Harmonizing the Biological Integrity Mandate of the Refuge Improvement Act with Existing Fish and Wildlife Service Policies and Practices

INTRODUCTION

The 1997 National Wildlife Refuge System Improvement Act[1] (Improvement Act) enacted sweeping changes to the management of the National Wildlife Refuge System. Beleaguered for years by its incohesiveness, a lack of a strong statutory framework, and increasing problems of incompatible uses (Fink 1994; Fischman 2003), the Improvement Act provided the Refuge System with a mission and a series of principles and management standards. The Improvement Act firmly established that national wildlife refuges are for wildlife conservation first and foremost. It provided a framework for evaluating uses of refuges to ensure they are compatible with wildlife conservation. The Improvement Act for the first time required comprehensive management planning of each refuge.

One of the most important management standards of the Improvement Act is a provision directing the Secretary of the Interior to "ensure that the biological integrity, diversity, and environmental health of the System are maintained for the benefit of present and future generations of Americans" (ecological integrity provision). Besides the mission of the Refuge System, the ecological integrity provision is the most important and pervasive provision of the Improvement Act. The ecological integrity provision is in fact an essential element of the Refuge System mission itself. Section 3 of the Improvement Act defines the key term "conservation" as sustaining or enhancing populations using the "methods and procedures associated with modern scientific resource programs." Further, Section 4 states that the mission of the Refuge System is "to administer a national network of lands and waters for the *conservation*, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats for the benefit of present and future generations of Americans" (emphasis added). As described below, maintaining the biological integrity, diversity and environmental health of protected lands are fundamental concepts widely recognized as basic to modern scientific resource management, and by virtue of the Refuge Improvement Act, the U.S. Fish and Wildlife Service (FWS) now has a fundamental legal duty to do so. Congress described the mandates which incorporate these concepts as "affirmative stewardship responsibilities" (House of Representatives 1997). FWS recognized this in their policy governing uses of refuges

[1] 16 U.S.C. §668dd

(Federal Register 62484-62496): "Uses that we reasonably may anticipate to conflict with pursuing this directive to maintain the ecological integrity of the System are contrary to fulfilling the National Wildlife Refuge System mission and are therefore not compatible."

To understand and implement this provision, the FWS issued a final agency policy on Maintaining the Biological Integrity, Diversity, and Environmental Health of the National Wildlife Refuge System (66 Fed Register 3818) on January 16, 2001. This paper discusses other efforts to implement an ecological integrity standard into FWS and other agencies' actions, describes issues with the final FWS policy and implementation, and suggests a new framework for incorporating the ecological integrity provision into refuge management.

Throughout this paper I use the term "ecological integrity" in place of the more burdensome "biological integrity, diversity, and environmental health". This is both for ease of reading and in recognition of the strong overlap of the meanings of these terms. The term ecological integrity is also used by the FWS in their final Refuge Planning Policy (65 Federal Register 33892) which defined it as the "integration of biological integrity, diversity, and environmental health; the replication of natural conditions." The draft FWS policy on the ecological integrity provision (63 Federal Register 3583) also used this term to combine the concepts of biological integrity, diversity, and environmental health. The term was later abandoned in the final FWS Ecological Integrity Policy (66 Federal Register 3810) because of commenters who "stated that it went beyond the Refuge Improvement Act by creating a term that was not contained in law or legislative history."[2]

BACKGROUND

> *A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise. - Aldo Leopold, 1949*

Before addressing what it means to maintain the biological integrity, diversity, and environmental health of the Refuge System, it is important to understand the history of these concepts and the context for their inclusion in the Improvement Act. While the notion of

[2] Response to Comments Received, Issue 1: The Term "Ecological Integrity", 66 Federal Register 3810. The FWS responded, "We never intended for the term "ecological integrity" to be more than a convenient means of referencing the terms biological integrity, diversity, and environmental health. We agree, however, that as we used

"integrity" in relation to the natural world goes back to at least Aldo Leopold, its acceptance and application as a management standard has been slow. For most of the twentieth century, wildlife management remained piecemeal and single species-based (Noss and Cooperrider, 1994).

After years of implementing the ESA and other species-based programs, and the continued loss and decline of many species, it once again became clear that a different, broader approach was needed to adequately conserve wildlife and their habitats. The term "biodiversity" was coined to focus attention away from traditional game species towards a focus on all species, communities and ecosystems (Wilson, 1988). Ecosystem management became the paradigm of the day in the early 1990's as a method of conserving biodiversity. Its foundation centered on two central ideas: 1) maintaining and restoring ecosystems will result in protection of individual species; and 2) ecosystems cross geo-political boundaries, requiring cooperation among many federal, state, local and tribal government jurisdictions and private landowners (GAO 1994).

Biological or ecological integrity emerged as a key concept in characterizing the goals of measuring, maintaining and restoring ecosystems. As summarized by the distinguished Committee of Scientists (COS) convened by the USDA Forest Service to provide technical and scientific advice on resource planning:

> Because of the unprecedented rate of change in ecological systems in the United States and the accompanying loss of biological diversity, environmental scientists have sought a way to measure or characterize the state of these systems. Such a metric would allow managers to assess the efficacy of their management practices in moving ecological systems toward, maintaining them within the bounds of, sustainability. The concept of ecological integrity has been put forth by a wide variety of scientists as a way to encapsulate appropriate metrics, and measurable definitions have been proposed. (COS, 1999)

BIOLOGICAL INTEGRITY IN OTHER LAWS AND AGENCIES

The 1988 Canadian National Parks Act

Biological or ecological integrity has been included in past laws, treaties, and agency regulations and lessons should be drawn from these past experiences. The 1988 Canadian National Parks Act amendment required that the "maintenance of ecological integrity, through the protection of natural resources shall be the first priority when considering park zoning and

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the term throughout the policy it appeared to take on a meaning beyond the reference to the three terms."

visitor use in a management plan." Ten years later, the Panel on Ecological Integrity was convened to identify issues, examine Parks Canada's approach for maintaining ecological integrity and provide recommendations for improvement. The Panel's key recommendations after examining the experience of Parks Canada implementation of their ecological integrity provision are highly relevant to the FWS:

> We recommend this revised definition of ecological integrity:
> "An ecosystem has integrity when it is deemed characteristic for its natural region, including the composition and abundance of native species and biological communities, rates of change and supporting process."
> In plain language, ecosystems have integrity when they have their native components (plants, animals and other organisms) and processes (such as growth and reproduction) intact.
>
> For national parks, this characteristic state must respect the following criteria:
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> - ecological integrity should be assessed with an understanding of the regional evolutionary and historic context that has shaped the system;
> - because ecosystems are dynamic, conservation strategies should maintain or restore key ecological processes within their natural range of variability;
> - ecosystems are multi-scaled and conservation should be considered at many scales. National parks are part of larger ecosystems and must be managed in that context;
> - functional connections between parks and equivalent protected areas within the regional ecosystem should be maintained or restored, to allow wildlife movement;
> - populations of species should be managed to levels that have a high likelihood of persistence;
> - ecosystems have characteristic rates of change. Understanding rates and direction are critical to understanding the system;
> - parks have a finite capacity to withstand use. Human use and facilities should be compatible with park ecosystem protection in type, amount, and timing;
> - ecological integrity must be assessed and understood at a landscape scale. While ecological integrity cannot be assessed at the scale of a single forest stand, campground, or parking lot, it can be compromised at any scale. Even small scale impacts can have cumulative effects and should be considered in this light;
> - the goal of conserving ecological integrity is best addressed by maintaining or restoring the diversity of genes, species and communities native to the region. It is simply consistent with the vision of integrity, which is "wholeness" - if parts are missing, the ecosystem is not whole.

U.S. National Forest Planning Regulations

Lessons can also be drawn from the United States. The final National Forest System Land Resource Management Planning regulations (Federal Register 67513-67581) proposed under the Clinton administration stressed the maintenance of "ecological sustainability" which, as envisioned by the COS, is founded on the notion of ecological integrity:

> we propose that an ecosystem has ecological integrity when it can maintain characteristic compositions, structures, and processes against a background of anthropogenic changes in environmental conditions. Ecosystems with high ecological integrity continue to express the evolutionary and biogeographic processes that gave rise to the current biota; they have a species composition, diversity, and functional organization expected from natural habitats of the region; and they are resilient to environmental change and disturbance occurring within their natural range of variability... The concept of [natural] range of variability as a characterization of reference conditions for management of the national forests and grasslands is based on the common-sense notion that the environmental conditions most likely to conserve native species are those under which they evolved. (COS, 1999)

U.S. Clean Water Act

Important lessons can also be learned from the implementation of the Water Quality Act Amendments of 1972 (CWA), which was the first U.S. law to use the phrase biological integrity. The CWA calls for the restoration and maintenance of "the chemical, physical, and biological integrity of the nations's waters." Despite this mandate, however, "it took nearly two decades to begin to incorporate that concept into water resource protection, *largely because appropriate benchmarks were not defined for evaluating success in attaining these goals*" (Karr and Chu 1995; emphasis added).

ECOLOGICAL INTEGRITY IS FUNDAMENTAL TO THE MANAGEMENT OF THE REFUGE SYSTEM

A thorough understanding of biological integrity, diversity, and environmental health must precede and influence other aspects of refuge management. This was recognized by the FWS itself in *The Fish and Wildlife Service and Biodiversity: The Common Thread* (Holle et al. 1991). Biodiversity, the first goal of which is to "maintain ecosystem integrity", "is a concept or set of principles that governs how the Service (and others) carries out its mandates through all existing programs. Biodiversity is not a program nor should it be carried out independently within one or more Service offices" (Holle et al. 1991). Successful implementation of the

Improvement Act's Integrity Provision will require the FWS to incorporate principles of this provision into all relevant Service policies and practices.

Implementing the ecological integrity provision does not necessitate a radical shift in management throughout the Refuge System. The Service, in accomplishing its wildlife conservation mission, has long been striving to maintain the ecological integrity of the System. Virtually all refuges are battling invasive species, from Melaleuca in Loxahatchee National Wildlife Refuge (NWR), to introduced foxes in Alaska Maritime NWR, which severely degrade ecological integrity. Some refuges are restoring important ecological communities, like bottomland hardwood forests. Refuge personnel are trying to reintroduce and mimic natural disturbance and other processes, like fire. Many refuges are key players in endangered species recovery and other innovative efforts, like Lower Rio Grande NWR, which is connecting important wildlife habitat and protecting rare and declining diverse communities.

The FWS has already firmly established important elements of what it means to maintain ecological integrity into national policy. The 1994 "An Ecosystem Approach to Fish and Wildlife Conservation" lays a visionary foundation for managing refuges and their surrounding ecosystems for improved ecological integrity. The goal of the Service's Ecosystem Approach is "the effective conservation of natural biological diversity through perpetuation of dynamic, healthy ecosystems." The document characterized the primary goal of the Ecosystem Approach as "conserving natural biological diversity and ecosystem integrity." The definition of Ecosystem Approach provided could easily be the description of maintaining ecological integrity:

> Protecting or restoring the natural function, structure, and species composition of an ecosystem, recognizing that all components are interrelated. Management of natural resources using systemwide concepts to ensure that all plants and animals in ecosystems are maintained at viable levels in native habitats and that basic ecosystem processes are perpetuated indefinitely (FWS 1994).

The Ecosystem Approach established an ecosystem planning framework which was to include goals that incorporated the following:

- perpetuation of natural communities of plants and animals;
- maintenance of naturally-occurring structural and genetic diversity;
- needs of rare and ecologically important species;
- minimization of habitat fragmentation;
- maintenance of uncomtaminated land and water;
- continued role of natural processes;
- control of undesirable exotic spcies

These are essential elements for maintaining ecological integrity.

Ecological integrity converges on the Ecosystem Approach because ecological integrity can only be fully understood and protected from a large-scale perspective. Unfortunately, the FWS Ecosystem Approach has not been fully realized for myriad reasons, including a problematic organizational structure, lack of accountability, and a lack of funds to carry out ecosystem planning. The FWS should take the lessons from the Ecosystem Approach when drafting the Ecological Integrity Policy and ensure the requirements and oranizational structure are in place to be implementable.

The Service incorporated important elements to protect ecological integrity of the Refuge System into its policies governing compatible refuge uses and refuge management planning. Secondary uses often impair the ecological integrity of a refuge. The final Refuge Compatibility Policy (65 Federal Register 62486) requires that "uses that we reasonably may anticipate to conflict with pursuing this directive to maintain the ecological integrity of the System are contrary to fulfilling the National Wildlife Refuge System mission and are therefore not compatible." The Compatibility Policy takes a precautionary stance towards evaluating secondary uses of refuges by requiring that "if available information to the Refuge Manager is insufficient to document that a proposed use is compatible, then the Refuge Manager would be unable to make an affirmative finding of compatibility and we must not authorize or permit the use." The Compatibility Policy also requires the necessary resources to monitor the impacts of a use over time. These requirements will prevent the future impairment of ecological integrity by secondary uses.

Refuge comprehensive conservation planning provides the best opportunity to evaluate refuge resources and plan management over the long-term that ensures that the ecological integrity of the unit is maintained. The first task in maintaining ecological integrity is

understanding what the status, trends, and stresses affecting ecological integrity are. The final Refuge Planning Policy (65 Federal Register 33892) states that to guide planning, refuges must "identify and describe the following conditions and their trends for the planning unit and, as appropriate, for the planning area:

> (i) Context of the planning unit in relation to the surrounding ecosystem.
> (ii) Structures, components, and functions of the ecosystem(s) of which the planning unit is a part.
> (iii) Natural and historic role of fire and other natural occurrences affecting ecological processes.
> (iv) Past land use and history of settlement, including a description of any changes in topography, hydrology, and other factors.
> (v) Current and historic description of the flora and fauna and the diversity of habitats and natural communities.
> (vi) Distribution, migration patterns, and abundance of fish, wildlife, and plant populations, including any threatened or endangered species, and related habitats.
> (vii) Fish, wildlife, and plants and their habitats and communities that are rare and/or declining within the ecosystem.
> (viii) Water resources including quality and quantity.
> (x) Significant problems that may adversely affect the ecological integrity or wilderness characteristics and the actions necessary to correct or mitigate the problems.
> (xi) Identify opportunities to improve the health of habitats or the functioning of ecosystems.
> (xii) Significant problems that may adversely affect the populations and habitats of fish, wildlife, and plants (including candidate, threatened, and endangered species) and the actions necessary to correct or mitigate the problems.
> (xiii) Known or suspected sources of environmental contaminants and their potential impacts on the planning unit (refer to the Contaminant Assessment Program).
> (xiv) Land acquisition or habitat protection efforts.
> (xv) Habitat management practices.

All of these elements are absolutely essential if refuge managers are to understand their resources in a larger context and make informed decisions that protect and restore the biological integrity, diversity, and environmental health of the refuge and ecosystem it is found. What is somewhat lacking in the Planning Policy, however, is clear guidance on what to do with this information.

What is needed is a policy that defines ecological integrity, fills in the policy gaps, sets ecological integrity as a management standard, and requires implementation of the ecological integrity provision into all relevant Service policies. Such a policy should be clear and concise.

It should be flexible, acknowledge uncertainty, and be adaptable to change, yet presciptive. Most important, it should harmonize with existing policies, rules, practices, organizational structure and capacity to be truly implementable.

FWS FINAL ECOLOGICAL INTEGRITY POLICY

The Fish and Wildlife Service issued a final policy on maintaining the biological integrity, diversity, and environmental health of the Refuge System (66 Fed. Reg. 3810; 601 FW 3 of the Fish and Wildlife Service *Manual*) on January 16, 2001.[3] The policy prescribes some bold provisions and significantly advances ecological protection in the Refuge System (Fischman 2003, p127). For example, the policy:

- assures "that densities of endangered or otherwise rare species are sufficient for maintaining viable populations." (Sec 3.14C)
- does not "allow [animal] densities to reach excessive levels that result in adverse effects on wildlife and habitat." (Sec. 3.14E)
- requires habitat management strategies that mimic historic conditions. "Farming, haying, logging, livestock grazing, and other extractive activities are permissible habitat management practices only when prescribed in plans to meet wildlife or habitat management objectives, and only when more natural methods, such as fire or grazing by native herbivores, cannot meet refuge goals and objectives." (Sec. 3.15B)
- requires managers to "prevent the introduction of invasive species, detect and control populations of invasive species, and provide for restoration of native species and habitat conditions in invaded ecosystems." (Sec. 3.16A)

Unfortunately, the language contained in the policy is at times ineffective and confusing and fails to provide a clear mechanism for implementation. It often falls victim to the same trends as other Service policies as described by Bean (1992):

> The Refuge Manual itself, the basic guiding document for the management of the National Wildlife Refuge System, is so riddled with exceptions and contradictory policies that almost anything... can be squared with it. And that fact, coupled with the further fact that the very concept of biodiversity conservation is itself rather open-ended and imprecise, means that almost any set of refuge management actions can be justified, post hoc, on the basis of their contribution to biological diversity

[3] The original effective date of the policy was delayed from February 15, 2001 to April 15, 2001 by the incoming George W. Bush administration.

For example, the issue of non-native species appears in three different sections. "Unless we determine that a species was present in the area of a refuge under historic conditions, we will not introduce or maintain the presence of that species..." (Sec. 3.11). "We do not allow refuge uses or management practices that result in the maintenance of non-native plant communities..." (Section 3.15). "We prevent the introduction of invasive species, detect and control populations of invasive species, and provide for restoration of native species..." (Section 3.16). Indeed, non-native and invasive species pose a serious threat to ecological integrity. However, the scattering of these provisions adds to the redundancy and confusion in the policy.

Throughout the policy, wording such as "we seek" and "we strive" is weak and adds to the confusion. For example, "We especially seek to identify keystone species, indicator species, and types of communities that occurred during the frame of reference" (Sec. 3.12B). Will indicator species be chosen or not? What happens after these species and communities are "identified"?

Much of the confusing and problematic wording found in these sections stems from the conflict the FWS perceives between individual refuge purposes and the mission of the Refuge System, including the ecological integrity provision. While the Improvement Act defers to refuge purposes if there is a conflict with the mission of the System (Sec 4 (D)), we believe the FWS continues to promote a false dichotomy between the mission and refuge purposes. Indeed there are rare instances of bizarre purposes, like the facilitation of agriculture and industry at Crab Orchard NWR[4], but most refuge purposes can be viewed as a subset of the broad mission to conserve all fish, wildlife, and plants. Thus by accomplishing a refuge's purpose, it is contributing to the mission of the System. More important, refuge purposes do not necessarily translate into specific management strategies, and in fact, in the words of refuge manager Jim Clark, these conflicts between refuge purposes and ecological integrity, "may be a result of subjective interpretation of the purposes" (Clark 1992). For example, many refuges established under the Migratory Bird Conservation Act (MBCA) of 1929 have the purpose for "use as an inviolate sanctuary, or for any other management purpose, for migratory birds." This certainly does not imply planting soy beans or intensively managing artificial impoundments to maintain a

[4] "... for the conservation of wildlife, and for the development of the agricultural, recreational, industrial, and related purposes ..." 61 Stat. 770, dated Aug. 5, 1947.

large population of migratory waterfowl. In fact, a strict reading of the above purpose, "as an inviolate sanctuary", would preclude hunting. Yet the interpretation of this purpose has changed with time, after passage of subsequent legislation (eg. Duck Stamp Act), social changes (eg. reduced market hunting), and developments in science. It is once again time to re-interpret refuge purposes in light of the Improvement Act, the dramatic changes in land-use that have placed a heavy burden on all fish, wildlife, and plants (Stein et al., 2000), and scientific developments particularly in the fields of conservation biology and landscape ecology.

The idea of integrating traditional refuge management with broader ecological management was recognized as far back as 1968 by the distinguished Special Advisory Board on Wildlife Management for the Secretary of the Interior which produced what is now called the *Leopold Report*:

> "For each refuge there will always be some primary or transcending function that receives and deserves major attention. The duck breeding refuges, like the Upper and Lower Souris are managed mainly as production areas. Wintering refuges like the Sacramento or Bosque del Apache are developed to shelter and feed wintering waterfowl. The Kofa Game Range is operated to favor perpetuation of the desert bighorn. And so on. But additionally, without impairing primary functions, virtually all refuge areas can be so managed as to produce a wealth of secondary wildlife values. A mudflat maintained for shorebirds, a woodlot supporting a heron colony, a tule border left for yellow-headed blackbirds or a thicket for transient warblers represents a value over and beyond the cloud of ducks and geese that occupy the central ponds. The number of Americans concerned with viewing or photographing wildlife is increasing at least exponentially with populations. Their interests should be served by the refuges, along with the interests of the hunting public.
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> "In essence, we are proposing to add a "natural ecosystem" component to the program of refuge management. Wherever a fragment of some native biota remains on a refuge it should be retained or expanded and restored insofar as this is practicable and in conformance with the primary function of the refuge. Native plants would be as much a part of this concept as native animals, and should where possible be used in landscaping and in development of wildlife coverts."

This does not necessarily translate into wholesale changes in refuge management. The many refuges established under the MBCA and the Emergency Wetlands Resources Act of 1986 targeted areas that would be beneficial to migratory waterfowl. These refuges protect the wetlands used as migratory stepping stones along our major flyways and because of this,

protecting migratory waterfowl habitat is likely their best contribution to maintaining the ecological integrity of the nation and ecosystem. What is needed is a thorough evaluation of the ecological systems, communities, and species found in the ecosystems that refuges are a part to determine the best contribution that refuge can make, given its landscape context, to the protection and restoration of ecological integrity.

Additional confusion stems from the apparent proposed conflicts between biological integrity, diversity, and environmental health. As stated by Fischman (2003):

> "The core meaning of the biological integrity, diversity, and environmental health criterion is that Congress tried three ways to express its intent to ensure that conservation biology and ecological science are deployed in the Refuge System to protect nature in the long term. Rather than try to distinguish among biological integrity, diversity, and environmental health, I believe it is more constructive to understand the elements together." (Fischman 2003, p130)

When these three concepts are taken together decisions can be made that cumulatively maintain or improve ecological integrity, or the corollary, decisions will not cumulatively or indirectly degrade ecological integrity. This will reduce confusion and the perceived conflicts between biological integrity, diversity, and environmental health. The essential elements of the various definitions for these concepts are: soundness, wholeness, naturalness, resilience, sustainability, maintaining ecological processes, structure, and composition, and maintaining the evolutionary adaptive processes. Thus, ecosystems are healthy and have integrity if they maintain ecological and evolutionary processes, structure, and composition (ie. diversity) which provide the system with resilience to perturbation.

The crux of the FWS Ecological Integrity Policy is understanding the "historic conditions" of a refuge's ecosystem, evaluating the degree to which current conditions differ from historic conditions, and designing strategies that maintain or restore those conditions. While historic conditions provide an important benchmark for understanding and managing ecological integrity, the heavy reliance of the policy on historic conditions ignores the actual capacity for the FWS to conduct this analysis. According the 1998 FWS Biological Needs Assessment, there are "about 310 biological field staff are distributed across 92 million acres [and 540 refuges]" and relatively "fewer staff have been assigned greater responsibilities, leaving little time to carry out well-designed population surveys; monitor, assess and report

impacts of management actions; or design, implement, and evaluate management plans and objectives." (FWS 1998, p7). The report adds, "Existing baseline data on refuge biotic communities are inadequate for monitoring trends in those communities. Instead, we intensively manipulate refuge habitats without knowing the full complement of resources affected." (FWS 1998, p10).

To be implementable, a policy needs to recognize the limits of the agency it is guiding. The FWS does not even understand the resources it manages today, let alone the structure, function, and composition of those resources historically.

A NEW FRAMEWORK FOR INTEGRATING ECOLOGICAL INTEGRITY INTO REFUGE MANAGEMENT

As I noted earlier, aspects of existing FWS policies (eg. Compatibility Policy, Planning Policy, Ecosystem Approach) contribute to fulfilling the Improvement Act's mandate to ensure that the biological integrity, diversity, and environmental health of the Refuge System are maintained. Unfortunately the implementation framework presented in the FWS Ecological Integrity Policy does not explicitly recognize, nor fit into these existing policies in important ways. It also appears as yet an extra planning burden on refuge managers, hampering implementation. At the refuge level, the comprehensive conservation planning process, and the step-down management plans stemming from it, are the best ways to integrate the ecological integrity provision of the Refuge Improvement Act into refuge management. I propose the following framework for implementing the Ecological Integrity policy. This framework explicitly fits into the existing comprehensive conservation planning process (Roman numerals refer to Section 3.4C(1)(e) of the FWS Refuge Planning Policy), thus does not require a new ecological integrity planning process, and retains the important elements included in the FWS Ecological Integrity Policy. The FWS has in the past, gone through many, if not all, of these steps when planning and managing refuges using good intuition and sound professional judgement. The framework below attempts to make an explicit, scientifically based decision making process[2].

[2]The steps presented here are based largely on the Nature Conservancy's *Five-S Framework for Site*

1. Identify refuge and ecosystem resources (including processes that maintain them) and land protection efforts throughout the ecosystem. This is largely accomplished in the Ecosystem planning and CCP process under preplanning (parentheses indicate corresponding ecological integrity components):
   (i) Context of the planning unit in relation to the surrounding ecosystem.
   (ii) Structures, components, and functions of the ecosystem(s) of which the planning unit is a part (*ecological integrity*).
   (iii) Natural and historic role of fire and other natural occurrences affecting ecological processes (*ecological integrity, environmental health*).
   (v) Current and historic description of the flora and fauna and the diversity of habitats and natural communities (*biological diversity*).
   (vi) Distribution, migration patterns, and abundance of fish, wildlife, and plant populations, including any threatened or endangered species, and related habitats (*biological integrity and diversity*).
   (vii) Fish, wildlife, and plants and their habitats and communities that are rare and/or declining within the ecosystem (*biological diversity*).
   (iv) Past land use and history of settlement, including a description of any changes in topography, hydrology, and other factors (*environmental health*).
   (xiv) Land acquisition or habitat protection efforts.
   (xv) Habitat management practices.

2. Of the resources identified above, select focal targets that
   a. Reflect national and ecosystem goals and refuge purposes
   b. Represent the refuge's best use of its size, condition, existing habitats, and spatial configuration to meet national and ecosystem goals
   c. Are fish, wildlife, and plants and their habitats and communities that are rare and/or declining within the ecosystem (vii).

3. For the conservation targets identify the stresses, problems and threats affecting them:

Conservation (TNC, 2000). TNC has been managing their lands for the protection and restoration of biodiversity and ecological integrity for years and we believe important lessons can be learned and adopted from their approach.

a. Significant problems that may adversely affect the ecological integrity or wilderness characteristics (x).
b. Significant problems that may adversely affect the populations and habitats of fish, wildlife, and plants (including candidate, threatened, and endangered species) (xii).
c. Known or suspected sources of environmental contaminants and their potential impacts on the planning unit (refer to the Contaminant Assessment Program)(xiii).

4. Identify the sources of the identified problems.
5. Identify the actions necessary to correct or mitigate the problems (x and xii) and opportunities to improve the health of habitats or the functioning of ecosystems (xi).
6. Identify a manageable set of indicators to monitor and establish benchmarks to evaluate success.

Step 1 - Identify refuge and ecosystem resources (including processes that maintain them) and land protection efforts throughout the ecosystem.

This is the most important step in understanding ecological integrity. The exact definitions of ecological integrity, biological integrity, diversity, and environmental health can be debated endlessly. It is much more useful to characterize in detail the composition, structure, and function of ecosystems, in their current and past condition (ie. their historical range of variability), "to provide a conceptual framework for assessing the impact of human activity on biological systems and to identify practical consequences stemming from this framework" (De Leo and Levin 1997). The list provided in Step 1 (taken from the FWS Refuge Planning Policy) is comprehensive and fairly self explanatory.

Many refuges during their CCP process have characterized these components. The planning team for the Little Pend Oreille NWR CCP relied upon the historic range of variability based on the premise that "(1) past conditions and processes provide context and guidance for managing ecological systems today, and (2) disturbance-driven spatial and temporal variability is a vital attribute of Western forested ecological systems." This provided the planning team with a thorough understanding of the ecological integrity of that refuge and allowed them to make decisions appropriately.

Step 2 - Select management targets

Step 1 provides the ecological context and information to make appropriate decisions affecting ecological integrity and refuge management in general. Step 2 tries to identify the best role an individual refuge can play within that context. Step 2 also recognizes that understanding and managing wildlife and ecosystems is extraordinarily complex and allows managers to select manageable, scientifically based targets for management attention. These management targets are intended to represent the biodiversity of the site and the biotic and abiotic processes (encompassed in biological integrity and environmental health) that maintain that biodiversity. These targets should include ecological systems, communities, species and species assemblages selected from multiple scales. Targets may be considered rare, declining, or unique, or may include dominant community types in the area.

The most obvious focal targets are those identified in the refuge's purposes and Service "trust" species. The list of management targets, however, should not end there, as it currently does on many refuges. In fact, many Service "trust" species may be adequately encompassed by target ecological systems, communities, or species assemblages. Management targets may appear in national, regional, and ecosystem plans. The FWS should also look at non-Service plans and analyses of the ecological region including scientifically-based State and non-governmental organization biodiversity conservation plans, such as Florida's habitat conservation plan (Cox et al. 1994) and the Nature Conservancy's Ecoregional Plans.

Species management targets could include federally listed species and other imperiled species and species of concern identified by the Natural Heritage Network (species ranked G1-G3), the FWS, and others. Other targets could include keystone species and species with special requirements, for instance habitat area (eg. wolves) or dispersal limited species (eg. amphibians) (Lambek 1997). Species should be grouped by guild, management requirements, or other criteria. For example, waterfowl as a group would be considered a management target for many refuges because of their similar habitat needs, as could forest-interior birds.

Larger scales should also be considered for management targets. For example, bottomland hardwood forests are already a management target on many refuges. By maintaining

and restoring bottomland hardwood forests, the Service is improving the composition, structure, and functioning (ie. the ecological integrity) of riparian areas and providing habitat to many species. Bottomland hardwood forests thus capture many other management targets.

The FWS Ecological Integrity Policy recognizes management targets throughout: "We provide for the breeding, migrating, and wintering needs of migratory species" (Section 3.10B); "We especially seek to identify keystone species, indicator species, and the types of communities that occurred during the frame of reference" (Section 3.12B). Refuge managers already choose targets to focus their management. These targets need to be reevaluated in the context of this policy. Generally, this will not preclude existing targets, but may lead to the inclusion of additional targets to improve the ecological integrity of the refuge. Ultimately, the selection of specific management targets that attempt to capture the biodiversity and contribute to the ecological integrity of a refuge's ecosystem will make the goal of maintaining ecological integrity more tangible and implementable, than if left as a general concept.

Step 3 - Identify the stresses, problems and threats affecting the focal targets

Stresses, problems and threats reduce the viability or persistence of a management target and thus reduce the ecological integrity of the refuge and ecosystem. Refuges are thought of as places where wildlife are safe from threats, where management focuses on maintaining the populations of certain species. Any active management, however, is essentially used to abate a threat, otherwise FWS intervention would not be required. Stresses, problems and threats include habitat destruction and fragmentation, alteration of natural disturbance processes, chemical, noise, and light pollution, anthropogenic changes hydrology, and disease.

Of course, the list of potential stresses is seemingly endless, and the Service has traditionally done an excellent job of identifying and understanding the problems affecting fish and wildlife. For example, the planning team at Stillwater NWR conducted a systematic resource problem identification and cause-and-effects analysis (FWS 2000, Appendix N). They found that altered topography and restricted flows, presence and spread of nonnative species, including domestic livestock, and unnaturally-high concentrations of contaminants in soils were the major underlying factors affecting biological diversity within the refuge complex. From these stresses, the planning team was able to prioritize the most serious threats, and identify the sources (Step 4) and the actions necessary to correct or mitigate the problems (Step 5).

Step 4 - Identify the sources of the identified problems

Stresses or threats and their causes are often thought of together, and indeed it is often difficult to separate them. Separating resource problems from what causes them, however, allows increased insight into potential solutions to the problems (TNC 2000). The separation of sources from problems appears in the draft policy: "Activities such as logging and mining or structures such as buildings and fences may modify security or thermal cover" (Section3.10C), but it is not made explicit. Without properly defining a problem, inadequate solutions will result. For example, public use may be perceived as a stress to some wildlife. But if we separate the source from the stress, the problem may not be public use but how, when, and where that use is occurring, and stipulations to that use can be devised. This particular example is well covered in the Compatibility Policy, but resource problems other than public use are not.

Another example increasingly affecting refuges is housing development. Is the housing development itself the threat or the source of threats? If housing development was perceived as the threat and blocking it from happening was unsuccessful, then the threat persists. By separating the problems stemming from housing development (eg. altered hydrology, sedimentation, loose pets, habitat fragmentation), appropriate actions may be developed to correct or mitigate them (Step 5). Again, refuge managers and other FWS personnel already go through this exercise, at least intuitively, but an explicit framework as presented here is important to maintain and restore ecological integrity consistently and thoroughly throughout the Refuge System.

Step 5 - Identify the actions necessary to correct or mitigate the problems

Actions that maintain and restore ecological integrity by correcting the problems and threats affecting management targets will appear as goals, objectives, and strategies in Ecosystem Plans, CCPs, and step-down management plans and day to day activities. Importantly, many problems affecting the ecological integrity of the Refuge System originate beyond refuge borders. Eloquently stated in the Service Ecosystem Approach: "The Service rarely controls or manages entire ecosystems. The actions and management of neighboring public and private lands strongly influences the ecological integrity of National Wildlife Refuges..."(FWS, 1994).

The FWS Ecological Integrity Policy instructs managers to address events occurring off refuge lands that "may injure or destroy the biological integrity, diversity, and environmental health of a refuge." These are indeed "bold instructions for a traditionally timid agency" (Fischman 2003). This discussion should emphasize using the full potential of the FWS. "Solutions will make the most efficient and integrated use of our many tools such as land acquisition, land protection easements, refuge management, habitat restoration, natural resource damage assessment, landowner assistance, endangered species recovery, regulatory evaluations, fish restoration, Federal Aid programs, outreach, and education" (FWS, 1994).

Step 6 - Identify a manageable set of indicators to monitor and establish benchmarks to evaluate success

Monitoring and adaptive management appear briefly in the Ecological Integrity policy and in the Refuge Planning policy, but neither provides much guidance. According to Fischman (2003) "there does not appear to be an easily measured bottom line for determining whether the Refuge System is meeting its ecological mandate. This is the greatest weakness of the FWS policy because measured outcomes tend to 'drive out work that produces unmeasured outcomes'" (Fischman 2003, quoting Wilson 1989). This is reiterated by Kay, "In the final analysis, to define ecological integrity is to define a set of ecological characteristics to be monitored for change beyond specific values. To operationalize the notion of integrity requires the development of a monitoring framework and its associated measures and indicators" (Kay 1993). In addition, given the complexity of ecological and human (eg. the socio-economic context affecting natural systems) systems, we will never fully understand or be able to predict the consequences of our actions. Systematic adaptive management is perhaps our best response. It deserves much more attention in FWS policy, guidance, and training.

Indicators should be selected from multiple spatial and temporal scales that measure biological integrity, diversity, and environmental health. Indicators should also be selected to track threat status and abatement. It is important to know, for instance, that contaminants are being reduced as a result of management actions. Knowing this alone, however, is not enough. Ultimately, it is more important to understand the biological response, because fish, wildlife, and plants and their habitats are what the Service is concerned with.

To aid implementation a national inventory and monitoring program should be

established, just as the National Park Service has done. The five goals of the National Park Service Inventory and Monitoring Program are (1) the completion of baseline inventories of biological and geophysical natural resources in all National Park System units with natural resources, (2) the development of long-term monitoring of the status and trends of ecosystems at various spatial scales, (3) the application of geographic information systems and other means to identify and evaluate management of natural resources, (4) the integration of inventory and monitoring with park operations, and (5) the coordination of inventory and monitoring with other governmental agencies to further cost-sharing and to avoid duplication of effort. Having such a program will enable the FWS to strategically plan and fund inventory and monitoring efforts, improve the efficiency of inventory and monitoring efforts, and be in a better position to rally dedicated funding

Conclusion

> *Our predecessors succeeded by taking risks, using innovation, continually trying new methods, and by working together. These same things are needed to tackle the resource issues facing us today... Conventional paradigms of fish and wildlife management must evolve to meet the challenges of the future. - FWS, 1994*

The ecological integrity provision of the Refuge Improvement Act means a lot of things - but not too many to make it worthless for direction. We know when species are in trouble, and we know a lot of the causes of their declines, from fragmentation and habitat destruction, to disrupted disturbance patterns and ecological processes, to soil, water, and air contamination, to competition by invasive species. At its most basic and understandable level, this is what the ecological integrity provision is all about, doing no harm, abating and mitigating threats to this Nation's natural heritage. The provision requires the FWS to think big, to think proactively, and to think about all indigenous organisms and how they fit into a functioning ecosystem before they decline to the extent that they have to be listed under the ESA, or worse yet, disappear from the planet. This is a complicated and tall order, but to make a good faith effort at accomplishing this goal, the Service needs to align its institutional culture and set its management strategies on a trajectory that preserves the biological integrity, diversity, and environmental health of the Refuge System. "The conservation of biodiversity underlies all of the Service's activities, responsibilities, and programs, and should be the primary consideration that managers give in planning and carrying out their day-today mission" (Holle et al 1991).

Ultimately ecological integrity may be more of an overriding goal - a trajectory, not an end point in and of itself. “Like many concepts of great value to people - justice, freedom, love, democracy - integrity is vague and slippery. But these concepts still inspire us; they seem to be fundamentally right” (Noss, 1995). Instead of endlessly debating definitions or struggling to determine end points, the Fish and Wildlife Service has the opportunity to proactively move forward to protect the Refuge System’s ecological integrity, without major changes to existing policy. The framework I recommend can be implemented during training course for refuge management planning.

While the FWS Ecological Integrity Policy took effect in 2001, it has yet to be fully realized. As I suggested above, this is at least partially due to its lack of harmonization with existing policies and practices. Nothing, however, will happen without the leadership of the Service making the maintenance of the Refuge System’s ecological integrity a priority.

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