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New Directions in Conservation for the National Wildlife Refuge System

VICKY J. MERETSKY, ROBERT L. FISCHMAN, JAMES R. KARR, DANIEL M. ASHE, J. MICHAEL SCOTT, REED F. NOSS, AND RICHARD L. SCHROEDER

The National Wildlife Refuge System Improvement Act of 1997 includes the nation's broadest statutory commitment to ecosystem protection: to "ensure that the biological integrity, diversity, and environmental health of the system are maintained." The act also directs the US Fish and Wildlife Service (FWS) to expand the scope of conservation monitoring, assessment, and management beyond refuge boundaries to encompass surrounding landscapes. The act thus gives the FWS a leadership role in developing research and management partnerships with other agencies, organizations, and neighboring landowners. Increasing research capacity and scientific expertise, and strengthening institutional resolve to limit activities that impede the attainment of this directive, are challenges for the FWS. Success requires reexamination of existing priorities, refocused training, the acquisition of new funding and technical expertise, and creative application of those new skills to meet the law's broad mandate.

Keywords: biological integrity, diversity, environmental health, National Wildlife Refuge System Improvement Act, refuge management

The US Fish and Wildlife Service (FWS) manages the 38-million-hectare National Wildlife Refuge System, the largest network of public lands reserved for conservation of native species and their ecosystems. The refuge system covers a huge variety of ecosystems in all 50 states and US territories; Alaska dominates the system, with 31 million hectares.

The biological significance of the refuge system derives from the size, scope, and protected status of these lands. The law and policies governing management of the system have changed dramatically over the past decade; the FWS has been challenged to implement a cutting-edge legal mandate to maintain biological integrity, diversity, and environmental health (hereafter we use "integrity" to encompass all three) during an era of declining budgets.

A 1990 legal settlement to review and end incompatible economic and recreational uses on national wildlife refuges—including grazing, farming, and motorized recreation—prompted Congress to enact the National Wildlife Refuge System Improvement Act of 1997 (NWRSIA), the only organic legislation concerning federal lands to be enacted since the 1970s. The act's novel ecological mandate builds on a century of science-based management aimed at making the refuges the nation's premier conservation reserve system.

In April 2004, Indiana University convened a workshop of legal and academic scholars, refuge managers, wildlife advocates, and agency administrators to discuss the meaning of biological integrity, diversity, and environmental health, and the keys to protecting these ecosystem features. Here we examine the goals of the act and outline the need to develop explicit measures of progress toward those goals. Finally, we illustrate the importance of viewing refuges in their landscape context and recommend approaches to resolve the major challenges faced by the FWS.

The National Wildlife Refuge System Improvement Act of 1997

The public land law reform movement of the 1970s bypassed the refuge system as it brought substantial changes to the organic laws governing national forests, national parks, and Bureau of Land Management lands. After a long wait, the NWRSIA amended the vague 1966 National Wildlife Refuge System Administration Act, catapulting the refuge system to the forefront of public land law (boxes 1, 2). The 1997 statute declared, "The mission of the System is to administer a

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Box 1. Sources of law for the National Wildlife Refuge System.

Statutes are legislation that binds the US Fish and Wildlife Service (FWS) and can be changed only by Congress. Most refuge legislation is collected in the *United States Code.* Examples affecting the FWS include organic law (e.g., the 1966 Refuge Administration Act and 1997 National Wildlife Refuge System Improvement Act), establishment legislation (e.g., the Minnesota Valley National Wildlife Refuge Act), and cross-cutting statutes (e.g., the Endangered Species Act).

Judicial decisions bind the FWS within the geographic jurisdiction of the court. Most decisions are published in law reporters such as the *Federal Supplement.*

Executive orders are presidential proclamations that bind the FWS; they are published in a variety of sources, including the *Federal Register.*

Rules involve public participation and publication in the *Federal Register.* A rule is codified in the *Code of Federal Regulations* and binds both the FWS and refuge users. Altering a rule requires another notice and comment procedure.

Refuge policies that are issued according to the procedures used for rules bind the FWS like rules. Refuge policies that involve less formal procedures are less likely either to bind the service or to receive deference in court. Both kinds of policies are codified in the *Fish and Wildlife Service Manual* (*www.fws.gov/policy/manual.html*).

national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

The NWRSIA established a hierarchical management scheme. Foremost in that hierarchy is the conservation mission; all recreational and economic uses are subservient. But Congress also granted a priority to "wildlife-dependent recreation"; required the FWS to prepare periodic unit-level plans laying out a conservation framework for each refuge; and, most important, imposed binding, substantive management criteria.

One of the most emphatic ecosystem conservation directives ever written by Congress is the NWRSIA mandate to "ensure that the biological integrity, diversity, and environmental health of the system are maintained." Not an aberration, this mandate amplifies a trend in environmental legislation toward biological (Karr 1991) and ecosystem perspectives (Keiter 2004), and it builds on the history of defining conservation success in the refuges in scientific terms (Fischman 2004).

Developing refuge goals

The binding policy that interprets the mandate to ensure biological integrity (601 FW 3) covers the breadth of issues associated with biodiversity conservation, specifically directing the system, for example, to assess each refuge's importance across landscape scales; to consider restoration as well as maintenance of integrity; and to consider such concepts as species composition, genetic and social structure of populations, food web organization, and biogeographic and evolutionary processes. The policy chooses historic conditions (those "prior to substantial human related changes to the landscape") as the benchmark condition and thus the goal for the integrity mandate.

Although human-related changes to landscapes certainly occurred before incursions of European cultures, the changes since European settlement clearly have been most harmful and best documented. Refuge system policy allows use of information such as the General Land Office surveys, which describe landscapes with some level of indigenous impact, for guidance in determining historic condition (601 FW 3, Schroeder et al. 2004). Factors such as extinctions and climate change (Millar and Woolfenden 1999) may prevent refuge managers from reaching historic conditions, even when these are defined to include some level of anthropogenic impact. System policy allows the use of "sound professional judgment" during planning, and directs managers to assess not only historic conditions but also "opportunities and limitations to maintaining and restoring" such conditions (601 FW 3). Such language gives managers wide latitude in refining their goals.

Managerial discretion can be used to adopt emerging methods that policy does not explicitly mention. For instance, high-quality reference sites (Hughes 1995) provide guidance for refining refuge goals by demonstrating achievable integrity. The best such sites will experience the same unavoidable constraints as refuge ecosystems and none of the remediable constraints, but data from sites with some impact from remediable constraints can still be helpful.

The NWRSIA instructs the FWS to defer to the purposes for which the refuge was established (so-called establishment purposes—often conservation of migratory waterfowl or migratory birds in general) when these conflict with the integrity mandate. Such conflicts do not regularly arise (box 3), but when they do, the act provides neither specific guidelines for resolving conflict nor a means of reviewing the current relevance of establishment purposes. From a conservation perspective, a more useful sense of priorities would elevate the goal of integrity over establishment purposes when conflicts occur, especially when the latter purposes have outlived their usefulness.

Under the act, refuges develop and implement comprehensive conservation plans (CCPs) on planning cycles of 15 years or less. These plans must include specific, measurable, science-based objectives for maintaining and restoring refuge integrity (602 FW 3). Policies for implementing the act also guide the determination of which recreational and economic (e.g., farming, logging, grazing) activities are compatible with refuge management under the integrity framework (603 FW 2), and these policies strengthen these criteria considerably over past guidelines. The binding compatibility policy specifically identifies habitat fragmentation as materially interfer-

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Box 2. Legal history of the National Wildlife Refuge System.

This outline of the National Wildlife Refuge System's legal history is modified from Fischman (2003), appendix A.

1903: President Theodore Roosevelt's presidential order reserves Florida's Pelican Island as a "preserve and breeding ground for native birds."

1905: Congress begins reserving lands that will become wildlife refuges.

1906: The Game and Bird Preserves Protection Act (Refuge Trespass Act) gives authority to the Bureau of Biological Survey to manage uses on preserves.

1908: Congress establishes the National Bison Range and authorizes the first acquisition for a wildlife refuge.

1918: The Migratory Bird Treaty Act implements treaty obligations to sustain populations of certain birds; refuges are still being created for this purpose.

1924: Congress authorizes and funds the first migratory bird refuge, the Upper Mississippi River Wild Life and Fish Refuge.

1929: The Migratory Bird Conservation Act authorizes the purchase of lands to conserve waterfowl; this is the most commonly used authority for creating new refuges.

1934: The Migratory Bird Hunting ("Duck") Stamp Act creates a fund for acquiring waterfowl refuges from sales of federal stamps that waterfowl hunters must carry.

1940: President Franklin Roosevelt creates the US Fish and Wildlife Service (FWS) by combining the Bureaus of Biological Survey and Fisheries.

1942: The FWS publishes its first *Refuge Manual,* containing national policies and guidelines for managing national wildlife refuges.

1956: The Fish and Wildlife Act "establishes" the FWS, which had already been in existence for 16 years. The act broadens FWS authority to acquire refuges.

1962: The Refuge Recreation Act limits refuge recreation activities to those that are compatible with refuge purposes and for which funding exists for proper management.

1966: The National Wildlife Refuge System Administration Act consolidates all of the FWS conservation lands into the National Wildlife Refuge System.

1973: Congress passes the Endangered Species Act; today, 61 refuges focus on listed species.

1980: The Alaska National Interest Lands Conservation Act adds 22 million hectares of land to the refuge system, tripling its size.

1996: An executive order by President Clinton reforms management of the refuge system and provides an ecological conservation mission.

1997: Congress passes the National Wildlife Refuge System Improvement Act, building on the principles of the 1996 executive order.

ing with, and therefore incompatible with, the system mission. This proscription against fragmentation provides a strong legal basis for denying or modifying proposed refuge uses that would cause ecological damage. Thus, the integrity mandate, together with the compatibility requirement, provides a yardstick against which to measure the acceptability of practices that were once common on refuges (e.g., agriculture, livestock grazing). In addition, the mandate provides impetus for new initiatives to restore degraded refuges through research, strategic partnering, acquisition, and innovative management.

The NWRSIA explicitly recognizes the importance of larger landscape scales. In the near term, refuge management is most likely to reflect realities of the surrounding landscape, including sometimes hostile land uses, high levels of contaminants, and insufficient connectivity (figure 1). Nevertheless, longer-term planning should seek to remedy these problems; the integrity policy specifically instructs managers to forge solutions to problems arising outside refuge boundaries.

If voluntary, collaborative approaches fail, the policy advises managers to seek redress before local planning and zoning boards and state agencies. This policy, though far from aggressive, is nonetheless the boldest guidance of its kind in federal law. Recently, the staff of the Minnesota Valley National Wildlife Refuge documented the environmental impact of a proposed 19,250-seat concert amphitheater on adjacent land. With these data, the FWS regional director opposed the project before the county commission. Opposition from the FWS and Friends of the Minnesota Valley (a local, private organization of refuge supporters) led the county commissioners to reject the permit application unanimously.

The National Elk Refuge in Wyoming illustrates improved management approaches in line with the NWRSIA. When Congress established the refuge in 1912 to provide habitat for wintering elk (*Cervus elaphus*), the elk had all but vanished from the western landscape. Winter feeding programs were combined with tighter controls on hunting to restore the elk population. Now refuge managers and their partners are moving away from feeding toward maintaining a landscape that can support more natural populations of elk and other native species. The refuge's CCP formalizes this trend toward harmonizing refuge purpose and practice with system mission and regional ecology. Most of the CCPs completed to date highlight ecological restoration as a primary goal, although most lack the required specific and measurable objectives. Without these, the FWS can neither document its progress for supporters nor defend its practices against critics.

Measuring progress

Integrity is not the antithesis of management; indeed, proper management will often move the landscape toward

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Box 3. Refuge purposes and biological integrity: Compatibility or conflict?

Migratory bird refuges: A range of establishment purposes. Many national wildlife refuges (NWRs) were established to protect migratory birds. The language used in establishing some refuges is very broad (Merritt Island NWR: "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds"), whereas other language is more specific (Fort Niobrara NWR: "as a preserve and breeding ground for native birds"), potentially excluding some activities, such as hunting. Refuges in California's Central Valley, established to conserve migratory waterfowl, were also established to keep ducks and geese from feeding in neighboring fields before harvest. These refuges often manage for unnaturally high densities of ducks and geese, and may plant agricultural crops of their own rather than rely only on natural wetland vegetation to attract waterfowl from privately owned fields. At a system level, high densities of waterfowl maintain population numbers closer to historic levels than would be possible if individual refuges managed for historic densities. But high waterfowl densities can degrade wetlands (Post et al. 1998), decreasing integrity at the refuge level. Reduced habitat availability thus creates a potential conflict between establishment purposes and integrity, as well as a conflict among ways of interpreting "historic conditions."

Endangered species refuges. All 61 refuges established under authority of the Endangered Species Act (box 2) have purposes specific to the objective of conserving endangered and threatened species. The Moapa Valley NWR's is exemplary: "to conserve (A) fish or wildlife which are listed as endangered species or threatened species...or (B) plants." The overriding objective of endangered species conservation could potentially be one of the most significant barriers to the integrity mandate on such refuges. Predator control is sometimes used to allow endangered populations to increase, and habitat management may artificially favor rare species and vary from historic conditions in order to preserve wider-scale integrity by maintaining species diversity.

Secondary purposes. Many refuges have miscellaneous (sometimes termed "secondary") purposes that are secondary to wildlife conservation. The Crab Orchard NWR is probably the most compelling example, including agricultural, recreational, and even industrial purposes. The Yukon Delta NWR adds treaty obligations and subsistence uses as purposes. The Minnesota Valley and Bogue Chitto NWRs add recreational purposes. The Charles M. Russell and Cabeza Prieta NWRs add improvement and provision of grazing lands for the public. The Wilderness Act eliminated profit-making enterprises on wilderness and thereby eliminated grazing on the Cabeza Prieta NWR, which is the largest wilderness refuge in the lower 48 states. Grazing continues on the Charles M. Russell NWR, but to a lesser extent than formerly, and only where it can be justified as part of grassland management.

Managing for integrity. Much active management on refuges that might be seen to conflict with the integrity mandate is required by land-use history and surrounding land uses. Dikes prevent water from flooding neighboring drained fields; pumps flood areas that were once drained; prescribed burning substitutes for natural fires; wetland drawdowns, fire, and herbicides are used to control invasive plant species. Clearly, the industrial complex and the 2400 hectares of farmed and grazed land at the Crab Orchard NWR, and the tangle of goals and physical and political constraints in the Central Valley refuges, illustrate the challenges that are inherent in serving both establishment purposes and the integrity mandate. Most establishment purposes, however, are more easily aligned with the goal of maintaining system integrity, and most cases of potential conflict are improving as refuges seek ways to accomplish establishment purposes within the integrity mandate.

greater integrity by restoring the role of evolutionary and ecological processes and restoring populations of decimated or extirpated native species. FWS policy directs refuge managers to evaluate the success of these goal-oriented management actions (602 FW 3), requiring managers to develop appropriate ways to measure progress toward desired ecological conditions.

Development of indicators to measure ecological conditions is a rapidly advancing area of science (Niemi and McDonald 2004); the refuge system need not invent new means of monitoring its progress. Composite indicators such as the index of biotic integrity (IBI; Karr and Chu 1999) incorporate multiple dimensions of living systems to quantify biological conditions in aquatic environments. IBIs and similar indexes also have been developed for terrestrial environments and for both animal and plant communities (O'Connell et al. 2000, Rooney and Rogers 2002, Karr and Kimberling 2003, Machado 2004). Originally devised to help measure progress toward the Clean Water Act's goal of protection of biological integrity, properly constructed IBIs measure biological conditions influenced by all the stressors that influence refuges. The metric identification and index validation processes can be adapted for individual refuges or groups of refuges. Refuges with similar contexts, stressors, or conservation roles may be able to work together in defining appropriate metrics, and thereby reduce development costs.

Robust biological metrics reflect environmental conditions when they are selected on the basis of strong empirical relationships with human activities (the drivers of biological degradation) on or near refuges. These activities may, for example, contaminate land and water, fragment or destroy habitat, or spread invasive species. Measures that connect human activity to environmental end points such as biological condition can be used to guide management decisions, for example, to preserve or mimic natural flooding cycles or fire regimes. Although many aspects of ecosystems can be measured, a much smaller subset can provide meaningful information about refuge condition. Some of the most commonly monitored quantities, such as the population size of an indicator species, are often too naturally variable to provide reliable signals of refuge condition. The most frequently included measures in multimetric indexes include taxa richness and the presence or relative abundance of stress-tolerant or stress-intolerant species and of species with selected ecological characteristics (such as primary food or nesting requirements). By selecting metrics that exhibit dose–response curves across a gradient of

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Figure 1. Refuge landscapes. This northeastern portion of Stone Lakes National Wildlife Refuge (left), sharply bordered by Elk Grove, a suburban development in California, represents a partnership of owners and managers. The open lands to the west of the highway are owned by state and county agencies and managed by the refuge; the refuge holds a development easement on corporate-owned lands to the east of the highway and manages them in partnership with the refuge friends' organization. The Big Oaks National Wildlife Refuge (center), at more than 20,000 hectares, includes one of the largest forested areas in the Midwest. Southern Indiana's rural agricultural landscape retains some forest, but the contrast to the refuge is obvious. The land is owned by the Army and managed by the refuge, except for a small portion that is still used for bombing practice by the Air Force. Over a third of the refuge contains unexploded ordinance and depleted uranium; staff cannot enter these areas, but controlled burning and other remote techniques can be used. In contrast to the other refuges shown here, Lostwood National Wildlife Refuge's almost 11,000 hectares (right) fit seamlessly into a much larger prairie pothole landscape in North Dakota. Grassland and wetland easements (smaller outlined areas) protect smaller areas throughout the surrounding lands. Images: US Fish and Wildlife Service (left photograph and overlays at right); US Department of Agriculture National Agricultural Imagery Program (center and right photographs).

human disturbance, managers can more effectively track refuge condition, because those measures are repeatedly linked to meaningful changes in environmental condition (Karr and Chu 1999).

The NWRSIA requires refuge managers to monitor and assess the ecological condition of refuges. Assessment results are then used to refine and adjust CCPs through the process of adaptive management, allowing managers to understand the results of management decisions and improve progress toward refuge goals (Holling and Meffe 1996). A continual and iterative feedback loop comprising management actions, monitoring and assessment of system responses, and adjustment of actions based on new knowledge is essential to adaptive management. Without monitoring, managers cannot determine which management actions are successes (i.e., fulfill stated goals) and which are failures. Moreover, for adaptive management to be successful, trigger points or thresholds in indicator values at which management will be changed must be identified (Noss and Cooperrider 1994).

Given the restricted resources available to refuges, efficient and carefully targeted monitoring is imperative. Just as uses that were previously considered compatible must now be judged against a new standard, monitoring must now meet new demands. Existing monitoring programs should not automatically be "grandfathered." Rather, monitoring systems should integrate old goals when they are still appropriate, new concerns as they arise, and relevant outside influences on the refuge, from local to international. Monitoring programs should also strive to detect biological changes even before the causes of those changes are recognized.

Ecological indicators will be a refuge's primary means of justifying its management actions (including compatibility determinations) and measuring and communicating progress. As the FWS implements monitoring programs for refuges across the continent, it has the opportunity to become a leader in the use of composite or multimetric indexes and other methods to assess ecosystem condition. However, the expertise and staffing needed to amass the requisite data and develop appropriate models are not available within the FWS. The NWRSIA encourages creative partnerships to meet these challenges; even with limited existing resources, the FWS is already making progress.

Under the integrity mandate, the monitoring tasks facing the FWS are similar to those facing many public agencies and conservation organizations. This means that managers must place a premium on sharing information, technology, and ideas. Perhaps only the FWS, however, by virtue of its relatively new and powerful mandate, is in a position to undertake a sys-

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temwide approach to developing these widely needed ecosystem monitoring tools. The FWS has an opportunity to expand on the integrative and cooperative research recently undertaken by the conservation community—government agencies, nongovernmental organizations, and academia—to apply high-quality monitoring approaches across the refuge system. Sister agencies with existing monitoring programs may also provide helpful lessons (Fore 2003, Oakley et al. 2003, USEPA 2005).

Building landscapes for conservation

The integrity mandate is a noteworthy step forward in ecosystem conservation and restoration, and one that is especially needed in the United States, where many ecosystems are endangered (Noss et al. 1995). This directive extends FWS responsibility far beyond refuge boundaries. Refuges have a head start in meeting this directive because they encompass a greater range of ecosystem types than any other public land system in the United States (Fischman 2003). Nevertheless, many conservation challenges may overwhelm even this advantage.

Conservation of large carnivores and other highly mobile species is among the clearest examples of a goal—connectivity at large scales—that cannot be achieved by any one agency or even by all land-owning agencies together (Noss et al. 1996). But conservation of less mobile species or of localized ecosystems (e.g., serpentine endemics, bogs) also requires a context larger than individual refuges (although probably less vast than is needed for carnivores). Conservation networks that allow adaptation to climate change will also require connectivity at regional and larger scales.

Adaptability and resilience to changing and often unpredictable conditions are fundamental to long-term refuge viability, at both species and ecosystem levels. Species richness (within or among groups), the diversity of functional groups in an ecosystem, and the presence of ecologically effective populations of keystone or highly interactive species (a higher standard than minimum viable populations) have been related to the ability of ecosystems to resist degradation or to recover from perturbations (Loreau et al. 2001, Soulé et al. 2003). Here, again, the resources to improve adaptability and resilience lie only partly within refuge boundaries.

For many refuges, landscape partnerships will be especially important because the landscape context of refuges both threatens integrity and strongly limits opportunities for expanding refuge boundaries to improve ecosystem and species protection (figure 1). Refuges tend to be at lower elevations, on richer soils, and with richer biotas—often former agricultural land—than other public lands (which tend to be in more mountainous or arid settings). As a result, refuges are often surrounded by more expensive and more intensively used lands than other public lands (Scott et al. 2004). Buying a way out of the problem will generally be impractical, but the conservation value of surrounding lands can be improved by altering the practices of neighbors and other potential partners. Existing FWS programs (such as Partners for Fish and Wildlife, private land stewardship grants, or fish passage assistance) can be used more frequently and more effectively to advance these goals than they currently are.

No single federal agency has sufficiently diverse landholdings to represent all native ecosystems and their ecological processes (Scott et al. 2004). Thus, the NWRSIA directive to perpetuate representative ecosystems encourages the FWS to work with its neighbors. Private landowners, transportation departments, county and regional planners, and other entities can, and in some cases must, collaborate with FWS to accomplish conservation goals.

Unfortunately, fear that the presence of endangered species on their lands will limit land-use options may cause potential landscape partners to distrust overtures from the FWS. The FWS continues to compensate for the disincentives of the Endangered Species Act through such initiatives as the "safe harbor" program. Under the safe harbor program, a landowner who enhances habitat for an imperiled species may receive an assurance from the federal government that the species attracted to the enhancement will not impose additional restrictions on land use (USFWS 2002). The George W. Bush administration expanded the program to delegate some certifying responsibilities to states under its "cooperative conservation" initiative (Executive Order 13,352) in 2004. Safe harbor programs have become a popular approach for managing forests to provide habitat for the red-cockaded woodpecker, for example.

The refuges themselves are often well regarded locally, and this may help overcome distrust. The FWS operates some of America's favorite natural areas, yet it has only recently begun to advance this far more positive view of its activities; refuge contributions have gone largely unrecognized in the past. The system will have more options for advancing ecosystem conservation if even reluctant partners see advantages accruing to them as a result of collaboration. Recent FWS efforts to expand the quantity and quality of recreation opportunities on refuges are a welcome development, assuming that compatibility with the goal of integrity, as well as compatibility with system mission and refuge purpose, is ensured. Similar efforts could highlight the role of the refuge system in advancing science and in conserving the national wildlands heritage, thus encouraging support for appropriate funding to steward these resources. On the local level, refuges can increase public awareness and understanding of the value of wildlife refuges by emphasizing the ecological services they contribute to a watershed or a political jurisdiction, including contributions to the adaptability and resilience of the surrounding landscape.

As refuge managers implement management practices that affect their lands and species, they must encourage stakeholders already cooperating with their refuges and extend monitoring efforts beyond refuge boundaries to document threats and seek remedies. Even where the FWS is powerless to improve conditions on surrounding lands, impacts on refuges and their conservation partners must be accurately assessed and management programs defined to minimize

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the negative effects of those conditions. To the extent that other agencies and organizations (including local groups of refuge supporters) are already involved in gathering relevant monitoring information and in conserving species and ecosystems, partners can provide information and even modify priorities for refuges.

The NWRSIA specifically encourages the FWS to think and act beyond its boundaries, but such directives are not new, nor do they ensure success. FWS commitment to the act can increase the number and creativity of efforts to promote partnerships; the act does not require that potential partners accede to FWS requests, however, nor does it penalize those whose actions degrade refuges. Thus, the FWS cannot impose partnerships; at best, it can make partnerships attractive and publicize environmental impacts so that public outcry may avert them.

FWS readiness

The FWS faces the challenges of the NWRSIA with some well-documented shortfalls. Few refuges have complete species inventories, many are missing other basic data, and no central database tracks the availability of such data. Many refuges still lack a staff biologist, let alone a team capable of effectively and completely carrying out a task as technically challenging as the integrity mandate while continuing to contribute biological expertise to an array of other management challenges. Currently, 545 refuges employ 768 biologists (1.4 biologists per refuge, or approximately 1 for every 50,000 hectares), including 343 technicians and trainees (many without degrees), suggesting that 768 represents a best-case picture of biological staffing.

The FWS documents the need for more biological staff support within the refuge system through the Refuge Operating Needs System (RONS), a database of operational priorities to support refuge management. The RONS database currently documents the need for 1084 additional biological staff positions for all refuge tasks. Roughly one-third of those positions (359) are designated as "mission critical," and 229 of those are associated with "survey and census"—operations central to monitoring. At the system level, RONS data illustrate that the refuge system is operating under a severe and chronic deficit of biologists, meeting only 37% of its identified staffing needs. Recent budget trends suggest that biological staffing will decline rather than increase. Neither the projected need nor the recent trend is consistent with meeting a challenge like the integrity mandate.

The refuge system expends considerable resources on monitoring refuge wildlife and habitat. In 2003, the FWS spent $28 million and the equivalent of 369 full-time positions to support surveys and censuses; 89 of these 369 full-time equivalents came from volunteer assistance. While substantial, this effort is not sufficiently rigorous and directed to support implementation of the integrity mandate. However, it does represent a significant capacity that, with appropriate redirection, could improve efficiency and effectiveness in an era of static or declining budgets.

The need for increased refuge staffing and support for biological surveys has been consistently identified as a priority in both internal and external reports. Most recently, the FWS convened a Conservation in Action Summit, which concluded that essential components of a scientific program for studying and managing the refuge system are in either inadequate or critical condition (USFWS 2005). In response, the FWS has worked with the US Geological Survey (USGS) to develop a Biological Monitoring Team (BMT). The BMT is charged with designing a systematic approach to collection and use of biological information to determine the status of refuge resources and to evaluate the results of management. The system envisioned will allow refuges to exchange data among themselves and with other organizations and will support monitoring of wildlife and habitats at landscape scales.

The BMT pilot program is an encouraging step to which the FWS and USGS have committed resources in a challenging fiscal environment. However, a far larger commitment of staff and funding is essential to move beyond the pilot stage, and substantial cultural resistance may arise within the refuge system. A successful program could strengthen partnerships between the scientific community and the FWS and substantially improve monitoring efforts.

Challenges and their resolution: Some recommendations

The NWRSIA ambitiously expands the nation's goals for wildlife refuges, and the FWS has made a promising beginning with its policies for the compatibility requirement and the integrity mandate. New and difficult challenges remain for an agency facing stark fiscal and political realities.

Two dimensions of partnerships will be crucial to achievement of the integrity mandate. First, partnerships with neighbors and others whose actions affect refuges will improve conservation in the landscape surrounding refuges. The amphitheater example described earlier demonstrates that the FWS can move beyond the encouragement of neighbors to active advocacy and partnering on behalf of refuges in the surrounding communities. Success in achieving the goals of the act will undoubtedly depend on more of these measures.

Second, partnerships with conservation scientists can strengthen the ecological foundations of management goals and strategies. This integration with conservation science will build on traditional refuge partnerships with game-oriented organizations. The external conservation science community, too, will benefit from the network of research sites for testing new approaches as well as from the scientific advances contributed by the FWS. The Centennial Scholarship program supported and highlighted just such efforts during 2005. Federal support of such programs strengthens refuge–science partnerships and is an important means of advancing the science on which effective refuge management depends; unfortunately, no such programs are scheduled beyond 2005.

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Partnerships to improve scientific capacity are already beginning. In addition to the BMT program described earlier, the FWS and USGS are cooperating in a "Future Challenges" initiative to define management approaches and scientific tools needed to preserve ecosystems in the face of large-scale and long-term challenges such as climate change, invasive species, regional habitat destruction and fragmentation, and water resource allocation. These efforts can easily expand science-based partnerships with colleges and universities around the country, but substantial funding increases and outreach beyond traditional academic partners will be required to realize that possibility.

Although partnerships are a necessity, the NWRSIA is the responsibility of the FWS, and much progress must also be made internally. Most fundamentally, the act requires institutional leadership, commitment to new practices, and effective use of the skills and capacity already present in the agency. The NWRSIA delivered a vastly expanded, science-based responsibility. The political will mobilized within FWS to enact that responsibility must now be tapped to fulfill it (Gergely et al. 2000). If the agency budget cannot expand to cover the necessary activities, then agency reports must accurately reflect the shortfalls, while partnering efforts seek to make up some of the difference.

The FWS will need to make adaptive management an organizational priority in order to fulfill the leadership role outlined in the NWRSIA. The CCP process requires all refuges to adopt adaptive management's cycle of action, analysis, and revision. As a practice, this approach holds great promise, but it represents a major institutional change in the context of refuge management. The FWS should encourage improved training, education, and communication for this new approach; the BMT approach would support research needed for the effort.

The fealty of the NWRSIA to the establishment purposes of individual refuges could slow the shift to managing for the broader integrity mandate. While respecting that refuge purposes can trump the system mission in case of conflict, FWS leadership should look to the breadth of the system mission to resist the narrow world that will result from an undue emphasis on establishment documents as the sources of refuge objectives. The broad principles in the act will better serve the overall objectives of individual refuges and of the refuge system as a whole.

Happily, some refuge managers have shown great willingness and creativity in responding to the NWRSIA. A case in point is the Sherburne National Wildlife Refuge in southern Minnesota. The original acquisition intent of the refuge was to provide habitat for migratory waterfowl. At the time it was acquired, farming was a principal land use. The CCP process provided the opportunity to consider the integrity requirements in relation to future management direction at Sherburne. Staff determined that, before it was farmed, the refuge had been dominated by oak savanna, which had since become rare in the Midwest. Nuzzo (1986) estimated that only 0.02% of midwestern oak savanna and woodlands remained. Furthermore, Sherburne staff determined that the refuge was not a major waterfowl production area, and could better serve waterfowl conservation as a migratory stopover. It might have been feasible to convert Sherburne's uplands to grassland, to support rare grassland birds, but that was not the historic natural habitat. Although oak savanna is not critical to many vulnerable migratory bird species, it is important to herpetofauna (Mierzwa 1994) and invertebrates (Shuey 1994); the ecosystem itself is ranked as globally imperiled (NatureServe 2005). A key factor in support of Sherburne's decision is that the FWS policy on integrity emphasizes restoration of historic conditions. System-level integrity considerations also supported the decision to restore savanna; within that region of the FWS (region 3), more than 70% of refuges protect grasslands, whereas only 15% protect savanna.

Sherburne had considerable latitude under its establishment purposes. The refuge had sufficient access to water to inundate large areas for waterfowl, and farming of uplands could have continued as a means of providing food for migratory waterfowl. Although such management would have violated the spirit of the NWRSIA, those options probably would have fallen within the FWS's legal discretion. But the refuge chose a less traditional and logistically more difficult route that honored the intent of the act by supporting migratory waterfowl while restoring a rare ecosystem.

Full restoration will not be possible: Bison (*Bison bison*) and elk are gone; fire regimes will not be entirely natural; invasive species will be a constant threat. Nevertheless, the changes at Sherburne demonstrate that refuges are willing and able to meet the challenges of their new mandate.

The NWRSIA gives the FWS a leadership position in the protection and restoration of natural areas. Serious challenges accompany this opportunity. If the integrity provisions of the act are to be implemented, many refuges will be unable to continue with business as usual. High levels of scientific excellence and accountability will be required, as well as institution-wide support of adaptive management.

To accomplish the NWRSIA mission, the act requires refuge managers to work to accomplish the integrity goal within refuge boundaries and beyond. Partnerships with local institutions will often provide the best promise of integrity beyond the refuge scale. FWS personnel are required by agency policy to use existing scientific information in refuge management activities and implementation of the integrity mandate (601 FW 3, 602 FW 3). The knowledge that managers develop as they pursue the integrity mission will guide further management; disseminating their findings will advance conservation within and beyond the refuge system. Conservation science can also be used to connect establishment purposes with the integrity mission. Finally, the success of the NWRSIA mission depends on institution-wide leadership and commitment to its lofty goals. FWS has much to do to fulfill the promise of the act; early responses are encouraging.

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