpose of the refuge is to produce nearly 10,000 waterfowl annually by restoring and protecting about 3400 ha of prairie pothole habitat (US Fish and Wildlife Service, 1988).

After delineating the boundaries of the proposed refuge, Service staff completed an inventory of current habitat and land use practices within the boundary. They then advanced eight different management scenarios, the first of which maintained the status quo and served as a control (Table 1). Mallard production under the first seven scenarios was predicted by means of the mallard model described above. The most promising scenario included a mixture of land acquisition, leases, conservation agreements, and various waterfowl management techniques, including protection of nesting hens from predation. This was predicted to cause an 8.5-fold increase in mallard production.

Table 1. Predicted increases in mallard production for Hamden Slough National Wildlife Refuge under eight alternatives

Alternative	Increase
Present habitat	1 X
Traditional acquisition and management	2 X
Non-traditional acquisition with conventional farming	2 X
Non-traditional acquisition with conservation farming	3 X
Traditional acquisition with predator exclusion	3 X
Traditional acquisition with predator removal	8 X
Non-traditional acquisition and mix of management options	8.5 X
Non-traditional acquisition and mix of management options—reduced area	5 X

Waterfowl productivity, site characteristics, proximity to other lands, existing land use, economics, and social impacts were analyzed and used to determine the method of protection, type of development, and management approaches under each alternative. Although the model does not incorporate economic or social features, these considerations were used in the final selection process. Concerns of the public were elicited during numerous public meetings. The scenario predicted to produce the most ducks was not selected because of public concern about the amount of land required for purchase. Purchase of land under that scenario was reduced. The resulting plan predicted duck production to be five times higher than that under the present landscape (Table 1).

Based on the planning process, a refuge management plan was prepared and habitat acquisition and management are in progress. Currently, about 1073 ha of the 2400-ha core area have been acquired. Unfortunately, public sentiment concerning wetland and flowage easements on the 1000 ha surrounding the refuge has not been positive, which has hampered restoration and easements on those lands. As more habitat restoration takes place on the refuge, attitudes may change. A citizen advisory committee was established in 1991 to encourage dialogue and public participation. Local concerns about the effects of the refuge on agricultural lands and loss of tax revenue will diminish only through communication by land managers.

Management of Private Lands

With over 95% of the land in the Midwest privately owned and administered, management practices that are compatible and supportive of wildlife populations take on enormous importance. Today's political, economic, and social environment limits the opportunity for purchasing large blocks of habitat that will provide complete life-cycle requirements of migratory or even resident species. Consequently, the US Fish and Wildlife Service recognizes the importance of private lands in wildlife management and is developing techniques and programs designed to assist and support private landowners who desire to improve habitats. As an example, it is sometimes possible to provide for some of a species' life-cycle requirements on lands that are used for agricultural production at other times of the year. A notable illustration is flooding of harvested rice fields in the lower Mississippi River valley, which provides excellent habitat for wintering water birds.

Available tools

The primary tools for management on private lands are easements, restorations, technical assistance, and management agreements. Depending upon location, several public agencies and a few private conservation organizations are willing to acquire conservation easements from private landowners for restoration and protection of fish and wildlife habitats. Most of these easements are perpetual and payments are commensurate with rights acquired from the landowner. Examples include easements under the Reinvest in Minnesota program, administered by the Minnesota Board of Water and Soil Resources, and Waterfowl Production Area easements, administered by the US Fish and Wildlife Service. More recently, the US Department of Agriculture, in cooperation with several other agencies and organizations, has initiated the Wetland Reserve Program. This program is designed to use conservation easements to restore and protect up to 400,000 ha of wetlands and associated uplands by 1995.

Restoration of complex ecological communities, such as native prairie, is challenging and rarely achieved. Natural resource agencies have neither the funds nor the techniques to restore the hundreds of species of grasses and forbs that originally occurred in these areas. Typically, native prairie restoration by resource agencies consists of establishing native grasses but few, if any, of the predominant forbs. With this in mind, one of our highest priorities as natural resource managers should be maintaining and enhancing remnant natural communities that exist on private and public land.

Short-term benefits on private lands are sometimes achieved through management agreements with public agencies, which provide technical assistance to landowners. Management agreements allow access to private lands. Most agreements specify the activities to be undertaken by the conservation agency and the responsibilities of the cooperating landowners. Management agreements are particularly useful with landowners who are reluctant to enter into perpetual agreements with conservation agencies or for agencies not able to offer long-term or perpetual easements. As a general rule, the most cost-effective management agreements are those that are of long duration that do not incur excessive restoration or management costs.

Short-term management agreements also can serve a useful role in ensuring protection of many important but ephemeral habitats. For example, bald eagle (*Haliaeetus leucocephalus*) nesting sites may be more appropriately protected on private lands through the use of a 10-year management agreement than through an expensive perpetual conservation easement. The nest tree may blow over or the nesting pair of eagles may abandon the site, rendering a perpetual easement a waste of funds.

Experiences show that some landowners, initially reluctant to enter into long-term or perpetual agreements with public conservation agencies, may agree to them after a short-term agreement expires and they have become comfortable in working with the agency.

Management agreements can also be used to increase or maintain wildlife populations on locally important production, migration, or wintering areas. Through these agreements, public conservation agencies can manage predators to improve waterfowl nesting success on privately owned islands and peninsulas in the Midwest. If necessary for disease control along migration corridors or on wintering grounds, management agreements can be used on private lands to disperse highly concentrated wildlife populations.

The public's views

An effective private lands program can be more acceptable than fee acquisition to landowners and elected officials. Private lands programs do not remove lands from property tax rolls. Nor do they tend to relocate rural families to cities or other areas. Participation in a private lands program is completely voluntary. When long-term or perpetual easements are acquired, landowners are frequently compensated for restoring or protecting habitats. In most cases, lands suitable for a private lands program are not highly productive agricultural lands. Significant support for private lands programs exists among private conservation organizations, many of which are willing to contribute time and funding towards these efforts.

Examples

Two examples illustrate the diversity of private lands efforts. One involves the restoration of 120 ha of wetland in a prairie complex in Kandiyohi County, Minnesota. The US Fish and Wildlife Service is providing $1250 of the $4000 total cost; the remainder is contributed by the Delta Waterfowl Association and three other wildlife groups. A smaller-scale project is the restoration of 0.8 ha of wetland and native prairie on property owned by the Iowa School for the Deaf, in Council Bluffs. This effort will have considerable outreach values and is cosponsored by several conservation groups.

Management by regulation and subsidy

Governmental agencies can use either 'stick' or 'carrot' approaches to manipulate the behavior of citizens; however, the latter approach is more effective. With respect to wildlife habitat, more incentives than penalties have been used. An example of a program with negative reinforcement is the 'Swampbuster' provision of the 1985 Food Security Act. Under that provision, any person who converts a wetland for agricultural production becomes ineligible for most federal farm programs. Swampbuster has been criticized by agricultural interests for interfering with normal farming practices, as well as by conservationists who cite instances of lax enforcement by neighboring farmers who serve on committees for the USDA's Agricultural Stabilization and Conservation Service. The US Fish and Wildlife Service, which also assists with enforcement of Swampbuster, sometimes wears a 'black hat' for this role. Conversely, the Service provides assistance to landowners who wish to restore previously converted wetlands, so they may qualify for federal agricultural programs.

Among the programs providing incentives for improving wildlife habitat and populations is the Wetlands Reserve Program, begun in 1992 on a trial basis by the US Department of Agriculture. That program offers payment to landowners who restore wetlands and permanently remove them from crop

production. Interest in the program far exceeded expectations in 1992. In Minnesota and Iowa, landowners bid 16,600 ha to enter the program, but only 14% of that area could be funded. The future of the program is uncertain at this time, but at the time of writing, the 1994 federal budget includes provisions to continue the program.

An example—the Conservation Reserve Program

Another incentive program with enormous impact on the landscape is the Conservation Reserve Program (CRP). The CRP was established by the 1985 Food Security Act primarily to bring crop production more in line with demand and to conserve and improve soil and water resources of highly erodible cropland. The strategy was to remove certain highly erodible or eroding lands from agricultural production by establishing permanent cover on them, thereby reducing soil erosion, reducing sedimentation of streams, and improving water quality. Another objective was to enhance habitat for fish and wildlife populations. Nationwide, the CRP has a target of restoring permanent cover on up to 18 million ha (Laycock, 1991), with 14.5 million ha enrolled to date. The northern Great Plains are markedly affected; the 4 million ha of land enrolled in Montana, North Dakota, South Dakota, and Minnesota account for more than one-quarter of all land included in the CRP.

Under the CRP, the US Department of Agriculture leases fields containing highly erodible cropland for 10 years; the landowner establishes, if necessary, perennial vegetation and agrees to leave the land idle for the length of the lease. The CRP is expensive; the latest sign-up, involving 446 000 ha, had an average annual rental cost of \$155 ha^{-1}. Although costs are lower in the northern Great Plains (\$81 ha^{-1} in North Dakota, for example), the total federal outlay is enormous.

The CRP has made major changes to the northern Great Plains on a landscape scale. Kidder County in central North Dakota, as one example, has seen more than one-quarter of its cropland returned to perennial vegetation. Such dramatic reversals from the trend toward intensified agriculture have affected a variety of wildlife populations. Resident game bird populations have been booming (Umber, 1992), along with recreation and associated economic benefits. Waterfowl nesting has been enhanced, although the coincidental drought in the area has so far prevented ducks from fully exploiting the newly available habitat. Kantrud (1993) and others recorded higher nest success in CRP fields than in habitats specifically purchased and managed for waterfowl production. Non-game birds, including a number of neotropical migrants, also are breeding in CRP fields in large numbers. Johnson and Schwartz (1993) searched 240 fields totaling 4654 ha in 1990 and 335 fields totaling 6181 ha in 1991. They reported 73 species of birds using those fields, at an overall density of 124 pairs per 100 ha. The two most common species were the lark bunting (*Calamospiza melanocorys*) and grasshopper sparrow (*Ammodramus savannarum*), both of which had declined by more than half during the previous 25 years, as indicated by results of the US Fish and Wildlife Service's Breeding Bird Survey. Other prairie birds that had been declining but were fairly common in CRP include the bobolink (*Dolichonyx oryzivorus*), clay-colored sparrow (*Spizella pallida*), Baird's sparrow (*Ammodramus bairdii*), and dickcissel (*Spiza americana*).

What does the Conservation Reserve Program mean to the wildlife professional? It should be treated as more than a no-cost, temporary habitat-creation plan. Although it may not cost natural resource agencies anything, the American taxpayer is paying a lot. Natural resource professionals bear a responsibility to determine the values, positive and negative, of federal programs such as the CRP. Our findings should be brought to the attention of involved agencies, Congress, concerned interest groups, and the public, so that informed decisions can be made about the current farm program and future

ones. Conservation Reserve Program contracts begin to expire in 1996, so the need for action is immediate.

It seems evident that the CRP will not continue in its present form, if at all. If the program is modified, what are key features to keep in place to provide maximal natural resource values at the lowest cost? Are large blocks of CRP, or fields contiguous with wildlife areas, better than smaller, widely dispersed fields? What are the benefits of CRP fields in proximity to wetlands? Since many types of grassland habitat degrade after long periods of idleness, how should CRP fields be managed? What roles do CRP fields play in the landscape? We need to supply that information.

In addition to passively enjoying the benefits of CRP, wildlife professionals can actively manage to leverage the gains. For example, restoration of wetlands near or in CRP fields provides all the requisites for nesting waterfowl and many other species. Since the CRP is taking out of production much land that never should have been cropped, we can work to maintain perennial cover on some of that land even after the program terminates. In North Dakota, wildlife interests are working with stockmen's groups to establish rotational grazing systems that are profitable to the landowner, but still maintain cover on the land and suitable habitat for wildlife.

Managing Through Partnerships

Critically important these days is the recognition that wildlife agencies cannot go it alone. They need the help of others who share, at least in part, common aspirations and values. Fortunately, there are many who share an interest in a healthy environment and abundant wildlife. These constitute prospective partners, and many of the effective management actions today are the results of partnerships. We cite an example, the North American Waterfowl Management Plan and its joint ventures, which involve federal agencies in three nations, numerous state and provincial agencies, and many non-governmental organizations.

The North American Waterfowl Management Plan

Because they range widely, often through several nations, waterfowl present special problems for habitat management. The North American Waterfowl Management Plan is a strategy to restore breeding populations of waterfowl and to reverse the continuing decline in the amount and quality of waterfowl habitat in North America. It represents an example of a cooperative effort to accomplish mutual objectives. In 1986 the plan was signed by the Minister of Environment for Canada and by the Secretary of the Interior for the United States. Mexico signed later. The plan document (US Fish and Wildlife Service and Canadian Wildlife Service, 1986) has stated goals for ducks, geese, swans, and their habitats in terms of breeding populations and land area. Thirty-four waterfowl habitat areas of major concern were identified. Five of these were priority areas, the largest being the Prairie Pothole Region.

The North American Waterfowl Management Plan is extensive not only in the area to which it applies but also in the resources required to meet its objectives. Obviously a new method of obtaining funding was required to finance and accomplish the work. Joint ventures were adopted as the mechanism for funding and implementing the plan. A joint venture is a group of partners with common interests and objectives who are willing to contribute resources to meet those objectives. To date, joint ventures have been successful in raising funds. New joint ventures have been formed and the area of the plan has been expanded.

Although the NAWMP had specific objectives, partners in several joint ventures have incorporated into their plans additional objectives that were beyond the original plan. This expansion was done in part to increase the number of potential partners, by providing objectives that satisfy those without strong concerns for waterfowl. Broadening objectives may be appropriate, but too many goals could dilute the original effort. It also makes it difficult to assess how well NAWMP is working, if progress toward the original goals is offset by the expansion of new ones.

Example: The Prairie Pothole Joint Venture

The US Prairie Pothole Joint Venture (PPJV) illustrates the technique of using partnerships or joint ventures to meet management objectives. The NAWMP set continental objectives for waterfowl habitat management and outlined broad guidelines. Joint ventures like the PPJV should have objectives that contribute to the continental objectives of the NAWMP. In addition, joint ventures are responsible for implementing the plan. The joint venture plans are more detailed than the continental plan and their implementation documents describe strategies for accomplishing the objectives. The implementation plan was developed by a steering committee that included representatives from US Fish and Wildlife Service's Regions 3 and 6; the states of Iowa, Minnesota, Montana, North Dakota, and South Dakota;

the Wildlife Trust; Ducks Unlimited; the National Wildlife Federation; Nature Conservancy; and the Wildlife Management Institute.

The objective of the PPJV is to maintain in years of average environmental conditions an average breeding population of 6.8 million ducks (including 1.2 million mallards and 1.1 million northern pintails (*Anas acuta*)) and 13.6 million ducks in the fall flight by the year 2000. This objective, like those of the NAWMP, is based on average duck populations during 1970-1979. It is translated into recruitment rates required to attain the objective. Detailed strategies that include habitat management on all classes of land ownership, habitat acquisition in fee and easement, and direct management of duck populations, were designed to meet these objectives. The implementation plan also includes strategies for communication, education, funding, legislation, and regulation.

Formulating plans and strategies does not guarantee that objectives will be met, of course. Like other joint ventures, the PPJV also developed evaluation plans that outline surveys and studies to measure progress towards the objectives and to identify needed modifications to the strategies.

The implementation plan does not address the question of where management activities should be carried out. This problem is being addressed through planning tools developed in US Fish and Wildlife Service's Regions 3 and 6. These tools are intended to assemble relevant data and obtain mapped information on the location and extent of habitat, convert this information to digital form that can be used in a GIS, and employ various models to determine where management should occur (P.M. Arnold and R.E. Reynolds, US Fish and Wildlife Service, personal communication, 1991). Although some work is in progress, it is hampered by lack of data suitable for use in a GIS, as discussed earlier. The PPJV took its lead in using a landscape approach to habitat management from its sister joint venture in Canada, the Prairie Habitat Joint Venture (Nelson and Wishart, 1988). There has been free exchange of ideas and methodology between these two joint ventures. This cooperation is essential because the two joint ventures are in the same ecological region.

In the past, wildlife habitat management has been fragmented. State and federal agencies as well as private organizations have set management objectives for lands under their jurisdiction. Private lands were often not considered in the planning process. The PPJV implementation plan poses five challenges, which demonstrate that joint ventures are intended to create an integrated approach to accomplishing the following objectives.

1. How can a spirit of cooperation and, most importantly, trust be built among partners in the Prairie Pothole Joint Venture?
2. How can traditional waterfowl management philosophy be changed from habitat management strictly on public land to management on both public and private land?
3. Where can funds be obtained for non-traditional approaches of paying landowners to conserve wildlife?
4. How can trust be built between landowners and wildlife agencies?
5. How can public attitudes regarding wildlife management be changed and a balance found with agricultural economics?

Conclusions

Past successes of wildlife management were largely due to the devotion of its professionals; men and women working for 'the resource' made good things happen. Life is more complicated today. A wildlife biologist may spend more time staring at a computer screen than at a wetland. Information comes from satellites as often as from bag checks, and our journals contain more mathematics than maps of study areas. The profession has indeed become more sophisticated. The challenge ahead will be to maintain the enthusiasm that brought so many to our field while making full use of the best tools available. As we perform our mission, we should articulate our objectives in clear and concrete terms. They should be explicit and quantifiable. We should be able to explain and justify them to others who may not share our values. We should know when we have met the objectives. Equally important, they should be real goals, not just objectives we state to appear as though we are organized. If we are concerned about a population of animals, our goals should be defined in terms of those animals. Buying habitat, for example, should be a means to an end, not the end itself. Likewise, placating private landowners is beneficial only if it ultimately improves the situation for wildlife. Throughout this paper, we have tried to provide a sense of the prairie pothole landscape, the cyclical nature of the habitat caused by recurring drought, and the heavy impacts of human settlement induced by plowing, fire suppression, and drainage. We offered a perspective on the techniques applicable for managing habitats for migratory birds on a landscape scale. Depending on management objectives—identifying blocks of unique or diverse habitats, proposing acquisition or work on private lands to protect migratory bird populations, enhancing habitats for critical or declining species, or evaluating impacts of agricultural conservation programs on the landscape—different levels of resolution and knowledge of the landscape and the needs of migratory bird species are mandatory. We have tried to provide an overview of some data and tools available for several management functions at a landscape level. We reiterate that, before projects can succeed, clear and quantifiable objectives must be defined, evaluation strategies developed, and data necessary both to manage and to evaluate results must be described and collected. Whether developing a geographical information system or a predictive model, whether contemplating acquisition, easement, or habitat restoration and enhancement, decisions on the most effective combinations of tools available, and their location on the landscape, can be made only if the impacts of the actions can be linked quantitatively to migratory bird management objectives and considered against available alternatives.

Acknowledgments

We are grateful to R.D. Schultz and W.A. Swanson of the US Fish and Wildlife Service for providing information for this report and to L.D. Igl, R.E. Kirby, J.T. Lokemoen, and L.L. Strong for thoughtful comments.

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