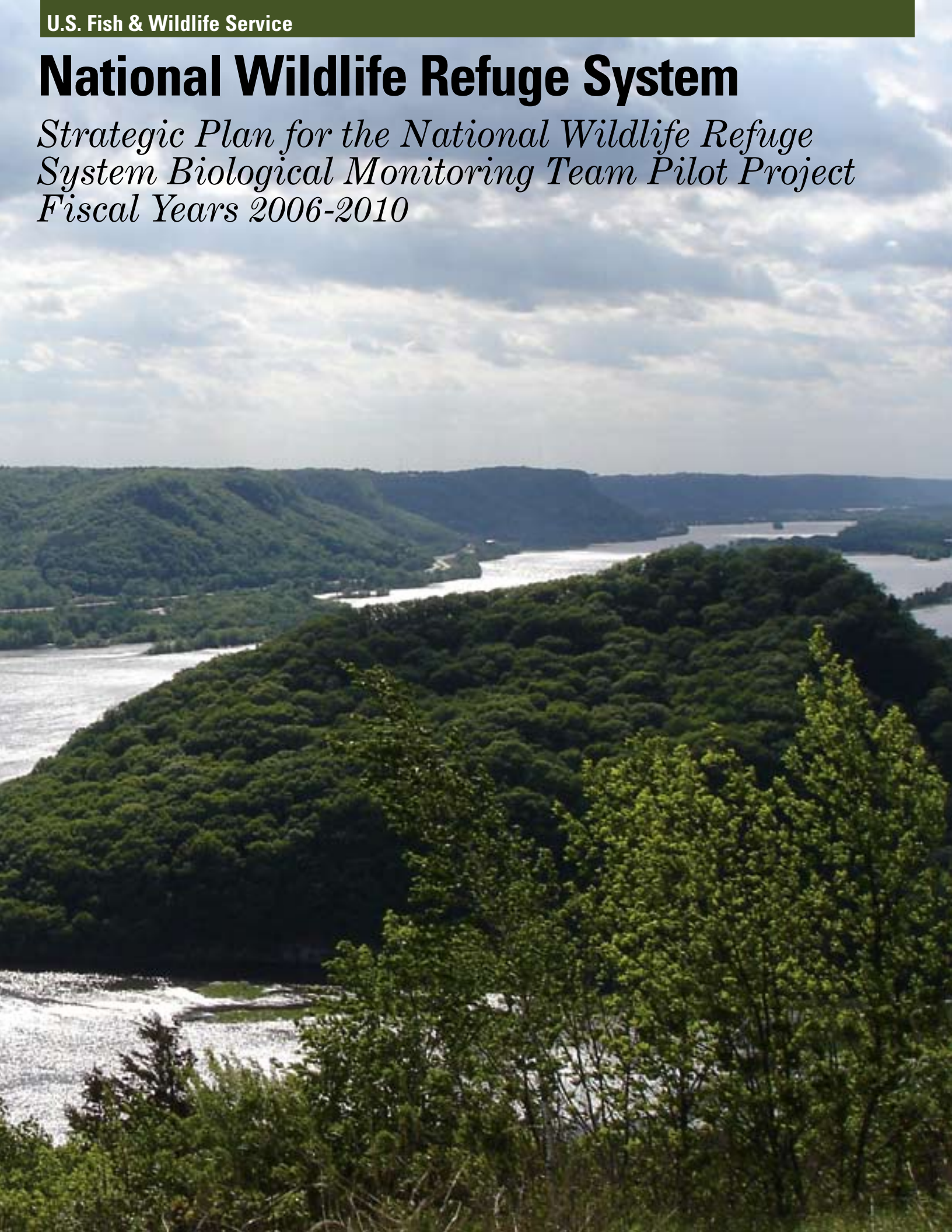
National Wildlife Refuge System

Strategic Plan for the National Wildlife Refuge System Biological Monitoring Team Pilot Project Fiscal Years 2006-2010



U.S. Fish and Wildlife Service Regions 3 and 5
Biological Monitoring Team
La Crosse, Wisconsin
November 2005

This goose, designed by J.N. "Ding" Darling, has become the symbol of the National Wildlife Refuge System.

Table of Contents

Executive Summary 2

Strategic Plan for the NWRS Biological Monitoring Team Pilot Project 4

Appendix A – NWRS Strategic Plan 17

Appendix B – Strategies for Implementation 19

Suggested citation: Knutson, M[A]., H. Laskowski[B], S. Lor[A], and T. Sutherland[A]. 2005. Strategic plan for the National Wildlife Refuge System Biological Monitoring Team Pilot Project, Fiscal Years 2006-2010. U.S. Fish and Wildlife Service, Biological Monitoring Team, La Crosse, WI. 18 pp.+ Appendices. (https://intranet.fws.gov/region9/refuges/biologywebsite/)

[A] U.S. Fish and Wildlife Service, Upper Midwest Environmental Sciences Center, 2630 Fanta Reed Rd., La Crosse, WI 54603
[B] U.S. Fish and Wildlife Service, 11978 Turkle Pond Rd., Milton, DE 19968

Executive Summary

The U.S. Fish and Wildlife Service National Wildlife Refuge System (NWRS) is the premier system of federal lands set aside primarily for the purpose of conserving fish, wildlife, and plants. Science based management decisions are needed for refuges to achieve their highest contributions toward wildlife resources, support refuge management decisions, reduce the uncertainty of management outcomes, and improve efficiency. The need to increase science capacity within the NWRS was identified as a priority issue by NWRS Promises Teams and the Conservation in Action Summit. The Strategic Plan for NWRS Biological Monitoring Team Pilot Project for Fiscal Years 2006 -2010 addresses biological monitoring and adaptive management as components of the NWRS biology program.

The Biological Monitoring Team (BMT) is implementing a pilot program to address biological monitoring and adaptive management needs for refuges. The BMT is starting as a small effort and will not address all monitoring needs of refuges nationwide. The BMT will focus on high priority monitoring and adaptive management needs common to multiple refuges in Regions 3 and 5. The pilot program defines a vision for biological monitoring and adaptive management in the NWRS and identifies three major goals and related objectives, with outcomes and strategies. The BMT will initiate the Strategic Plan under the auspices of the U.S. Fish and Wildlife Service NWRS Regions 3 and 5 as a first step towards a national monitoring program.

Todd Sutherland/USFWS

Biologist collecting soil samples at Trempealeau NWR

BMT Vision for Biological Monitoring and Adaptive Management

The NWRS achieves its highest contributions toward sustaining wildlife resources through effective collection, storage, and analysis of biological data to help determine management priorities, inform management decisions, and guide management actions. Refuges make efficient use of biological information to determine the status of trust resources and evaluate resource responses to management leading to state-of-the-art wildlife management programs. The exchange of data while monitoring wildlife and associated habitats at multiple landscape scales contributes to the efficiency of the NWRS.

To help achieve this vision, the BMT will facilitate the development of biological inventory and monitoring tools that help refuges:

- Determine when to initiate management actions to benefit trust resources;
- Evaluate management actions to optimize benefits to trust resources;
- Evaluate progress toward meeting local, regional, and national NWRS performance objectives; and
- Share biological data with other conservation partners to achieve landscape-scale conservation objectives.

BMT Goals and Objectives for Biological Monitoring and Adaptive Management

1. Refuges will evaluate achievement of their wildlife and habitat goals and track the management and conservation of their natural resources over time and space through systematic collection, storage, and reporting of biological data addressing specific management information needs.
    a. Develop or initiate monitoring plans (protocols, sample designs, and databases) for five high priority NWRS inventory and monitoring needs by 2010.
    b. Make refuge ecological data from five monitoring plans readily available to internal users and outside partners by 2010.
    c. Develop efficient systems for synthesis, analysis, and reporting of refuge inventory and monitoring data for five monitoring plans by 2010.

2. Refuges will initiate management-focused research (Adaptive Management) and develop new tools and techniques to fill information gaps. (Adaptive management research will be used to clarify the outcomes of specific management actions and guide future management programs.)
    a. Identify information gaps and needed management tools, seek funding to support four management-focused research projects, and coordinate two or more active projects through 2010.
    b. Apply new information from research and new, innovative tools to fill refuge information gaps and increase the effectiveness of management actions on at least 100 refuges by 2010.

3. Refuges will contribute to regional, national, and continental conservation of trust resources as partners with other FWS Programs (Migratory Birds, Fisheries, Endangered Species, and others) and the States by collaborating with other agencies performing similar monitoring efforts to ensure that data can be easily exchanged for analyses at multiple landscape scales.
    a. Synthesize and report refuge biological data from three monitoring plans to show the relative contributions of individual refuges to the conservation of trust resources within a larger context (state, ecosystem, region, nation, and continent) by 2010.
    b. Make refuge ecological data from five monitoring plans readily available to internal users and outside partners by 2010.

John Drummond

Dickcissel

Introduction: Fulfilling The Promise

"The mission of the National Wildlife 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 within the United States for the benefit of present and future generations of Americans."

(Refuge System Improvement Act of 1997; Public Law 105-57)

The U.S. Fish and Wildlife Service National Wildlife Refuge System (NWRS) is the premier system of lands set aside for the purpose of conserving fish, wildlife, and plants. With more than 93 million acres of land, 545 refuges, 3,000 waterfowl production areas, and 40 million visitors annually, the NWRS is one of the jewels in the Nation's system of public lands.

The 1997 *Refuge Improvement Act* provided a long-awaited, unifying Refuge System mission and standards for management, use, planning, and growth. In response to this new congressional mandate, stakeholders and representatives from all national wildlife refuges in the nation assembled at Keystone, Colorado (Keystone Conference 1998), to discuss the future of the NWRS. (Note: Throughout this document 'refuges' refers to all field stations of the Refuge System, including refuges and wetland management districts.) Results were published as *"Fulfilling the Promise -Visions for Wildlife, Habitat, People, and Leadership"*. The first seven Vision statements from that historic conference relate to the Refuge System's role in maintaining and restoring ecological integrity and contributing to the science of wildlife and fisheries management. These statements establish a direction and shared sense of purpose for the Refuge system:

Wildlife Comes First:
Refuges are places where wildlife comes first.

Anchors for Ecosystem Conservation:
Refuges are anchors for biodiversity and ecosystem-level conservation and the System is a leader in wilderness preservation.

Healthy Wildlife Habitats:
Lands and waters of the System are biologically healthy and secure from outside threats.

Leaders and Centers:
The System is a national and international leader in habitat management and a center for excellence where the best science and technology are used for wildlife conservation.

Strategic Growth:
Strategically located lands and waters are added to the System until, in partnership with others, it represents America's diverse ecosystems and sustains the nation's fish, wildlife, and plant resources.

Models of Land Management:
The System is a model and demonstration area for habitat management fostering broad participation in natural resource stewardship.

A Legacy of Wildlife:
A strong and vibrant System provides an enduring legacy of healthy fish, wildlife, and plant resources for people to enjoy today and for generations to come.

The FWS works under a system of measurable performance goals and the Refuge System has a five-year Strategic Plan. The plan establishes baselines and targets to help guide budget and management decisions. The Refuge System leadership worked with conservation partners to develop shared priorities during the May 2004 Conservation in Action Summit (Summit; http://refuges.fws.gov/ConservationSummit/). As part of the summit, five white papers identified priorities for refuges in the future and workshops were held among a broad cross-section of internal and external participants. Priorities that emerged from the Summit had many commonalities with priorities identified in *Fulfilling the Promise* (U.S. Fish and Wildlife Service 1999) and are addressed in the NWRS Strategic Plan.

The *Promises* Teams and the Conservation in Action Summit identified the need to increase science capacity within the NWRS as a priority issue. Refuge System *Promises* Teams worked for several years to assess the status of inventory and monitoring programs and data management on refuges nationwide. Science is needed for refuges to achieve their highest contributions toward wildlife resources, support refuge management decisions, reduce the uncertainty of management outcomes, and improve efficiency. The Conservation in Action Summit participants and the *Promises* Teams were concerned that biological monitoring programs and information management systems to track and measure performance goals on refuges were woefully inadequate. The Conservation in Action Summit participants concluded that all five essential components of the NWRS science program were in condition class 3 (inadequate) or class 4 (critical). The essential elements were: Systematically collect and store status and trends data, fill information gaps by conducting management-oriented research or developing new tools, synthesize and apply data to management decisions, provide adequate organizational capacity, and communicate with scientific community and the public. This Strategic Plan and a pilot Biological Monitoring Team (BMT) were developed in response to recommendations made by the *Promises* Teams and the Conservation in Action Summit.

This step-down *Strategic Plan for NWRS Biological Monitoring Team Pilot Project* addresses the first Outcome Goal from the NWRS FY 2006-2010 Strategic Plan (U.S. Fish and Wildlife Service 2005) (Appendix A).

Conserve, manage, and where appropriate, restore fish, wildlife, and plant resources and their habitats to fulfill refuge purposes, trust resource responsibilities, and biological diversity/integrity.

Bill Buchanan/USFWS

Green heron

Scope Of The Biological Monitoring Team

The Biological Monitoring Team (BMT) is implementing a pilot program in Regions 3 and 5 to address biological monitoring and adaptive management needs for refuges. The BMT is starting as a small effort and will not address all monitoring needs of refuges nationwide. The BMT will focus on high priority monitoring and adaptive management needs common to multiple refuges in Regions 3 and 5. Also, the BMT pilot program will work to clarify the contributions refuges can make toward larger landscape monitoring objectives in the two Regions.

As a pilot effort, the BMT will work with refuges in both Regions to identify their priority monitoring needs and solicit refuge review of draft products. Products will be developed by User Acceptance Teams (UATs). User Acceptance Teams will include refuge staff that will use the monitoring products and additional subject matter experts as needed.

Some of the biological monitoring needs addressed by the pilot program may be applicable to refuges in other Regions. Therefore, all information and products developed will be shared with all FWS Regions. It is more efficient to incorporate the needs of other Regions during product development rather than modify a completed product. Thus, as monitoring and adaptive management projects are identified in Regions 3 and 5, other Regions may be invited to participate. Participation by other Regions is voluntary on their part.

As a new NWRS initiative, the BMT will be learning about the processes of coordinating adaptive management projects and developing monitoring plans and databases among multiple refuges. There will be successes as well as lessons learned. Once the pilot program has experience with these processes, the NWRS may want to build upon this work and form a team to revise the Strategic Plan to address biological monitoring needs of the entire NWRS.

USFWS

Collecting impoundment bathymetric data at Prime Hook NWR

Vision, Goals, Objectives, and Strategies

This *Strategic Plan for NWRS Biological Monitoring Team Pilot Project* presents a vision for the future of biological monitoring on refuges, and sets out goals and objectives that address some essential elements of Refuge science practice. Refuges inventory and monitor their biological resources to ensure that management strategies are achieving wildlife habitat conservation, management, and restoration objectives. Monitoring can prevent problems from developing and help refuges honor their legal responsibilities. Furthermore, coordinated monitoring among multiple refuges helps them identify their respective conservation priorities, thus supporting habitat management within the broader landscape. Monitoring is a key element of adaptive management; monitoring measures progress toward achieving an objective and provides justification for continuation or change in resource management approaches.

Vision for Biological Monitoring and Adaptive Management

The NWRS achieves its highest contributions toward sustaining wildlife resources through effective collection, storage, and analysis of biological data to help determine management priorities, inform management decisions, and guide management actions. Refuges make efficient use of biological information to determine the status of trust resources and evaluate resource responses to management leading to state-of-the-art wildlife management programs. Refuges exchange data among themselves and other organizations while monitoring wildlife and associated habitats at multiple landscape scales.

To help achieve this vision, the Biological Monitoring Team will facilitate the development of biological inventory and monitoring tools that help refuges

- Achieve biological goals and objectives;
- Determine when to initiate management actions to benefit trust resources;
- Evaluate management actions to optimize benefits to trust resources;
- Evaluate progress toward meeting local, regional, and national NWRS performance objectives; and
- Share biological data with other conservation partners to achieve landscape-scale conservation objectives.

Goals and Objectives for Biological Monitoring and Adaptive Management

1. Refuges will evaluate achievement of their wildlife and habitat goals and track the management and conservation of their natural resources over time and space through systematic collection, storage, and reporting of biological data addressing specific management information needs.
    a. Develop or initiate monitoring plans (protocols, sample designs, and databases) for five high priority NWRS inventory and monitoring needs by 2010.
    b. Make refuge ecological data from five monitoring plans readily available to internal users and outside partners by 2010.
    c. Develop efficient systems for synthesis, analysis, and reporting of refuge inventory and monitoring data for five monitoring plans by 2010.

2. Refuges will initiate management-focused research (Adaptive Management) and develop new tools and techniques to fill information gaps. (Adaptive management research will be used to clarify the outcomes of specific management actions and guide future management programs.)
    a. Identify information gaps and needed management tools, seek funding to support four management-focused research projects, and coordinate two or more active projects through 2010.
    b. Apply new information from research and new, innovative tools to fill refuge information gaps and increase the effectiveness of management actions on at least 100 refuges by 2010.

3. Refuges will contribute to regional, national, and continental conservation of trust resources as partners with other FWS Programs (Migratory Birds, Fisheries, Endangered Species, and others) and the States by collaborating with other agencies performing similar monitoring efforts to ensure that data can be easily exchanged for analyses at multiple landscape scales.
    a. Synthesize and report refuge biological data from three monitoring plans to show the relative contributions of individual refuges to the conservation of trust resources within a larger context (state, ecosystem, region, nation, and continent) by 2010.
    b. Make refuge ecological data from five monitoring plans readily available to internal users and outside partners by 2010.

Organizational Structure

The pilot program for inventory, monitoring, and adaptive management projects is supported by the U.S. Fish and Wildlife Service (FWS) Regions 3 and 5 National Wildlife Refuge System. The program is expected to grow into a national program with support and contributions from all Regions. A Biological Monitoring Team (BMT) has been formed to initiate the program in Regions 3 and 5. The BMT has a lead Regional Biologist (Laskowski), two wildlife biologists (Knutson, Lor), an Information Technology Specialist (Sutherland), and a SCEP student biologist (Ranallo). The BMT's primary functions are to coordinate, facilitate communication, and provide technical staff assistance to refuges engaged in inventory, monitoring, and adaptive management projects.

The BMT, their supervisors, and Regional Chiefs from R3 and R5 conduct conference calls approximately every 6 weeks. The purpose of these conference calls is to set priorities, identify processes to accomplish projects, develop strategies for refuge participation, and address various issues or problems that are identified. To date, major topics of these conference calls have revolved around the logistics of establishing a new FWS office and setting the direction of the BMT through development of this Strategic Plan. It is anticipated that when the BMT becomes well established, the frequency of these conference calls will decrease. In addition, to ensure that the BMT is addressing priority biological monitoring and information needs, we will create a Steering Committee to advise the Chiefs.

Establishment of Steering Committee

A Steering Committee (SC) will be created to advise and guide work activities and priorities of the BMT. Such a committee is necessary because of the diversity of biological monitoring needs of refuges, competing needs of Regions, and often controversial or politically driven issues that may influence prioritization of monitoring needs.

1. The SC will initially assume the following structure:
    a. The Chiefs of Refuges in Regions 3 and 5 (Nita Fuller [R3] and Tony Léger [R5]) have overall administrative responsibility for the program.
    b. A 10-member SC will advise the Chiefs regarding strategic program direction. The committee members will include
        i. Regional biologist from Region 3/5 (1 person),
        ii. Refuge supervisor from Region 3/5 (1 person),
        iii. Refuge field biologists from Region 3/5 (2 persons),
        iv. Refuge project leaders from Region 3/5 (2 persons),
        v. Regional Refuge Biologist from another Region (1 person),
        vi. The Division Chief of Wildlife Resources (Washington Office),
        vii. USGS Status and Trends Program (1 representative), and
        viii. BMT Leader, Hal Laskowski, R5, will serve as an Ex-Officio Steering Committee member.
    c. SC Members (i. – v.) will serve 2-year terms. Terms will be staggered so the entire membership of the Committee does not change at one time.
    d. The SC will conduct business primarily through conference calls. If required, an annual meeting may be held to review program progress and make recommendations regarding the BMT annual work plan.

2. The BMT Leader will schedule conference calls and provide a draft agenda and background information for discussion during conference calls or meetings. The SC will discuss and provide guidance on BMT priorities, potential projects, processes to accomplish projects, and other logistical or strategic issues relative to biological monitoring and information needs of the NWRS. Decisions and recommendations of the SC will be recorded in notes of the conference call or meetings.

3. Strategic growth of the BMT will require expansion or revising composition of the SC as participation from other FWS Regions and Programs (e.g. Migratory Birds, Fisheries, Endangered Species) increases.

Todd Sutherland/USFWS

Refuge staff explains Trempealeau NWR water level management issues to a BMT biologist

The Goals

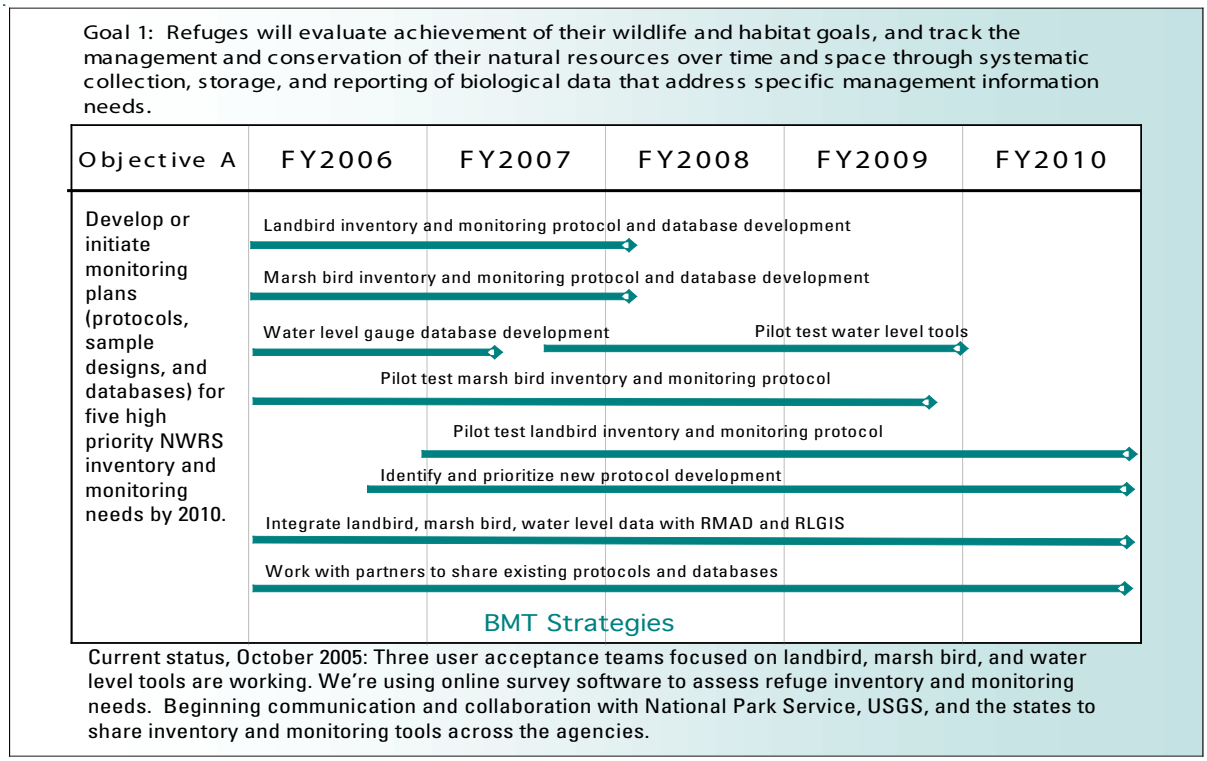
The Strategic Plan has three distinct goals, but with some overlap. Goal 1 is oriented toward developing biological monitoring plans addressing information needs common to numerous refuges. This goal focuses on the need to evaluate the efficiency and achievement of refuge objectives when there is a relatively high degree of confidence or certainty about the management action. Additionally, this monitoring may provide threshold metrics that trigger a management response at a refuge. Biological monitoring plans will be collaboratively developed to address these information needs.

Goal 2 is focused on management issues common to multiple refuges when there is a degree of uncertainty about the management action. In addressing these uncertainties, adaptive management principles will be used in a coordinated effort among multiple refuges conducting the management actions. In conducting these adaptive management efforts, a formal monitoring plan will be required. We anticipate that as the management uncertainty is resolved through this process, the monitoring effort will evolve into a monitoring plan falling under the principles of Goal 1. In the same regard, if current monitoring efforts (Goal 1) identify new uncertainties about a management action, refuges may modify the management actions to better achieve objectives. Therefore, monitoring efforts under Goal 1 will sometimes evolve into formal adaptive management research projects, thus falling under guidelines of Goal 2.

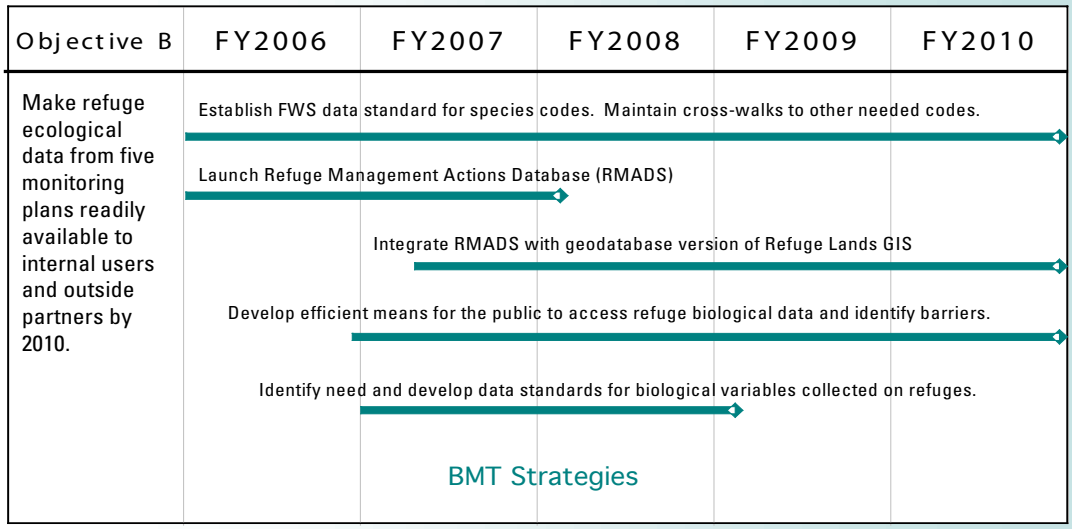
Refuges need to determine their contributions toward wildlife resources within the larger landscape. This knowledge is critical for the identification of appropriate resource objectives and management strategies. Additionally, calls for coordination of both management actions and evaluation of those management actions among agencies are increasing. Goal 3 is directed toward identifying NWRS contributions at these larger landscape scales. Currently, many offices and groups are working to determine landscape wildlife objectives; the BMT will not duplicate these efforts. The BMT will achieve Goal 3 through the design of refuge biological monitoring plans (Goals 1 and 2) that allow efficient exchange of data among agencies. The BMT will actively collaborate with agencies or other organizations to design common protocols and sample designs to meet biological information needs for decision making at multiple landscape scales. Data management tools will be provided for efficient data exchange among the various agencies.

The following charts provide a timeline for tasks (Figs. 1-3) now envisioned for the Biological Monitoring Program. For each goal, they illustrate the current status of protocols, databases, and research that are underway or planned. In addition, the primary outcomes (benefits) of implementing the goals, how the goal may evolve in the future, and constraints are described. Additional specific strategies for each Goal are listed in Appendix B.

Figure 1: A series of charts showing Goal 1 with objectives, tasks, and estimated timelines.

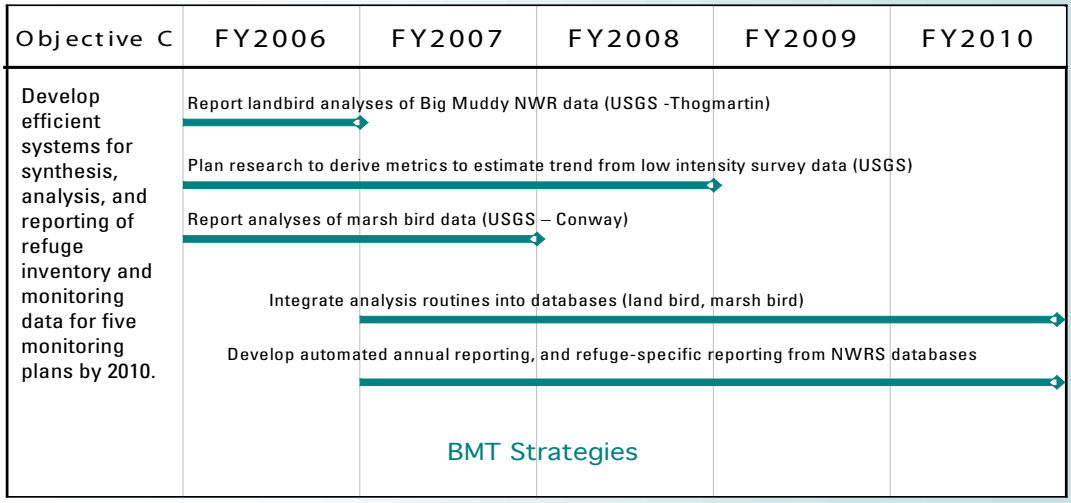


Goal 1: Refuges will evaluate achievement of their wildlife and habitat goals, and track the management and conservation of their natural resources over time and space through systematic collection, storage, and reporting of biological data that address specific management information needs.



Current status, October 2005: Working across FWS to establish a data standard for species codes (Integrated Taxonomic Information System codes) and develop cross-walks with other needed coding systems. RMADS V1.0 scheduled for release January 2006. Discussions started with RLGIS developers to ensure smooth integration of RMADS and RLGIS. Making plans to implement internet-based training for refuges.

Goal 1: Refuges will evaluate achievement of their wildlife and habitat goals, and track the management and conservation of their natural resources over time and space through systematic collection, storage, and reporting of biological data that address specific management information needs.



Current status, October 2005: USGS is conducting analyses of landbird and marsh bird data, exploring analysis options. Land bird database expected to be completed November 2005; beginning to plan automated analyses. Proposals developed for research to derive metrics to estimate trend from low intensity survey data. Planning conference symposia and workshops on monitoring issues.

Outcomes
A wide variety of biological inventories and surveys are conducted at refuges. Currently, there are few resources for biologists seeking to initiate new surveys or evaluate existing surveys; standardized protocols, databases, and analysis approaches are lacking. There are delays in the translation of data into management information, storage of biological data is inadequate, and the application of data in planning and evaluation are inefficient. The effort required to assemble multi-refuge biological data stored in a multitude of formats, spatial scales, and collected under multiple study designs defeats all but the most motivated scientists seeking to synthesize and analyze the data. As a consequence, refuge biological data often remain in raw form and are only superficially used to inform management decisions.

Successful implementation of Goal 1 will result in a biological monitoring and data management program that facilitates efficient collection, management and analyses of data for making and defending refuge wildlife and habitat management decisions. Effective biological data management will facilitate a better understanding of current habitat conditions and the associated fish, wildlife, and plant population status and trends. Individual refuges will be able to effectively and efficiently use their data to support adaptive management decisions. Regional analyses will be conducted to determine the current (through inventory data) and potential (through modeling exercises) contribution of the NWRS to resources of concern, within the larger landscape. Refuges will be able to better manage the ecological communities under their care, such as taking preventive measures to curtail invasive species outbreaks and avoid or stem population declines in trust resources.

An organized, system-wide information management approach for storing biological data and its spatial component will allow the Refuge System to develop a quantitative biological legacy resilient to changes in personnel and loss or deterioration of paper and electronic files. Also, this approach will attract the attention and skills of biometricians within and outside the FWS interested in conducting analyses to meet specific management objectives.

Standardized monitoring protocols that address objectives common to numerous refuges will improve the quality of refuge biological data into the future and increase its information value. Development of standard monitoring protocols for surveys common to numerous refuges will improve NWRS efficiency and allow for the sharing of data among refuges and other agencies. Biological data will be available for reporting achievement of refuge goals and objectives. The NWRS will be able to document biological outcomes and make more reliable natural resource management decisions. All products will be made available to the entire NWRS via the national Biology website.


USFWS

Checking a well in a wilderness area at Agassiz NWR

Evolution
1. The BMT will develop a framework for incorporating monitoring data into long-term refuge management decision-making.
    a. The difficulty with long-term goals and objectives is that the management action and the observation of results are separated by long time periods.
    b. Objectives tend to change over time, so the target is often moving.
    c. A framework is needed for applying adaptive management principles to long-term monitoring data. Many changes are incremental; predictions from models and monitoring must be evaluated over time rather than in conjunction with large annual changes.
    d. Scientists (USGS) and biologist practitioners (FWS) need to work together to explore the theory and tools available for conducting long-term adaptive management and monitoring on refuges.

2. Options will be explored for collaboration with other FWS Programs and land management agencies engaged in similar pursuits (Migratory Birds, Fisheries, National Park Service, Forest Service, Bureau of Land Management, USGS) to determine whether their products can be adopted or modified for Refuge purposes.
    a. Successful collaboration to modify existing

protocols and databases used by other agencies could greatly expand the resources available to refuges.

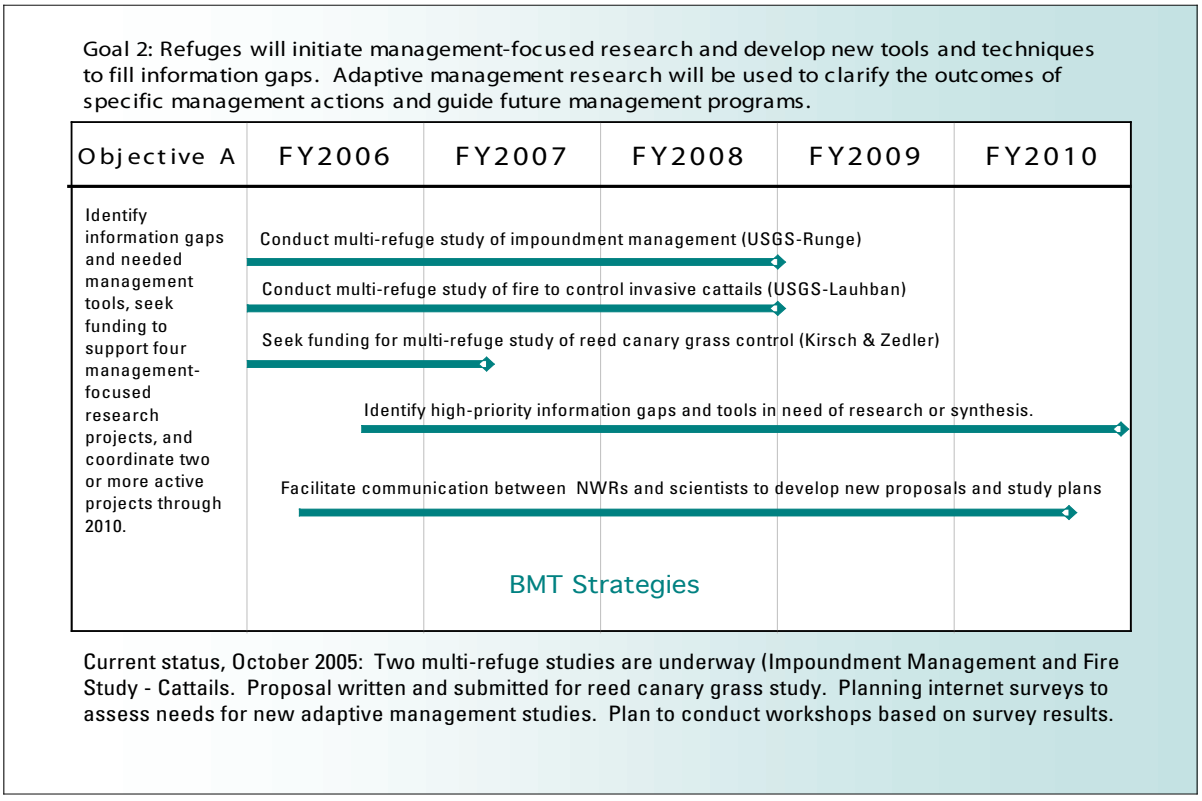
3. Protocols, databases, and reports will be reviewed every five years by the BMT Steering Committee and BMT staff. The review will
   a. Ensure that the protocols and data continue to be scientifically defensible and effectively used to guide management decisions and that refuge needs are being met;
   b. Consider whether the volume and regional extent of the data justify more in-depth analyses by a biometrician(s) to address regional or national refuge management questions;
   c. Recommend changes to the protocols, database, or sampling designs; and
   d. Rank potential new monitoring protocols and databases for development, based on recommendations by the BMT.

4. The steering committee and BMT staff will work to ensure the products are available to the entire NWRS and have application beyond Regions 3 and 5.

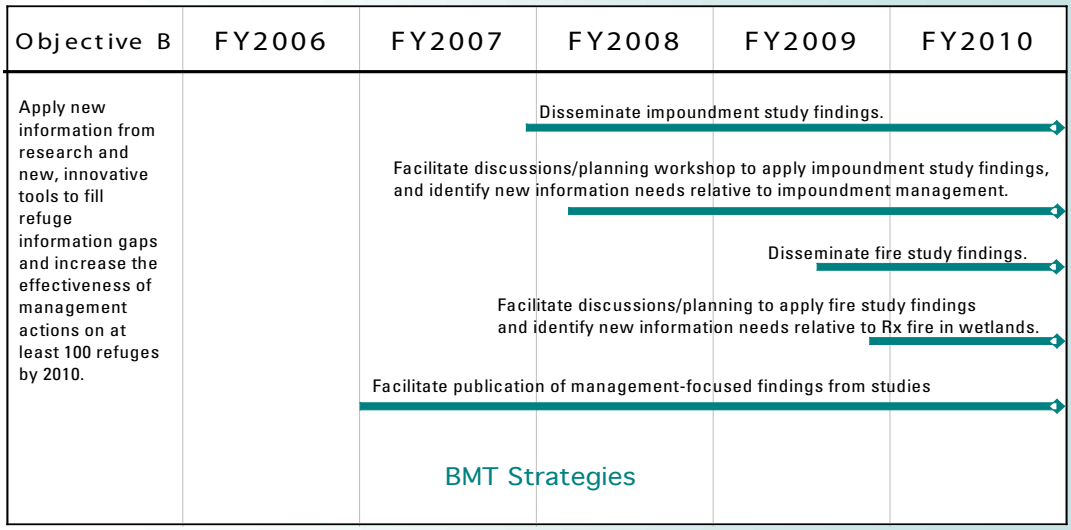
Constraints

1. The BMT will be constrained by the Refuge System's overall level of commitment to achieving the goal.
   a. Involvement and communication between refuges and other FWS programs and BMT staff are crucial to the success of the program, since its primary purpose is to support refuge biological programs.
2. The BMT will be constrained by funding.
   a. The intent is to function as a pilot program with a small efficient staff and with cooperation from many refuge biologists and technical experts. The program is expected to evolve in a decentralized manner, with each Region contributing tools and products that further the program goals.
   b. Operating funds are needed for travel to meetings and to contract for scientific, statistical, and technical expertise.
   c. Database development requires funding for FWS staff and contractors at the National FWS Information Technology Office in Denver.
3. Many of the strategy tasks require the cooperation of a wide variety of partners who are also under tight financial constraints.
4. Technological constraints include security firewalls and the translation of data between desktop computers and servers, and among federal agencies (USGS and FWS).
5. FWS data standards are not in place for most biological data that will be flowing into the databases. Developing standards for a large set of data elements is a long-term endeavor.
6. The process for achieving a NWRS information management system for biological data will be lengthy. The challenge will be to evolve management system functions as data management technology advances.

Figure 2: A series of charts showing Goal 2 with objectives, tasks, and estimated timelines.



Goal 2: Refuges will initiate management-focused research and develop new tools and techniques to fill information gaps. Adaptive management research will be used to clarify the outcomes of specific management actions and guide future management programs.



Current status, October 2005: No research results available to date.

Outcomes

Successful implementation of Goal 2 will reduce uncertainty in resource management decision-making and produce biological metrics to gauge the success of the System in conserving and restoring fish, wildlife, and plant populations. Refuges will provide national and international leadership in habitat management and serve as 'centers for excellence' where high quality science and technology are used for wildlife conservation. Improved habitat and wildlife population management will provide healthy populations of fish, wildlife, and plants throughout the System and will enable the Refuge System to be an effective partner in achieving broader conservation goals beyond the boundaries of refuges themselves.

Evolution

1. Adaptive management projects on refuges will evolve as the science of natural resource decision-making evolves.

2. New projects will incorporate lessons learned from prior projects that produced efficient working relationships and useful management information.

3. The steering committee and BMT staff will develop plans to expand the geographic focus of these projects beyond Regions 3 and 5 within two years.

Constraints

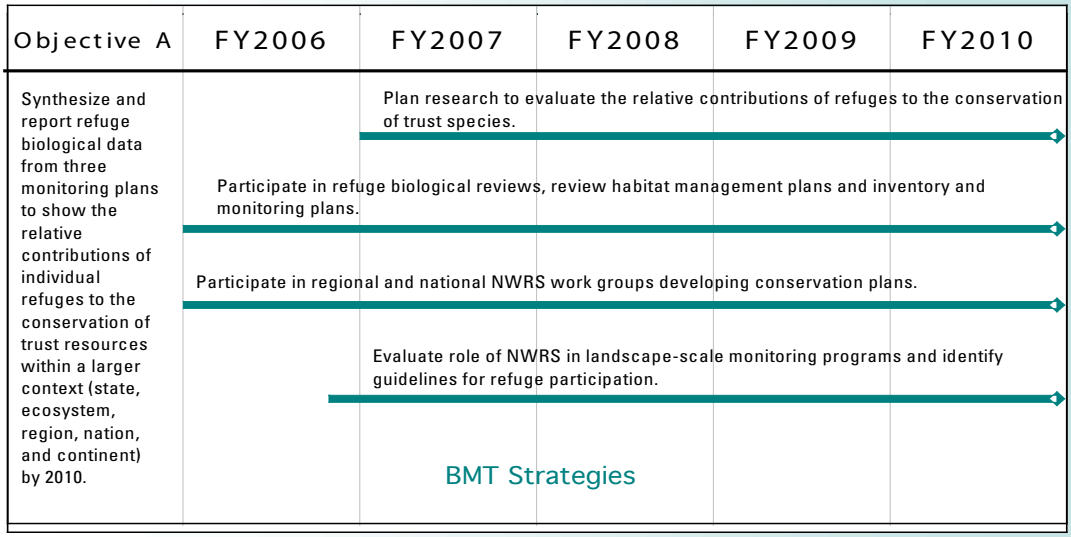
1. The BMT will be constrained by the Refuge System's overall level of commitment to achieving the goal.

2. Adaptive management research requires science expertise and refuge staff time; funding will be a constraint.
   a. Staffing limitations at some refuges may restrict their ability to participate.
   b. Funding and time limitations will restrict face-to-face meetings, making it difficult for refuge staff and scientists to develop working relationships and communicate study objectives, design, and strategies.

3. Refuges need scientists interested in adaptive management questions. These questions tend to be 'messy' and the data analysis is often complex and confounded by other environmental or logistical factors outside the control of the refuge managers. Finding scientists willing to take on these issues may be a constraint, especially if research funding is limited.

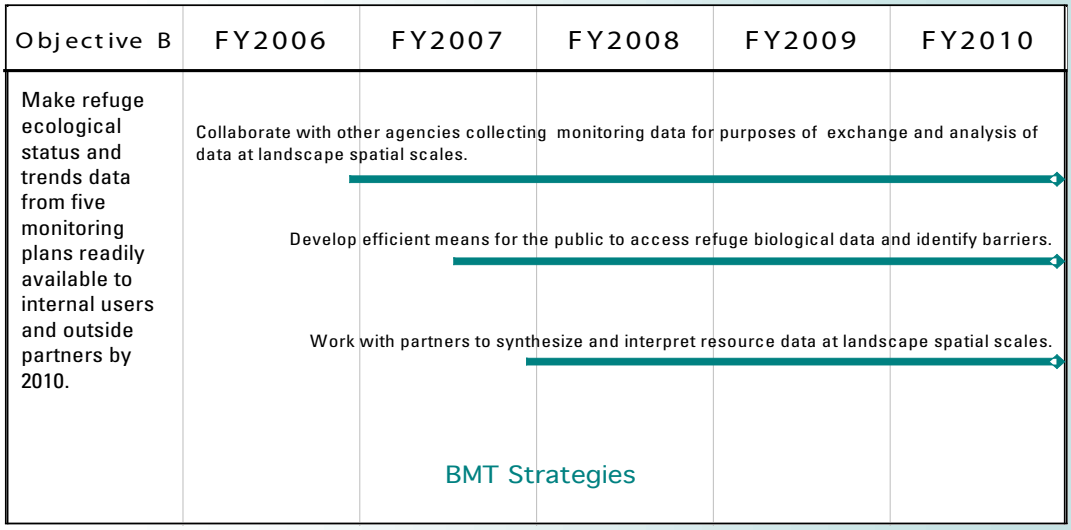
Figure 3: A series of charts showing Goal 3 with objectives, tasks, and estimated timelines.

Goal 3: Refuges will contribute to regional, national, and continental conservation of trust resources as partners with other FWS Programs (Migratory Birds, Fisheries, Endangered Species, others) and the States, by collaborating with other agencies performing similar monitoring efforts to assure that data can be easily exchanged for analysis at multiple landscape scales.



Current status, October 2005: Participated in multi-refuge meetings in R5 to review biological programs on refuges and develop habitat management plans and monitoring programs. R3 all-biologists meeting planned for February 2006. Participating in NWRS national work group to revise the inventory and monitoring policy for the Service Manual. Consulting with Joint Ventures as needed.

Goal 3: Refuges will contribute to regional, national, and continental conservation of trust resources as partners with other FWS Programs (Migratory Birds, Fisheries, Endangered Species, others) and the States, by collaborating with other agencies performing similar monitoring efforts to assure that data can be easily exchanged for analysis at multiple landscape scales.



Current status, October 2005: Participating in species-focused workshops and joint venture committees to develop regional conservation plans for species of concern. Participating in User Acceptance Team developing refuge interface for the National Point Count Database (USGS).

Outcomes
Other FWS Programs and state agencies have primary responsibility for state, regional, and national conservation of migratory birds, fishes, threatened and endangered species, and other species of conservation concern, including hunted species. Refuges manage land important to the conservation of these species. Unfortunately, the status of many of these species is poorly understood at the landscape scale; a better understanding of the relative conservation value of specific geographic locations is needed.

The NWRS will design refuge biological monitoring programs that will allow for sharing of data at larger landscape scales. Most refuge monitoring is conducted at the local scale for the purpose of directing refuge management actions. However, to determine refuge management objectives and priorities, it is important to evaluate a refuges' relative contribution toward the conservation of taxa at larger spatial scales. The BMT will work with refuges, other FWS programs, and other agencies to allow for consistency and sharing of data where appropriate to meet these needs. As a conservation partner, the NWRS will increase its understanding of how refuges individually and collectively contribute to the broader conservation of trust resources, especially species that migrate or occupy specialized habitats managed by the NWRS.

Evolution
1. Landscape-scale conservation planning is evolving rapidly. The BMT will be a partner in developing strategies to comprehensively address the monitoring needs of trust resources at local, regional, national, and continental spatial scales.
    a. As landscape-scale planning evolves, new refuge goals and objectives will become incorporated into Comprehensive Conservation Plans and Habitat Management Plans.
    b. Monitoring programs will evolve to meet these new goals and objectives.

2. The steering committee and BMT staff will develop plans to adapt these strategies for application beyond Regions 3 and 5 within two years.

Constraints
1. The BMT will be constrained by the Refuge System's overall level of commitment to achieving the goal.

2. The BMT will be constrained by staff time. Working with multi-agency partners is time-consuming but has the benefit of producing results of wide acceptance and enduring value.

3. Many of the strategy tasks require the cooperation of a wide variety of partners who are experiencing very tight financial constraints themselves.

4. Specific management strategies that will most efficiently meet the needs of many imperiled species are not defined.

5. Technological constraints include the ease with which data can be moved and translated between desktop computers and servers, and between federal agencies (USGS and FWS).

Scott Yess/USFWS

Mussel survey at Rice Lake NWR

Summary

This Strategic Plan provides a framework for addressing deficiencies in the science capacity of the NWRS identified by the Promises Teams and by the Conservation in Action Summit. The three goals will support processes that refuges are currently seeking to implement: habitat management plans, inventory and monitoring plans, and the management of biological data, both short-term and long-term. The Refuge System will address these issues in cooperation with other FWS Programs and outside partners. The Biological Monitoring Team is charged with initiating this Plan. We envision all FWS Regions working together to implement the goals and objectives of the Plan to support management of the precious natural resources entrusted to the NWRS.

Surveying amount and conditions of feed for deer at Minnesota Valley NWR

Literature Cited

U.S. Fish and Wildlife Service. 1999. Fulfilling the promise: the National Wildlife Refuge System, visions for wildlife, habitat, people, and leadership. U.S. Fish and Wildlife Service, Arlington, Virginia USA.

U.S. Fish and Wildlife Service. 2005. Draft Strategic Plan for the National Wildlife Refuge System: FY 2006-2010. National Wildlife Refuge System, Arlington, VA.

USFWS

Measuring water depths for bathymetric map of impoundment at Prime Hook NWR

Appendix A

National Wildlife Refuge System, FY 2006-2010 Strategic Plan, Goal 1. Conserve, Manage, and Where Appropriate, Restore Fish, Wildlife, and Plant Resources and Their Habitats to Fulfill Refuge Purposes, Trust Resource Responsibilities, and Biological Diversity/ Integrity.

Outcomes: Successful implementation of this goal will result in habitats being maintained in good condition so that they effectively contribute to the biological integrity, diversity, and environmental health of the NWRS. Habitat management in conjunction with population management will provide healthy populations of fish, wildlife, and plants throughout the System and will enable the Refuge System to be an effective partner in achieving broader conservation goals beyond the boundaries of refuges themselves. This is the central focus of the Refuge System as provided in the "wildlife first" mission of the Refuge System Improvement Act of 1997. The NWRS plays an especially significant role in the recovery of federally listed threatened and endangered species. About 20% of the over 1,200 federally listed threatened and endangered species in the U.S. occur on units of the NWRS. Fifty-nine refuges have been established with a primary purpose of conserving threatened or endangered species. Threatened and endangered species or those known to be imperiled are given increased management attention on refuges and more labor intensive actions such as reintroduction programs or control of limiting factors like disease or habitat deterioration occurs where endangered species are involved. Species that are imperiled but not listed as threatened or endangered are also given increased attention so that corrective actions can be taken before a species becomes endangered.

Strategies: Natural resource management responsibilities of the NWRS are varied and complex. A wide range of planning, inventory, monitoring, and analysis actions are necessary to determine the status and condition of natural resources and to effectively guide their stewardship. A systematic, science-based approach will be applied to meet this need (Figure A) 1) establish a process for setting conservation priorities for both species and habitats that allows quantification of national, regional, and local objectives; 2) establish standardized protocols for a systematic nationwide approach to conducting inventory and monitoring of species and their habitats; 3) use state-of-the art technology such as Geographic Information Systems and other information technology applications to analyze and apply all information; and 4) dedicate appropriate multi-disciplinary staffing to enable effective utilization of the overall strategy. This is an essential first step to carry out the Refuge System Improvement Act direction to preserve the biological integrity, diversity, and environmental health of the Refuge System.

Refuge biological management processes for individual refuges are displayed in Figure A. It identifies relationships among goals, planning, and monitoring and displays the fact that different refuges may initiate the process at different stages depending upon information available at a given time. The circular structure of the diagram identifies that this is an iterative process that continues to improve over time.

Natural resource management on refuges most frequently occurs through habitat management that falls into four broad categories: habitat restoration, habitat management, animal population management, and invasive species management.

Habitat restoration includes: 1) restoration of hydrology and functions of wetlands; 2) restoration of upland habitats by revegetation (generally either reforestation or reestablishment of grassland habitats); 3) rebuilding of riffles, pools, and similar structural components within stream channels or other water bodies; 4) restoration of riparian zones by stabilizing streambanks and reestablishing vegetation immediately adjacent to stream channels; and 5) restoring degraded marine or estuarine habitats. Wetland restoration within this work process also provides for the installation or expansion of water management facilities such as dikes, levees, pumps, spillways, water level control structures and associated facilities needed to initiate water level control within impoundments.

Habitat management includes a broad array of habitat manipulation methods that occur either every year or on a repeating basis. For purposes of this strategic plan, it excludes fire management activities related to rehabilitation and hazardous fuels reduction that are treated under long-term goal 11. Active habitat management occurs on over 3.5 million acres of refuge habitats every year and includes: managing extensive wetland impoundments and other bodies of water by adjusting water levels; managing vegetative habitats through prescribed burning, farming, mowing or

haying, grazing, forest treatment by harvest or selective thinning; mechanical treatments such as disking, plowing, or root raking; and application of herbicides to control pest plants.

Animal population management includes monitoring the status of animal populations, especially trust species, and managing populations of waterfowl, large ungulates, predators, fur-bearers, and fish. Population studies are conducted to estimate the size, movement, and survival rates of many populations, especially imperilled, hunted, and trust species.

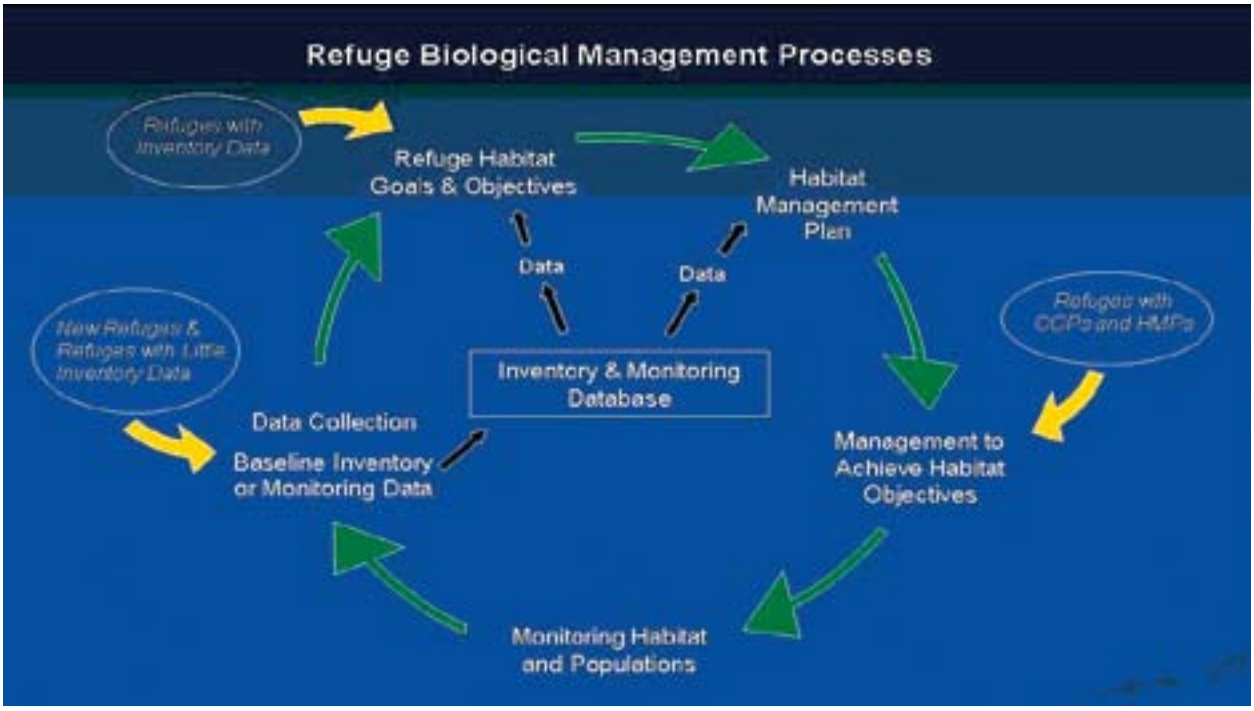
Invasive species management includes all actions to prevent the introduction and spread of invasive species, and to control or remove them where they are already established. Use of integrated pest management techniques is applied wherever feasible but mechanical removal or herbicide application is often necessary where extensive infestations occur. Early detection and treatment of newly emerging problems is sought wherever possible to prevent problems from growing to the point of requiring more difficult and costly treatment regimes. Regular assessment and surveillance of habitats is needed to detect invasions and rapid deployment capabilities are vital. Invasive species can be very persistent; therefore, adequate control frequently requires repeat treatment over an extended period of time. Cooperative work with other entities is necessary to have the greatest opportunity to successfully control invasives. Public education and outreach efforts are important techniques to bolster cooperative detection, prevention, and control approaches.

Due to the need to collaborate with an array of partners and the need to keep all apprised of sometimes contentious management decisions, it is essential that resource management efforts include a focused communications program to keep key internal and external audiences advised as activities proceed.

The Conservation in Action Summit identified many priorities associated with this goal; among them were improving invasive species control, implementing a comprehensive inventory and monitoring program for the entire NWRS starting with a focused monitoring program for migratory birds, and improving the application of science to refuge management needs.

Performance Measurement: Performance is gauged by response of fish, wildlife, and plant populations to the mix of management actions. Developing the standard protocols, the capability to carry out inventory and monitoring programs, and then to complete associated data analyses to guide management adjustments is an essential first step in making progress against this goal. Reporting on the health of NWRS lands requires an understanding of land condition as it relates to fulfillment of the NWRS mission. Also, with respect to invasive species management, the majority of the outcomes of invasive species work are manifested in impacts to vegetative habitats; however, invasive species in some cases directly impact fish, wildlife, and plant populations without affecting vegetation. For purposes of this strategic plan, reporting for invasive species control will be quantified in acres of habitat.

Figure A. Flow chart describing the elements and inter-relationships of the refuge biological management process.



Appendix B

Strategies for Implementation of the Strategic Plan for NWRS Biological Monitoring Team Pilot Project

Goals and Objectives for Biological Monitoring and Adaptive Management

1. Refuges will evaluate achievement of their wildlife and habitat goals and track the management and conservation of their natural resources over time and space through systematic collection, storage, and reporting of biological data addressing specific management information needs.
    a. Develop or initiate monitoring plans (protocols, sample designs, and databases) for five high priority NWRS inventory and monitoring needs by 2010.
    b. Make refuge ecological data from five monitoring plans readily available to internal users and outside partners by 2010.
    c. Develop efficient systems for synthesis, analysis, and reporting of refuge inventory and monitoring data for five monitoring plans by 2010.

2. Refuges will initiate management-focused research (Adaptive Management) and develop new tools and techniques to fill information gaps. (Adaptive management research will be used to clarify the outcomes of specific management actions and guide future management programs.)
    a. Identify information gaps and needed management tools, seek funding to support four management-focused research projects, and coordinate two or more active projects through 2010.
    b. Apply new information from research and new, innovative tools to fill refuge information gaps and increase the effectiveness of management actions on at least 100 refuges by 2010.

3. Refuges will contribute to regional, national, and continental conservation of trust resources as partners with other FWS Programs (Migratory Birds, Fisheries, Endangered Species, and others) and the States by collaborating with other agencies performing similar monitoring efforts to ensure that data can be easily exchanged for analyses at multiple landscape scales.
    a. Synthesize and report refuge biological data from three monitoring plans to show the relative contributions of individual refuges to the conservation of trust resources within a larger context (state, ecosystem, region, nation, and continent) by 2010.
    b. Make refuge ecological data from five monitoring plans readily available to internal users and outside partners by 2010.

Strategies

Goal 1. Refuges will evaluate achievement of their wildlife and habitat goals, and track the management and conservation of their natural resources over time and space through systematic collection, storage, and reporting of biological data that address specific management information needs.

Goal 1, Objective A. Develop or initiate monitoring plans (protocols, sample designs, and databases) for five high priority NWRS inventory and monitoring needs by 2010.

1. The BMT will review the inventory and monitoring surveys for R3 and R5 collected by the Promises Inventory and Monitoring Database Team (WH 9.1, March 2004).

2. We will use internet surveys to obtain information from refuges about their current inventory and monitoring needs. Refuges will be asked to identify their management objectives for conducting the surveys. Some example objectives include:
    a. Baseline inventories (species or community focus) help determine refuge biological objectives and priorities.
    b. Monitor trends of specific species or groups of species to determine when to initiate a management action.
        i. A threshold change in some biological metric triggers a management response.
        ii. A change in a species' status results in new refuge management objectives.
    c. Evaluate management actions and identify Best Management Practices.
        i. Comparison of biological responses on treatment and control sites, or among alternative treatment strategies.

3. The BMT will summarize and rank the high priority monitoring needs as defined by refuges. Criteria used to prioritize inventory and monitoring needs are
    a. Number of refuges sharing a common monitoring need,

b. Opportunity to coordinate with other agencies,
c. Cost of management action (Costly management actions are a high priority for monitoring.),
d. Long-term consequences of management action (timber harvest),
e. Priority or special status of target wildlife/plant species or communities,
f. Frequency of management action,
g. Frequency of monitoring activity,
h. Cost of monitoring (Evaluation to identify the most cost-effective monitoring that will achieve the goal is a high priority.), and
i. Potential to resolve a controversial or sensitive biological issue.

4. The Steering Committee will review and make recommendations to the Regional Refuge Chiefs regarding priorities and the annual work plans for the BMT.

5. For the highest priority inventory and monitoring needs, the BMT will identify existing data collection protocols and databases that have the potential for development into standardized protocols for refuge use.

6. The BMT will identify protocols that should be adapted or developed into a standard protocol for refuge use, along with biologists and scientists with expertise in their use. Criteria for selection includes monitoring that
   a. Addresses the needs of multiple refuges,
   b. Addresses important refuge management questions,
   c. Addresses the needs of FWS trust species, and
   d. Addresses biological indicators or metrics needed by regional or national refuge managers.
   e. Makes use of existing protocols that are widely used or were developed using state-of-the-art science.
   f. Examples include
      i. Marsh bird surveys and database,
      ii. Landbird surveys and database,
      iii. Water level database, and
      iv. Protocols and databases developed by the National Park Service.

7. A User Acceptance Team (UAT) will be formed to oversee the development process for each selected protocol. These teams will be composed of refuge biologists and technical experts. In some cases, a request for proposals (RFP) will be initiated to solicit contracts for needed technical and scientific expertise.

8. A facilitated meeting of the UAT will launch the development process for each protocol. This meeting will clarify how the monitoring will address management objectives, what decisions will be based on the survey results, what reporting is desired, and the most efficient means of collecting and storing the data. Follow-up communication will be via conference call, with a final meeting when we have a product.

9. For each priority monitoring objective, the BMT will work with a biometrician to develop an appropriate survey design to meet refuge management objectives. Survey designs will include guidance on the sampling frame, sampling intensity needed to achieve statistical power, statistical analyses, and example reports. These topics will also be addressed at the initial meeting of the UAT.

10. Protocols will undergo pilot testing by a small set of refuges before they are finalized.

11. Each final protocol and set of sampling designs will undergo peer review in accord with FWS policies. Peer reviewers will include, at a minimum, a biometrician, refuge biologist, and an appropriate technical expert (ornithologist, plant ecologist) outside the FWS. Members of the UAT that developed the protocol are not eligible to serve as peer reviewers.

12. Final protocols will be provided to refuges in a standardized format to be determined. (The FWS Service Manual chapter on Inventory and Monitoring- 701 FW2) is under revision.)

13. An appropriate relational database will be developed to store the data from each standardized protocol. The BMT will work with IT and GIS specialists to develop databases for each protocol. The UAT will provide user requirements and feedback to the developers.

14. Each protocol-specific database will become a module within a larger Refuge Biological Information Management System (RBIMS). The RBIMS will be comprised of a variety of refuge biological data modules, each with the appropriate relational structure and linkages, such that refuge data may be joined with other biological data collected at a refuge.

15. The UAT will identify at what spatial scales the data will be used. If the data are only relevant at the refuge level and sharing of data is not anticipated, then stand-alone applications may be most appropriate. However, if data is to be used at various spatial scales beyond a single refuge or shared, integration with RBIMS will be required.

16. Where appropriate, the BMT staff will coordinate database development with other FWS Programs, organizations, and agencies that have a similar need to monitor wildlife populations at larger landscape scales. Examples of these include Migratory Birds, Fisheries, Endangered Species, USGS Coop Units or Centers, and the Program for International and Regional Shorebird Monitoring (PRISM). Working with

other organizations during monitoring and database development will facilitate the exchange of data with these organizations.

17. BMT staff will conduct and coordinate training to help refuge staff use the protocols and databases.

18. BMT staff will actively solicit feedback from refuges which have adopted a protocol, database, and sample design. This feedback will be summarized and evaluated for any needed modifications to the products.

Goal 1, Objective B. Make refuge ecological status and trends data from five monitoring plans readily available to internal users and outside partners by 2010.

1. Protocols for storage of data will meet FWS quality assurance standards. Care will be taken to ensure that the data entered are accurate and transcription errors are minimized. For example,
    a. Field collected data will be entered into an electronic media whenever appropriate and uploaded into the applicable management information system [laptop computer or personal digital assistant (PDA)].
    b. Data fields will be constrained to the set of possible values for that field. (For example, a data field that requires integers will not accept input of letters or decimals.)
    c. Data will adhere to standards established by the Department of the Interior, the FWS, and the NWRS.

2. RBIMS will be located within FWS and maintained by staff at the National FWS Information Technology Office in Denver. Due to rapidly changing technologies, this office will collaborate with the BMT and others on the overall system architecture and design of RBIMS to facilitate linkages with other appropriate information management systems. Database development may be conducted by FWS, USGS, contractors or others.

3. Routine quality control will be required for data integrated into RBIMS. Potential problems will be identified by the BMT. The BMT will work with the submitting refuge to resolve the issue. Examples include
    a. Summary reports generated to identify erroneous labels,
    b. For quantitative data, analyses to identify outliers, and
    c. Additional data quality checks as recommended by an experienced database administrator or biometrician.

4. The BMT will provide information to refuges that are developing their own local databases (Microsoft Access or the current DOI database standard for desktops) to hold data unique to that refuge. This information will be in the form of data standards, and appropriate relational structures and linkages such that the local refuge data may be joined with other existing refuge data.

5. BMT staff will coordinate updating the databases, fixing bugs, and provide troubleshooting support as needed.

6. Staffing plans will be developed and forwarded to the Steering committee as the program grows and maintenance of databases, protocols, and other products exceeds the time available under current staffing.

Goal 1, Objective C. Develop efficient systems for synthesis, analysis, and reporting of refuge inventory and monitoring data for five monitoring plans by 2010.

1. The BMT will develop annual refuge, regional, and national summaries of Refuge System inventory and monitoring activities.
    a. The BMT Steering Committee will identify data elements that should be summarized and reported annually.
2. The BMT will facilitate analysis of multi-refuge data to identify areas where refuges could collaborate on data collection or planning in the future. For example,
    a. Cooperative management plans and monitoring to address the needs of trust resources that depend upon multiple refuges, ecosystems, or regions.
    b. Metrics that represent indicators of the biological integrity of the Refuge System as identified in legislation and the NWRS FY2006-2010 Strategic Plan.
    c. Analyses that clarify the relative contributions of individual refuges to the conservation of trust resources within ecoregions or other conservation planning units (see Goal 3).

Goal 2. Refuges will initiate management-focused research and develop new tools and techniques to fill information gaps. Adaptive management research will be used to clarify the outcomes of specific management actions, and guide future management programs.

Goal 2, Objective A. Identify information gaps and needed management tools, seek funding to support four management-focused research projects, and coordinate two or more active projects through 2010. This goal will be achieved primarily through a cooperative effort with USGS, pairing refuges sharing a common information need with USGS scientists to address resource management questions. In a cooperative framework, each agency will contribute important, but distinct skills. Multiple refuges may contribute study sites, conduct management actions, and conduct data collection; USGS will contribute scientists to ensure sound study design, analysis, and report writing. The USGS has welcomed the opportunity to partner with

the FWS-NWRS to provide the science needed to underpin our mission and advance the vision and recommendations outlined in *Fulfilling the Promise* (U.S. Fish and Wildlife Service 1999), particularly as they relate to Wildlife and Habitat recommendations (WH1-20).

A major benefit of this cooperative framework for refuges is that projects will specifically address management information needs shared by a large number of refuges. Working together, FWS biologists and USGS scientists clarify the biological uncertainties associated with monitoring actions, and develop appropriate sample designs, monitoring protocols, and data management systems to track refuge management activities and habitat/wildlife responses to management.

Adaptive management studies will focus on resolving uncertainties of existing refuge management actions. Refuge staff will be conducting management treatments and collecting needed data, therefore, all projects must be within the practical limits of refuge staff time and technical skills. Projects that require highly specialized skills, costly technological equipment, or are focused on answering basic ecological questions will be funded and conducted through other sources. Logistics may also dictate the ranking of projects. Staff at a refuge will likely only have resources to participate in one project at a time, given their other responsibilities. Concurrent projects will need to address the needs of a diversity of refuges to avoid over-taxing staff. For example, one project may focus on wetland management and another on grassland management.

1. The BMT solicits from each refuge their highest priority needs for research or technical information.
    a. Internet surveys will be employed to identify needs.
    b. Refuges enter their needs into the Fish and Wildlife Information Needs Database (FWINS, online resource).

2. The BMT will summarize and rank the high priority research and information needs as defined by the refuges. Candidate projects will obtain information that addresses
    a. The needs of multiple refuges,
    b. Refuge staff constraints to participate in a study,
    c. Important refuge management questions (Projects will build upon existing refuge management actions.),
    d. The needs of FWS trust species,
    e. Biological indicators or metrics needed by regional or national refuge managers, and
    f. Priority needs and a possible source of funding for the research.

3. The Steering Committee will review the rankings and make recommendations to the Regional Refuge Chiefs regarding priorities and the annual work plans for the BMT.

4. Adaptive management is necessary to improve the refuge biological decision-making process. Adaptive management is an iterative process for improving decisions while facing uncertainty. A wide variety of uncertainties are inherent in natural resources management, including weak or inaccurate models of how ecological systems function, the variability of soil and climate conditions, incomplete knowledge about animal life cycles and behavior, imperfect understanding of wildlife and human interactions. Adaptive management is a process of integrating both science and management so that carefully designed experiments will directly inform management actions and reduce uncertainty (Figure B).
    a. "By monitoring the system's reaction to management and comparing the result against the predictions of each of *(a set of)* competing models, we can discern over the long run which of the candidate models produces better predictions and then favor that model in future decisions." (Kendall 2001).

5. Adaptive management is an advanced scientific endeavor and resources inside and outside the U.S. Fish and Wildlife Service (FWS) will be required, including refuge managers and biologists, and scientists from USGS, other federal agencies, and universities.

6. The BMT's functions are to coordinate, facilitate communication, and monitor the progress of adaptive management projects that hold the greatest potential benefit for the entire NWRS.

7. The BMT will form a user acceptance team (UAT) for each of the highest priority research issues. The UAT will consist of representatives from the refuges (biologists and managers) engaging in a particular adaptive management project.

8. The BMT and UAT will plan multi-refuge meetings to further develop each priority issue into a reasonable plan for adaptive management research. To minimize costs, face-to-face meetings will only be used when the goal cannot be achieved without it. Whenever possible, meetings will coincide with meetings to define monitoring issues (Goal 1) or be associated with other professional meetings (e.g., State Wildlife Society meetings).

9. The BMT and UAT facilitate multi-refuge coordination meetings focused on a single priority issue.
    a. Participants include interested refuge staff along with scientists with expertise in the topic. Scientists include USGS, Coop Units, and academic scientists.
    b. The purpose of the coordination meeting is to
        i. Clarify and refine refuge inventory, monitoring, and adaptive management

goals and objectives and other needs;
ii. Provide a forum for scientists outside FWS to communicate with refuge staffs and increase their understanding of refuge needs so that proposals closely reflect these needs; and
iii. Increase the quality of proposals developed under short timelines. (A current problem is that when funding is identified, adaptive management research proposals need to be developed quickly and there is insufficient coordination between scientists and refuges.)

c. The format of the meetings will employ a facilitated process to clearly define the management uncertainties and identify research approaches that will address these uncertainties.
d. Meetings will usually be held at a refuge with an interest/need in the selected topic. The UAT is asked to assemble background information on the issue, with assistance/guidance from BMT.
e. The products are
i. A three-page summary (pre-proposal) of adaptive management research focused on reducing management uncertainty about the selected issue. (This document captures agreement by refuge staff and scientists about the main issues and an approach to solving them);
ii. Summary information entered into the FWINS database;
iii. Enhanced communication and understanding among refuges with common issues, and between managers and scientists; and
iv. A solid foundation for developing a full proposal if new funding is identified and further proposal development is needed.
f. Well-developed pre-proposals will attract interest and funding from a variety of sources. It is likely that the scientists involved will search a variety of funding sources to find one that applies to the issue defined in the pre-proposal.

10. Funding is identified for one of the pre-proposals. A variety of funding sources may be used:
a. Funding is allocated specifically for adaptive management research by FWS or USGS and an RFP is issued to solicit proposals. The BMT coordinates the RFP process.
b. Funding is identified from another source: SSP, EPA, Department of Defense, National Fish and Wildlife Foundation, National Fire Program, etc. In this case, the project will be adapted to meet the requirements of the RFP.

11. The BMT works with one or more of the UAT's with a pre-proposal to develop it into a proposal submission.

12. The BMT seeks a principal investigator(s) who will carry the primary responsibility for proposal development. This could be accomplished through a Request for Proposals or another process.

13. If funding is secured for a specific project, the BMT provides refuge coordination before and during the study and is a primary point of contact for the principal investigator(s).

14. The BMT and PI work with participating refuge staff to refine questions, determine treatment actions, develop complete study design, data collection protocols, and training needs.

15. The BMT seeks to include a standardized monitoring protocol and database to store the data, suitable for widespread use by the NWRS, as part of the deliverable products listed in the study plan.

16. The BMT identifies a project officer who will be responsible for monitoring the progress of the project and accepting products.

17. The BMT facilitates publication of study results in a variety of formats (see Reporting).

Goal 2, Objective B. Apply new information from research and new, innovative tools to fill refuge information gaps and increase the effectiveness of management actions on at least 100 refuges by 2010.

1. The BMT will organize workshops and symposia to disseminate the information from recent research to refuge staff.

2. Results of the adaptive management research projects will be reported in technical reports and scientific journals. Two major types of reports will be produced:
a. Reports that describe the Best Management Practices that resulted from the study. (What management actions were conducted and what worked best? The best outlet for these papers needs to be determined.)
b. Reports that disseminate the scientific knowledge gained from the project. (The best outlet for this information is a scientific journal or federal technical paper series.)

Goal 3. Refuges will contribute to regional, national, and continental conservation of trust resources as partners with other FWS Programs (Migratory Birds, Fisheries, Endangered Species, others) and the States, by collaborating with other agencies performing similar monitoring efforts to assure that data can be easily exchanged for analysis at multiple landscape scales.

Goal 3, Objective A. Synthesize and report refuge biological data from three monitoring plans to show the relative contributions of individual refuges to the conservation of trust resources within a larger context (state, ecosystem, region, nation, and continent) by 2010.

1. The BMT will achieve this goal through coordination with a wide variety of government and non-government organizations in the design, coordination, and exchange of data to address landscape-scale conservation issues.

2. The BMT will contribute to landscape-scale conservation by facilitating the collection of data on refuges that is compatible with similar data collected by other organizations outside refuge lands.

3. The BMT will coordinate with Land Management and Research Demonstration (LMRD) Biologists whenever possible.

4. The BMT will participate in multi-agency efforts to design Regional or National monitoring efforts that also meet NWRS needs.

5. Sharing and exchange of information with other partners will assure that refuges have the information they need to identify their contributions to wildlife resources, improve coordination of management efforts, and meet trust resource needs. For example,
    a. Skagen and Knopf (1994) studied wetland sites in the Central Region to evaluate relative contributions to shorebird migration habitat.
        i. Their findings suggested that at each wetland site, habitat quality for shorebirds varied annually with climatic factors. However, with a coordinated management and monitoring plan, larger landscape wetland complexes can collectively ensure that shorebirds are provided appropriate stopover habitat, every year.
    b. Bird conservation groups are working on continental and hemispheric plans that address the needs of migratory birds. Refuges have an evolving role in monitoring and habitat management within these plans. For example, Partners in Flight and the North American Bird Conservation Initiative are
        i. Translating continental wildlife population objectives into regional and local targets;
        ii. Translating population objectives into biologically sound and measurable habitat objectives; and
        iii. Developing quantitative estimates of how much habitat is needed, where, and in what time frame (Partners in Flight 2005).
    c. Elements of the conservation planning process used by Partners in Flight are
        i. Landscape characterization and assessment,
        ii. Bird population response modeling,
        iii. Conservation opportunities assessment,
        iv. Optimal landscape design, and
        v. Monitoring and evaluation.
    d. The FWS National Ecological Assessment Team (NEAT) has outlined an Ecoregion Conservation Assessment Process that involves all branches of the FWS, as well as a host of outside conservation and resource management agencies.

6. The BMT will work with the FWS Migratory Bird Program and other FWS program staff to identify opportunities for collaboration with partners outside the FWS.

7. Refuges will conduct monitoring and evaluation of management actions and will publish their findings so that the conservation community will benefit from their experience.

8. The Steering Committee will review and make recommendations to the Regional Refuge Chiefs regarding priorities and the annual work plans for the BMT.

Goal 3, Objective B. Make refuge ecological status and trends data from five monitoring plans readily available to internal users and outside partners by 2010.

1. Refuge monitoring data will be shared among refuges and with partners by downloading data on request from relational databases.

2. We will work with USGS and NBII to provide consistent and user-friendly portals for access to refuge data.

Literature Cited

Green, R. E., A. Balmford, P. R. Crane, G. M. Mace, J. D. Reynolds, and R. K. Turner. 2005. A framework for improved monitoring of biodiversity: Responses to the World Summit on Sustainable Development. Conservation Biology 19:56-65.

Kendall, W. L. 2001. Using models to facilitate complex decisions. Pages 147-170 in Modeling in natural resource management (T. M. Shenk and A. B. Franklin, Eds.). Island Press, Washington, DC.

Partners in Flight. 2005. The five element process: designing optimal landscapes to meet bird conservation objectives (VERSION May 2005). Partners in Flight Technical Series No. 1. Partners in Flight Science Committee, http://www.partnersinflight.org/fiveelements.

Skagen, S. K. and F. L. Knopf. 1994. Migrating shorebirds and habitat dynamics at a prairie wetland complex. Wilson Bull. 106:91-105.

U.S. Fish and Wildlife Service. 1999. Fulfilling the promise: the National Wildlife Refuge System, visions for wildlife, habitat, people, and leadership. U.S. Fish and Wildlife Service, Arlington, Virginia USA.

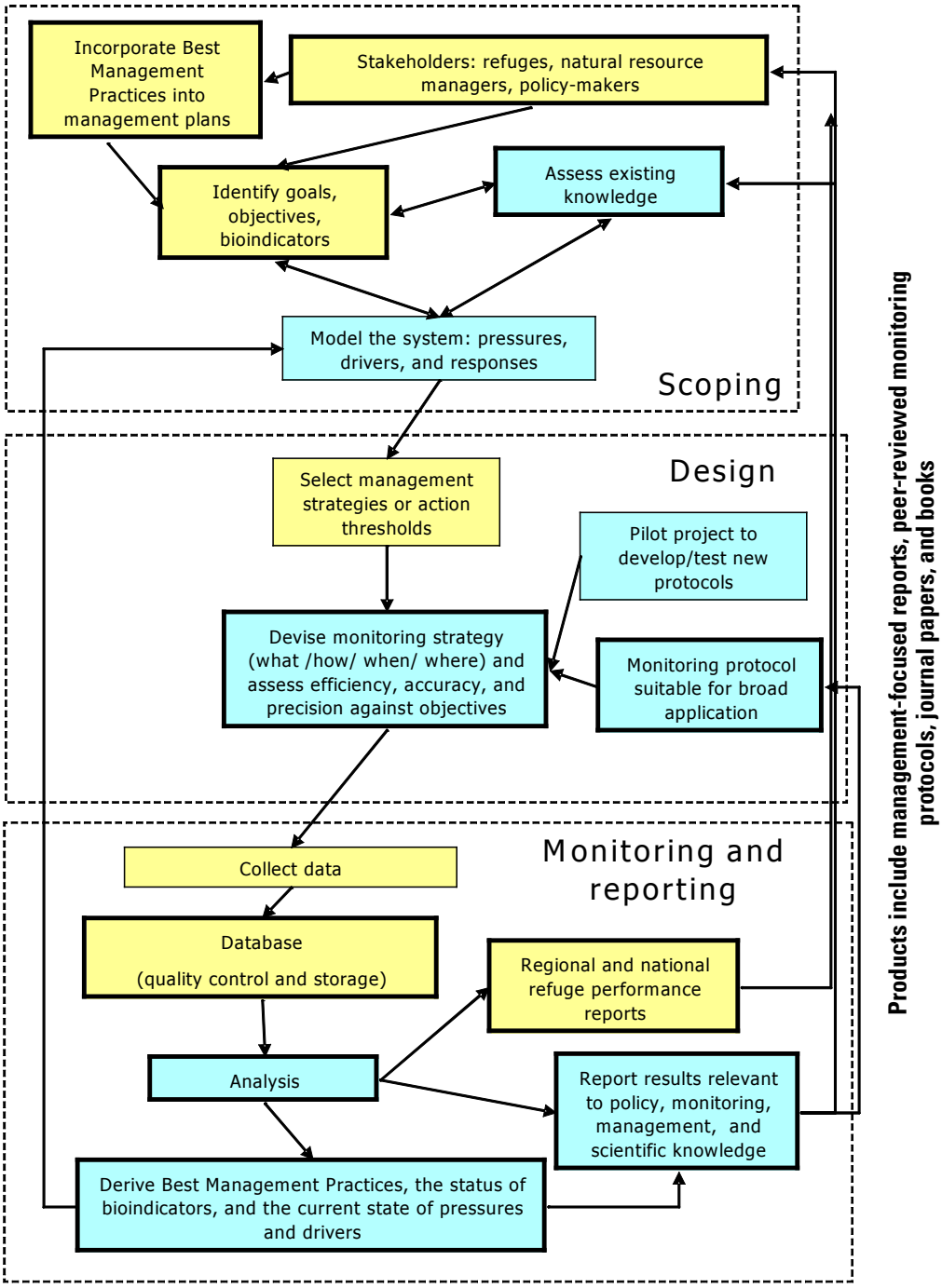


Figure B. Flow diagram of adaptive management process, including the scoping, design, monitoring, and reporting phases. Yellow indicates that the National Wildlife Refuge System has primary responsibility; blue indicates probable collaboration with a science research team (USGS or academia). Bold boxes indicate participation by the Biological Monitoring Team. Adapted from Green et al. (2005).

Northeast Region
U.S. Fish & Wildlife Service
300 Westgate Center Drive
Hadley, MA 01035
413/253 8200
http://www.fws.gov/northeast/

Midwest Region
U.S. Fish & Wildlife Service
1 Federal Drive
BHW Federal Building
Fort Snelling, MN 55111
612/713 5360
http://www.fws.gov/midwest/

Federal Relay Service
for the deaf and hard-of-hearing
1 800/877 8339

U.S. Fish & Wildlife Service
http://www.fws.gov
800/344 WILD

November 2005

Upper Mississippi River National Wildlife and Fish Refuge and adjacent Perrot State Park
Terry Hubert/USGS