U.S. Fish & Wildlife Service

Surrogate Species Version 1.0

Status Report

Draft – November 26, 2013

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U.S. Department of the Interior
Fish and Wildlife Service
Region 3 (Midwest Region)

The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people.

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.

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PREFACE

The following is a draft status report of the Region 3 – Surrogate Species Technical Team entitled, "Surrogate Species Version 1.0" for your review. The report is in the form of a five-page bulleted summary that addresses the seven points listed in the U.S. Fish and Wildlife Service's Director's Memo Attachment A: Strategic Conservation Management – Advancing SHC, Identifying Species and Population Objectives: Version 1.0. A full report providing greater detail as to the evolution of the process is provided in Appendix A.

The report summarizes the process for selecting surrogate species and provides the resulting draft list of surrogate species for the Eastern Tallgrass Prairie and Big River (ETBR) Landscape Conservation Cooperative (LCC) area of the U.S. Fish and Wildlife Service's (Service) Midwest Region. Development of the process, using the July 20, 2012 draft *Guidance on Selecting Species for Design of Landscape-scale Conservation,* began at a workshop in January 2013. The workshop focused on further defining the term "functional landscape" used in the guidance document and how surrogate species can be used to evaluate how effective the Service was in achieving its conservation goals. Following the workshop, a Technical Team comprised of representatives from each of the five Service program areas and 12 states that make up the Midwest Region's LCCs, was charged with developing the process for and selecting a draft list of surrogate species. An Oversight Team, comprised of representatives from each of the five Service program areas, was established to monitor the actions of the Technical Team and develop communication and outreach strategies. The Technical Team began working in April and continued over 17 online meetings and two in-person workshops (June, Indianapolis, Indiana and November, La Crosse, Wisconsin).

The draft surrogate species list consists of 21 species in 12 groups that can serve as umbrella and environmental indicator species for the ETBR landscape. Populations of these species are influenced by at least one of three dominant limiting factors on the ETBR landscape: loss of free-flowing and connected rivers, streams, and associated wetlands; water pollution related to agricultural fertilizers; and loss of grasslands. Of the more than 14,000 species on the ETBR landscape, 475 are federal trust species. The selection process involved an initial assessment of the data available about the response of each species to the three limiting factors. Next, the ability of the species to serve as an umbrella or environmental indicator species was assessed using eight questions related to the following areas: ability to estimate species life history parameters, response to habitat management actions, harvest, response to the chosen limiting factors, population status, the key limiting factors across the range, and response to climate change. Finally, several preliminary lists were generated based on the two assessments, and the data and preliminary lists were discussed and reviewed with panels of taxonomic experts. The supporting appendices describe the selection process in detail according to the ten steps outlined in the draft technical guidance, the limitations on use of the list, and the recommendations for further development in other geographic areas (Appendix A). We also include reports on ways the Service can work together to further select surrogate species (Appendix B) and how the Service might use surrogate species to create landscape scale design for implementation and effectiveness monitoring (Appendix C).

STATUS REPORT – SURROGATE SPECIES VERSION 1.0

Draft – November 26, 2013

In this report:

THE GEOGRAPHY AND KEY ECOLOGICAL FEATURES (E.G., HABITAT TYPES, AQUATIC SYSTEMS)

- Eastern Tallgrass Prairie and Big River Landscape Conservation Cooperative (ETBR LCC) landscape (Fig. 1) and three habitats (grasslands, rivers, and associated wetlands)

OUR STARTING POOL OF SPECIES

- Of the over 14,000 species that exist in the states that comprise the ETBR landscape, we reviewed over 50 conservation plans prepared by the U.S. Fish and Wildlife Service (USFWS, Service), state agencies and non-governmental organizations to develop a preliminary list of approximately 2,900 species of conservation interest in the landscape.
- From this preliminary list of species of conservation concern we further evaluated only those species that are considered federal trust species (Migratory Birds, Threatened and Endangered Species, and interjurisdictional fish). The resulting pool included 475 species. Species for which states have primary management authority were not considered in the selection process beyond those included under the definition of "Interjurisdictional" for fish in the Upper Mississippi River and the Ohio River basins (Appendix A).

A PROPOSED VERSION 1.0 LIST OF SURROGATE SPECIES

- Twenty-one species in 12 groups were chosen as umbrella and environmental indicator species addressing the limiting factors of habitat loss and degraded water quality due to agricultural land use (table 1). Because of the large geographic extent, species were grouped to cover the entire ETBR landscape as well as to consider key times of migration in the annual cycle of migratory birds.
- The selection process involved an assessment of the data available about the response of each of the 475 species to the limiting factors and the ability of the species to serve as an umbrella or

environmental indicator species. This assessment and preliminary list was reviewed by taxonomic experts and refined using their additional data and input. This documented, data-driven, expert-refined selection process is transferable and could be replicated for other landscapes.

- The selection process, limitations, and recommendations for further development are explained fully in Appendix A.

Species Requiring Special Attention

- The hypothesized numbers of species "represented" by the selected surrogate species are shown in table 1. Species that occur in forests, shrublands, barrens, caves, riparian zones, and lakes will require additional attention. A more comprehensive list of surrogates was also selected for eight broad habitat categories within in the landscape (Appendix A, table A8).
- The "representation" of multiple species by one or more surrogates is an initial hypothesis that will require validation through research and monitoring. These research needs create an opportunity for targeting future partnerships as we implement Strategic Habitat Conservation (SHC).

Population Status and Objectives

- Where available, population status was gathered during the species assessment for all 475 species. Sources for existing population objectives were gathered for the bird species that are on the proposed Version 1.0 list. Population objectives still need to be gathered or generated for the fish species on the list. All population objectives are not at the scale of the LCC and a process for gathering and scaling existing objectives should be developed.

Limiting Factors

- Beyond information on habitat loss and water quality issues due to agricultural land use, other limiting factors were gathered during the species assessment for all 475 species where they were known or assumed. Sources for the information are reported in the species database (Appendix A).

SMART Management Objectives

- SMART objectives should be developed after a more thorough review of the Version 1.0 list has occurred and additional thought is put toward implementation. Joint Venture and Bird Conservation Region objectives will need to be scaled to the ETBR landscape for many species. Other species, including most fishes, may need population objectives set for the ETBR landscape.
- Recommendations regarding how to assess where and how often conservation delivery occurs to address these objectives at field stations across the Midwest Region are provided in Appendix A.

RECOMMENDATIONS

REVIEW AND REVISION

The process for selecting surrogate species requires further review and engagement of Tribal partners, and the following should occur before implementation proceeds:

- State, Tribal, and other partner review of the selection process and the resulting Version 1.0 list.
- Engagement of Tribal partners was initiated just prior to the November workshop to test and review the selection process. Restricting our analysis of species to federal trust species only is potentially problematic for some Tribes. Prior to implementation, base data review, inclusion of additional Tribal resources of concern, and Tribal input into the selection process should be considered.
- All base information gathered in the species database (Appendix A) would benefit from a crowd-sourcing exercise, wherein taxonomic experts review and revise data. Upon complete review and revision of the base data, the filtering process could be run again to aid in generating subsequent iterations of a surrogate species list.

TRANSITION TO IMPLEMENTATION

LCC-based teams should explore a conservation design and delivery tool that will allow future conservation actions to be tied to expected population responses (Lor et al. 2011; Appendix B – Alternative 2). In this way, an effective monitoring program can be developed that explicitly links the species, their limiting factors, and proposed management actions. Specifically, the following should be considered:

- Use the Version 1.0 surrogate species list to test implementation of SHC at the LCC scale before expanding the list to other habitats or landscapes. Implementation may yield great insights into the effectiveness of this process for selecting surrogate species and may help realize efficiencies in developing subsequent iterations of the list. Additionally, the Version 1.0 list provides a mechanism for understanding Service priorities in the ETBR landscape and can help focus partnerships with states, Tribes and other conservation entities to better align collaborative and complementary work. One of the most important uses of the list is the development of a conservation design for the ETBR landscape. This design entails creation of spatially explicit model and other decision tools tailored to the design and to how the agency makes decisions about where, when, and how to deliver conservation actions. We should consider where the selected species-habitat relations can be reliably measured at landscape scales and then ensure surrogate species reflect those same measures. As part of initial implementation, we also recommend that the Oversight Team provide clearer guidance in terms of how they would like surrogate species to be implemented. Finally, identifying which state and tribal priority species align with each of the surrogate species or groups could foster this initial conversation with partners. Version 1.0 is a list of regional surrogate species whose job it is to tell us about the success of our habitat conservation actions. For example, have we restored enough acres or river miles in large enough size? Does the habitat contain the important juxtaposition of habitats necessary to support populations at our desired scale? Have we reduced the amount of nitrogen flowing into major rivers? We need to remain cognizant of this regional scope and context as planning, management, and monitoring decisions proceed.

- Revisit with partners the decision to start with federal trust species. Some state managed species have the potential to serve as excellent surrogates, and selecting the "best" set of surrogates would provide the greatest efficiency for conservation design, delivery, monitoring, and evaluation. Additionally, tribal resources overlap with many state managed species and thus tribes have an interest in seeing the starting list expanded to include more species. Crowd sourcing of data for additional species could be readily accomplished using new technologies. In particular, the decision regarding the starting pool of species will need further discussion among all partners as selection expands to the Upper Midwest and Great Lakes and Plains and Prairie Potholes landscapes.
- Revisit the definition of "interjurisdictional" for fish in the Upper Mississippi River and the Ohio River basins. The species identified for the Ohio River needs further review, and defining Service trust fish species will be required to expand to other landscapes.
- Revisit the decision to limit the scope of surrogate species selection to the three habitats identified by the LCC partnership. Similarly, revisit the decision to focus on the limiting factors of habitat loss (e.g., minimum patch size, habitat configuration) and water quality issues related to agricultural runoff (e.g., nitrogen-based fertilizer pollution). The base dataset holds species-habitat-limiting factor information for more habitat categories and limiting factors.
- Adjustments to the Version 1.0 list are expected as further information is gathered for each species. The base data tool provides great flexibility to rerun the analyses as new information is gathered. Transparency is retained as sources for new information are added in support of changes. We recommend the Midwest Region invest in creating an Access database of the species information that is currently contained in an Excel spreadsheet to facilitate future analyses and reporting.

Figure 1. Geographic Boundary of the Eastern Tallgrass Prairie and Big River Landscape

Table 1. Proposed Version 1.0 List of surrogate species for the Eastern Tallgrass Prairie and Big River Landscape

#	Common Name	*Scientific Name*	Habitat	Sub-habitat or Migration Timing	Surrogate Approach	Hypothesized # of Species Represented
1	Henslow's Sparrow	*Ammodramus henslowii*	Grassland	tall grasslands and idle grasslands	Umbrella	68
2	Grasshopper Sparrow Bobolink	*Ammodramus savannarum* *Dolichonyx orizivorus*	Grassland	mid-height and idle grasslands mid-height and haylands	Umbrella	
3	Upland Sandpiper	*Bartramia longicauda*	Grassland	open, short patchy grasslands	Umbrella	
4	Weed shiner Topeka shiner Blackside darter	*Notropis texanus* *Notropis topeka* *Percina maculata*	Riverine	warm water, headwaters, and smaller streams interchangeable across LCC sub-basins	Umbrella	192
5	Greater redhorse River redhorse Shoal chub Pallid sturgeon Shovelnose sturgeon	*Moxostoma valenciennesi* *Moxostoma carinatum* *Macrhybopsis hyostoma* *Scaphirhynchus albus* *Scaphirhynchus platorynchus*	Riverine	warm water, mid-size to mainstem rivers interchangeable across LCC sub-basins	Umbrella	
6	Black redhorse	*Moxostoma duquesnei*	Riverine, Aquatic	cool water, mid-size rivers, and backwaters	Umbrella	
7	Paddlefish	*Polyodon spathula*	Aquatic	large river, flowing water chutes	Umbrella	46
8	Green-winged Teal Mallard Pectoral Sandpiper	*Anas crecca* *Anas platyrhynchos* *Calidris melanotos*	Palustrine	early migrant, wide distribution across LCC mid-migrant late migrant	Umbrella	83
9	Marsh Wren Virginia Rail	*Cistothorus palustris* *Rallus limicola*	Palustrine	emergent marsh, breeder interchangeable across LCC	Umbrella	
10	Smallmouth bass	*Micropterus dolomieu*	Riverine	cool water, headwaters to mainstem	Environmental Indicator	192
11	Black redhorse	*Moxostoma duquesnei*	Aquatic	cool water, mid-size rivers, and backwaters	Environmental Indicator	46
12	River redhorse Pugnose minnow	*Moxostoma carinatum* *Opsopoeodus emiliae*	Aquatic	warm backwaters warm backwaters; clear, vegetated pools	Environmental Indicator	

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DISCLAIMER

Please note the list of participants does not necessarily imply endorsement of methods or results. We anticipate further discussion and effort as the process evolves.

ACKNOWLEDGMENTS

In addition to the Technical Team and Oversight Team members, the following individuals participated in development of the selection process.

January workshop – Dr. Eric Lonsdorf (Chicago Botanic Garden) served as the Decision Analyst; Region 3: Dean Granholm (NWRS; member of the NWRS Planning Implementation Team), Cathy Henry (NWRS; member of the NWRS Planning Implementation Team), Mark Holey (Fisheries); Region 5: Julie Slacum (Ecological Services); Region 4: Bill Uihlein (Science Applications; member of the National Ecological Assessment Team and co-author of the NEAT report [USFWS and U.S. Geological Survey {USGS} 2006] and the SHC Handbook [USFWS 2008]); Dr. Melanie Steinkamp, Office of the Science Advisor; Mike Millard, Assistant Regional Director for Science Applications.

June workshop – Charlie Wooley (Assistant Regional Director – Region 3), Glen Salmon (Eastern Tallgrass Prairie/Big Rivers LCC coordinator), John Rogner (Great Lakes LCC Coordinator), Jeffrey Kiefer (NWRS Partners for Fish and Wildlife Program), and Scott Pruitt (Field Supervisor-Ecological Services)—all USFWS.

November workshop – Taxonomic experts consulted include Brant Fisher (Indiana DNR), Andy Forbes (USFWS), Keith Gido (Kansas State University), Jeff Kiefer (USFWS), Melinda Knutson (USFWS), Brian Ickes (USGS), Louise Mauldin (USFWS), Teresa Newton (USGS), Mike Redmer (USFWS), Bob Russell (USFWS), and Tom Watters (Ohio State University).

We also thank Will Allen (The Conservation Fund) and Andrew Milliken (Region 5, USFWS) for WebEx presentations to the Technical Team in June.

Appendix A: A Process for Selecting Surrogate Species

In this section:

Introduction

The U.S. Fish and Wildlife Service (FWS, Service) has trust responsibility for migratory birds, federally threatened and endangered species, marine mammals, interjurisdictional fish, the National Wildlife Refuge System (NWRS), and a consultation requirement for Tribal coordination. These diverse responsibilities require a strategic means of planning, designing, delivering, and assessing the success of the agency's conservation actions. Strategic Habitat Conservation (SHC) was adopted in 2006 as the Service's business model for setting and achieving conservation objectives at multiple scales. SHC relies on an adaptive management framework to identify information gaps, develop species-habitat models, provide recommendations for conservation delivery, and structure monitoring to achieve desired conservation outcomes. In both the 2006 National Ecological Assessment Team Report (USFWS and USGS 2006) and the 2008 SHC Technical Implementation Guide (USFWS 2008), a surrogate species approach, referred to in this document as a "focal species" approach, was suggested as one method for use in biological planning and provides a means for entering into the SHC process (figure A1).

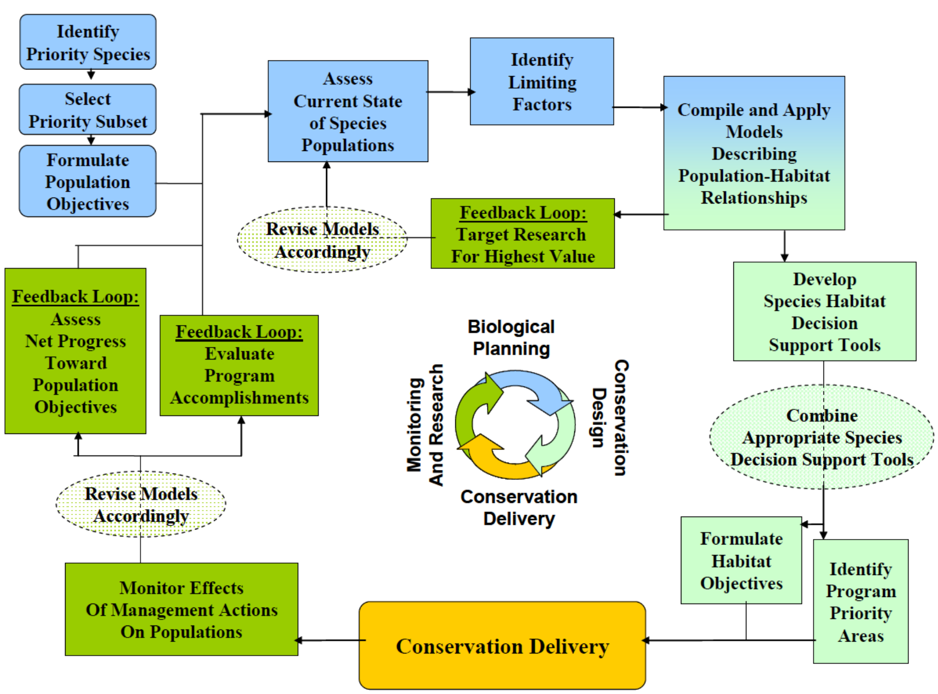


Figure A1. Strategic Habitat Conservation Framework from Strategic Habitat Conservation: Final Report of the National Ecological Assessment Team (USFWS and USGS 2006)

Using a surrogate species approach assumes the Service can focus activities on a reduced number of species yet still benefit a larger pool of trust resources. In addition, tracking progress toward our conservation goals could be effectively managed. The main assumption underlying the surrogate species approach is that by implementing management strategies that support the ecological conditions favored by the smaller set of species within a prescribed area, the needs of the larger set of species will be met. Thus, focusing efforts on surrogate species allows managers to more effectively direct their conservation actions, and the Service can more easily communicate with the American public about our goals and achievements.

SHC is about making decisions. Where do we need more habitat? Where can we work with landowners to improve connectivity between protected areas? Where should we be working and on what projects to more effectively reach our conservation goals? The draft *Guidance on Selecting Species for Design of Landscape-scale Conservation* provides a vision of how surrogates species can help the Service work toward accomplishing its mission (USFWS 2012).

Each decision is predicated on the Service's primary conservation objective as laid out in the draft guidance and the Service's mission statement, which are to "characterize and maintain functional landscapes capable of supporting self-sustaining fish, wildlife and plant populations" and "working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people." For example, the draft guidance states the Service's conservation objective is to characterize and maintain functional landscapes capable of supporting self-sustaining fish, wildlife, and plant populations. Functional landscapes are defined as *"…lands and waters with the properties and elements required to support desirable populations of fish and wildlife, while also providing human society with desired goods and services, including food, fiber, water, energy, and living space*" (pp. 10, 36, USFWS 2012). This statement is a vision of what the Service desires of the American landscape to help meet the agency's mission.

1. Develop and clearly specify the management or conservation objectives for surrogate species selection approach
2. Identify geographic scale
3. Determine which species to consider
4. Select criteria to use in determining surrogate species
5. Establish surrogates
6. Identify species requiring special attention
7. Identify population objectives
8. Test for logic and consistency
9. Identify knowledge gaps and uncertainties
10. Monitor the effectiveness of the approach

Figure A2. The 10 Steps to Selecting Species for the Design of Landscape-Scale Conservation (USFWS 2012)

As with most vision statements, the draft guidance sets a general direction but is vague about the details needed for implementation. Similarly, the subsequent steps in the guidance each require interpretation (figure A2). For example, the guidance states that "Selection criteria should be chosen based on which surrogate species approach (e.g., umbrella, landscape) will be used. Different approaches may be needed even within the same geography" (p. 13, USFWS 2012). However, this statement again, provides little guidance as to why to choose a particular surrogate approach or how to choose the appropriate selection criteria. Thus, the draft guidance is a series of major decisions. The Regional Directors were asked to interpret and implement the draft guidance and generate a Version 1.0 list of surrogate species by the end of 2013.

The Midwest Regional Directorate Team assigned the Office of Science Applications to devise a process and implement the draft technical guidance. Here, we report on the process and recommendations resulting from the work of the Technical Team to generate a species selection process and the Version 1.0 list of surrogate species for the Midwest Region. Throughout the report, we highlight key decisions about the selection process, the scope and scale of Version 1.0, recommendations for further review and development of the selection process, and recommendations for use of the surrogate species through the rest of the SHC cycle.

The Oversight Team

The Oversight Team is a set of cross-programmatic representatives from the Service and one partner state agency. The primary function of the Oversight Team is to provide guidance regarding scope and interpretation of the draft technical guidance to aid the Technical Team in implementing the guidance. The Oversight Team also facilitates communication with staff at the national-level and with staff engaged in other regional-level surrogate species initiatives as well as develops communication strategies for Service staff and partners. The Oversight Team held one-hour weekly conference calls from March through December 2013.

Clarifying the Purpose and Approach of the Technical Team

The Technical Team drafted a purpose statement, guiding principles, and a vision statement for the benefits of working as a partnership to define and work towards a developing a surrogate species list. These were the first products of the team before it began implementing the draft technical guidance.

Purpose Statement for Technical Team

Across each of the LCC geographies, the Technical Team will determine the species metrics that characterize "functional landscapes" to guide Service activities and contribute to broader conservation community goals and objectives, as appropriate.

The Technical Team will identify a set of species for the Service to use to focus conservation decisions and actions to achieve specific biological outcomes. This list of species is not limited to Service's trust species, but can be augmented with additional species to reflect specific objectives for the selected surrogate species. Establishing surrogate species will:

1. Represent
    a. broadly recognized conservation priorities or a broad range of species and habitats, and
    b. associated ecosystem service objectives;
2. Inform explicit measures (for species identified, such as site requirements, regional geographic distribution) for conservation objectives;

3. Identify priority locations for the protection, restoration/re-creation, and on-going management of habitats or other landscape features through the use of geospatial mapping tools;
4. Inform a systematic approach to setting population objectives that considers multiple benefits, tradeoffs, and cost-benefit relations;
5. Guide spatial modeling and biological monitoring activities; help to promote greater integration among planning, modeling, implementation, and monitoring.

The Technical Team will work with the Oversight Team to ensure proposed surrogate species follow guidelines set forth in the decision framework currently under development via a national, state and Service leadership team. For purposes of the Technical Team's work, the Service will only select state trust species with concurrence from the state(s) involved.

Anticipated Implementation of Surrogate Species

Surrogate species will provide the foundation for SHC. This means surrogate species will receive increased attention for biological planning, conservation design, monitoring and implementation.

Biological planning work will directly incorporate surrogate species into planning efforts, as priority species for guiding acquisition, restoration, and management activities; surrogate species parameters will be considered outcome-based metrics of "success," leading to increased consideration of population targets (i.e., down-scaled population targets at multiple scales) and ultimately relied upon as a measure for accountability purposes.

Conservation design will focus on prioritizing the benefits for surrogate species and their habitats. Related spatial modeling will focus on the development and refinement of models and decision support tools to evaluate priorities for surrogate species and explore the biological implications of future landscape changes.

Conservation delivery (protection, restoration, and management activities) will use surrogate species-related tools as one means for evaluating opportunities and developing targeted strategies. Limiting factors associated with surrogate species will help drive acquisition and management decisions.

Monitoring efforts will emphasize tracking surrogate species populations or related species parameters (such as survival, occupancy, nest success), and linking monitoring data with spatial models used for conservation design and related decision support tools. Monitoring and research efforts will also work to evaluate assumptions related to non-surrogate species, to determine whether the surrogate species approach is encompassing the needs of other important species and ecosystem services.

Guiding Principles and Strategic Objectives

Structured Decision Making and Rapid Prototyping

We relied on two approaches to aid in implementing the draft technical guidance and designing our surrogate species selection process. Following the format for deconstructing any decision process provided by Hammond et al. (1999), the Technical Team quickly but logically thought through the problem and created a prototype solution that could be revisited, tested, and improved later. The following steps: Problem definition, Objectives, Actions, Consequences, and Tradeoffs (PrOACT) were used to arrive at ideas for an initial prototype.

Second, the process of rapid prototyping is often used in engineering to quickly learn and develop a model as a low investment-high return means of addressing problems. The process of rapid prototyping was used to quickly learn and develop a model by moving quickly through the steps. Via this rapid process, the pace at which learning and improvement of prototypes is accelerated by building multiple versions and only adding detail as needed.

Strategic Objectives

Strategic and process objectives are especially important in decisions made by government agencies (Moore 1995). In this situation, both what is chosen and how the alternative is chosen are important. The following three strategic objectives guided all of the Technical Team's decisions when interpreting the draft technical guidance and designing the surrogate species selection process:

1. Transparency. Use a clear, well-defined process.
2. Replicable. Ensure that the process is well-documented and can be replicated in the future as required by the SHC cycle.
3. Inclusiveness. Value all team members' opinions in the process.

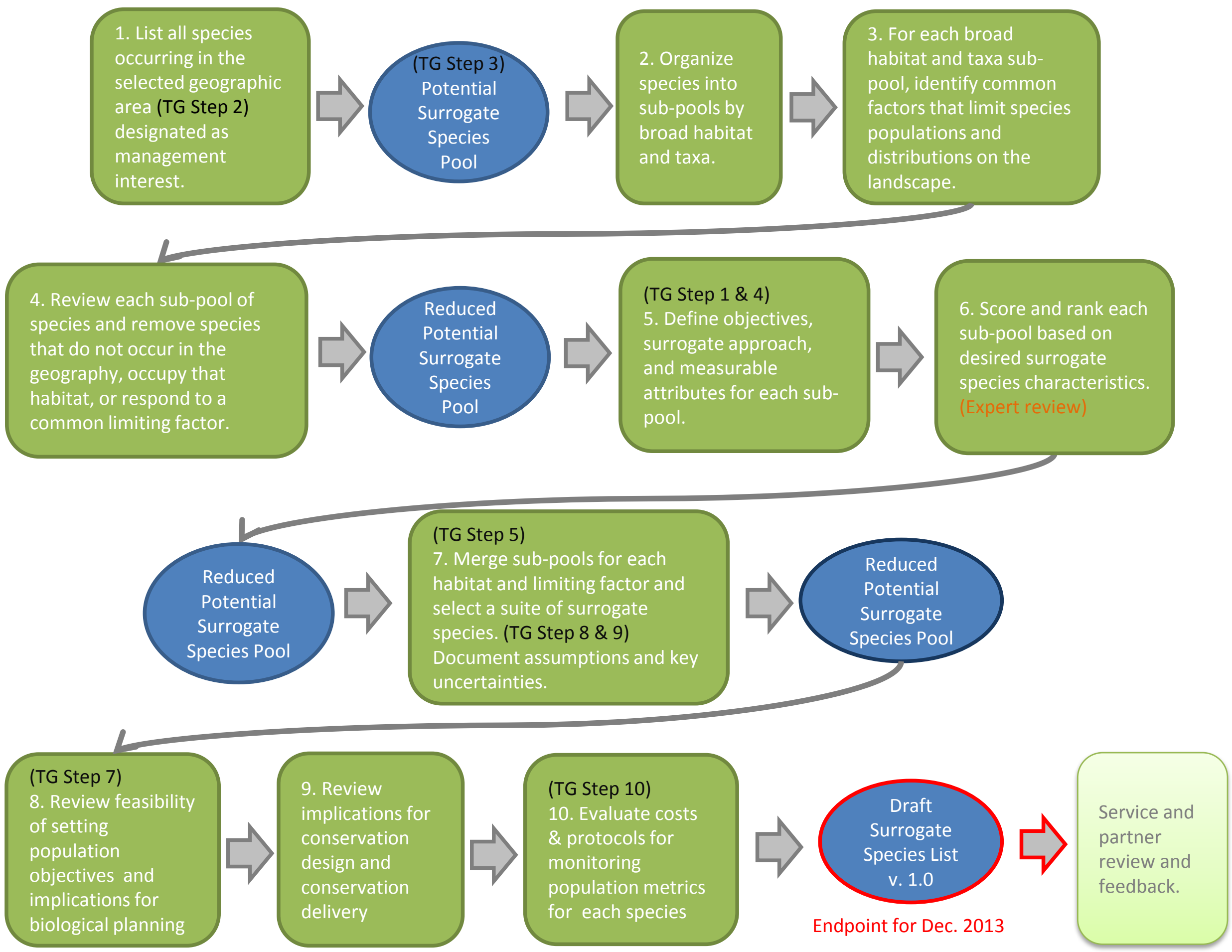
Implementation Process

The Technical Team struggled with the complexity of implementing the ten steps in the draft technical guidance based on Wiens et al. (2008). The struggles primarily centered on how to focus objectives on habitat and limiting factor categories in a transparent fashion. We needed a method that could be understood and used to develop subsequent versions of the surrogate species list and as the species are used throughout the SHC process. We developed a process diagram (figure A3) to aid us in implementing the ten steps in the guidance and highlight the key decisions we had to make to implement the guidance.

We had to make the following key decisions in our process diagram:

- Organizational scheme to delineate broad habitats – Step 2
- Degree to which we divide species into taxa groups and guilds – Step 2
- Method and information sources to identify factors that limit species populations and distributions on the landscape – Steps 3 & 4

- Process for defining means objectives, measurable attributes, and surrogate approaches – Step 5
- Subject matter experts to review and staff to conduct literature review – Steps 3, 4, & 6
- Criteria to score and rank the sub-pools – Step 6
- Criteria and technique for merging sub-pools – Step 7
- Information sources and method to evaluate existing population objectives – Step 8
- Information sources and method to evaluate conservation design tools and existing management actions – Step 8
- Information sources and method to evaluate monitoring approaches, protocols and existing programs – Step 10



(TG Step #) – indicates steps in draft technical guidance

Figure A3. Process Diagram to Aid the Technical Team in Implementing the 10 Steps of the Draft Technical Guidance

A log of the Technical Team's decisions made during our 17 online meetings that occurred from April 15 through October 30 is provided below (table A1). Additional information about the rationale, context, or additional supporting discussion can be found in the meeting minutes associated with each decision and the documents posted on the Team's Basecamp site. Appendix C provides more information on the preliminary workshop held in January.

Table A1. Log of the Technical Team's Decisions

Date	Decision/Item	Reason/Rationale
5/1/2013	Prototype filtering process for single ecosystem.	Test process as presented for a single broad habitat type. Share with Technical Team next week for identification of considerations and modifications necessary.
5/1/2013	Evaluate primary filtering options based on conservation priorities.	Review primary filtering options presented and share considerations with the next Technical Team meeting to hone options preferred for initial prototyping.
5/15/2013	Develop a technical team charter for surrogate species.	Defining how surrogate species will be used influences the selection process. We need a document that can be used as a reference during the process to check ourselves.
5/22/2013	Draft objective statement.	Agreed as a group it is an acceptable draft at this point with the understanding that we may need to re-visit at some point
5/22/2013	Sharing draft objective statement with Oversight Team.	Agreed that it can be shared as is with the caveat that it is a work in progress and shows a focus on habitat restoration, protection, and management.
5/29/2013	Accepted Craig C's revisions to Objective Statement.	Changes seem reasonable. Minor tweaks to the language were made.
5/29/2013	Objective document can be shared with R3 Director and HQ.	Need to understand that it is a work in progress and provides the opportunity to show others our approach.
5/29/2013	Agreed to the revised definition of functional landscape.	Group discussion on the bounds, parameters, and role of surrogate species in a functional landscape.
6/5/2013	Agreed that the updated process to use habitat limiting factors in supporting surrogate species selection is acceptable.	Agreement that this is a reasonable approach.
6/5/2013	Agreed we can begin to populate database (through Step 4) with limiting factors based on information identified in state wildlife action plans (SWAPs).	Will help to provide information during the workshop.
6/12/2013	Confirmed workshop agenda.	It is reasonable to complete Step 8 by the end of the workshop. We will focus on the developing process.
6/12/2013	Surrogate selection process.	We can pre-populate through Step 5 for each coarse habitat and LCC boundary prior to the workshop to facilitate discussion. Utilize the SWAPs for a good start on threats.
7/17/2013	Group decision making.	Criteria for group decisions were determined. See page 3, Item III.c.i.1 of meeting minutes for a list of the criteria.
7/17/2013	Use of "test rockets" to evaluate team concerns with certain aspects of process.	Team agreed with pursuing test rocket approach proposed as a way to evaluate some of the concerns shared at the June workshop. Team requested a means for consistent evaluation of alternatives reviewed.
7/31/2013	Group decision making.	Amended (clarified) the criteria to include that decisions will be made by a majority vote of quorum present at the time of the vote.
8/14/2013	Draft evaluation document.	Reduction needed to move forward with evaluation

Date	Decision/Item	Reason/Rationale
		method for review of our test rockets.
8/14/2013	Test rocket evaluation.	Test out the 15 needs on the reduced pool at the end of each test rocket process.
8/28/2013	Evaluation of learning objectives.	Objective weighting helped to eliminate objectives for evaluation.
9/11/2013	Test rocket evaluation.	Reduced quantitative evaluation of test rockets to reduce redundancy.
9/11/2013	Scope of Version 1.0.	Reduced scope of v1.0 due to time limited and added flexibility from national office. Focus on ETBR LCC and federal trust species.
9/11/2013	Use International Union for Conservation of Nature (IUCN) threat taxonomy to organize limiting factors.	Standard with SWAP revisions best practices.
9/25/2013 & 10/30/2013	Refine selection diagram.	Final reports from two test rockets and species selected in optimal selection process indicated a further need to ensure species that are outcome of selection process can be used for full SHC circle.

INTERPRETING THE 10 STEPS OF THE DRAFT GUIDANCE

DEVELOP AND SPECIFY CONSERVATION OBJECTIVES

DEFINING A FUNCTIONAL LANDSCAPE

One significant challenge faced by the Service and other land management agencies is understanding the needs of multiple species in the context of current and potential future landscapes. More specifically, how we design the system of protected areas, influence the matrix of private lands that surround them, and how well the designs support all species once conservation plans are realized. By understanding what is limiting wildlife populations in a particular landscape or throughout the organisms life cycle, we can begin addressing deficiencies via conservation actions (e.g., land acquisition, easements, best management practices, policy changes, etc.). Functional landscapes for fish, wildlife and plants can be created through a shared vision about *how* conservation agencies and the public can affect land use practices and *where* they desire to protect, restore or reconstruct wildlife habitats.

Examining the definition of a functional landscape in detail at a workshop in January provided us a key insight to interpret Step 1 in the draft guidance:

"*Functional landscapes are defined as lands and waters with the properties and elements required to support desirable populations of fish and wildlife, while also providing human society with desired goods and services, including food, fiber, water, energy, and living space*." (p. 10)

The team realized that the "properties and elements" phrase indicated that a set of characteristics could be a way to further define functionality of a landscape. These "properties and elements" are the factors that limit populations of wildlife, fish, and plants within that geography. To select surrogate species, defining a functional landscape in this way allowed us to focus on the factors that limit species populations. This discussion of how to define and interpret what a functional landscape is proved to be difficult and remains a point of contention with some Technical Team members. This perspective state that functional landscapes simply cannot be defined.

SETTING CONSERVATION OBJECTIVES: SPECIES VERSUS HABITAT OBJECTIVES

There was repeated debate on the Technical Team about whether to 1) select species *a priori* and then look for habitat relationships and resource needs or 2) to look at the landscape along with the resources of concern to identify the resource needs and select species. The draft technical guidance directs us to select species first, but there was concern about doing this without considering features of the landscape. Setting our objectives to define our functional landscape required looking forward in the SHC framework (figure A1). At a generic level, the team had to think about the limiting factors, the population-habitat relationships, and the ways to set habitat objectives for the species in the landscape.

In preliminary work to implement Step 1 of the guidance, the team initially focused on habitat objectives and identified landscape characteristics that support species and define landscape quality. Within the context of structured decision making, providing a landscape that supports species became our fundamental objective. We then identified characteristics, those properties and elements, we felt most influence landscape quality (our means objectives). We selected measures for each objective that reflected the effects of conservation actions on those objectives, and we identified a pool of species that were related to our means objectives. Appendix C contains more detail on this process.

For a second round of preliminary work, we used the State Wildlife Action Plans for the states within ETBR landscape to generate a possible list of limiting factors (i.e., threats) that affect the species that use each of ten broad habitat categories (e.g., grasslands, forests, riverine systems) as placeholders for our species-habitat needs. This approach remained unsatisfying to some of the Technical Team members because of the opaque link to the specific factors that limit the species on the landscape.

To implement Step 1 of the draft technical guidance for Version 1.0, we conducted a search of all the limiting factors for the species that use the ETBR landscape (see the section, Identify Geographic Scale). We used existing priority species lists and compiled and screened these lists based on guidance in the NWRS's Handbook for Selecting Resources of Concern (USFWS 2009). As shown in figure A1, we used a combined species and habitat approach. Literature searches helped to delineate how many species were affected by a particular limiting factor and the habitat associations of those species. Although our literature search was conducted for only the 475 federal trust species (See the section Determine which Species to Consider) in the ETBR landscape, this approach resulted in a database of limiting factors that can be used to prioritize among the factors based on how frequently they affect species and could be expanded to include other species of conservation concern. We used these limiting factors (i.e., habitat loss, connectivity, water quality) to set objectives for species selection and focus our surrogate approaches on umbrella and environmental indicator species (Caro 2010). Although still a point of contention with some Technical Team members, the objectives hierarchy diagram represents our definition of a functional landscape and how we focused our search for surrogate species (figure A4). Stated formally following structured decision making terminology, our objective for the ETBR landscape is as follows:

- **Fundamental Objective:** Maximize sustainable populations of trust species in ETBR landscape in grasslands, rivers, and associated wetlands. Species objectives should be stepped down from continental or regional plans as appropriate. In this case, maximize indicates that most species population abundance will need to increase to meet population objectives.

- Maximize self-sustaining/desirable populations of federal trust species in grasslands.
    - Select species sensitive to minimum patch size and/or landscape configuration to serve as umbrella species.
- Maximize self-sustaining/desirable populations of federal trust species in rivers and associated wetlands.
    - Select species sensitive to aquatic connectivity to serve as umbrella species.
    - Select species sensitive to nitrogen-based fertilizer to serve as environmental indicator species for agricultural water quality issues.

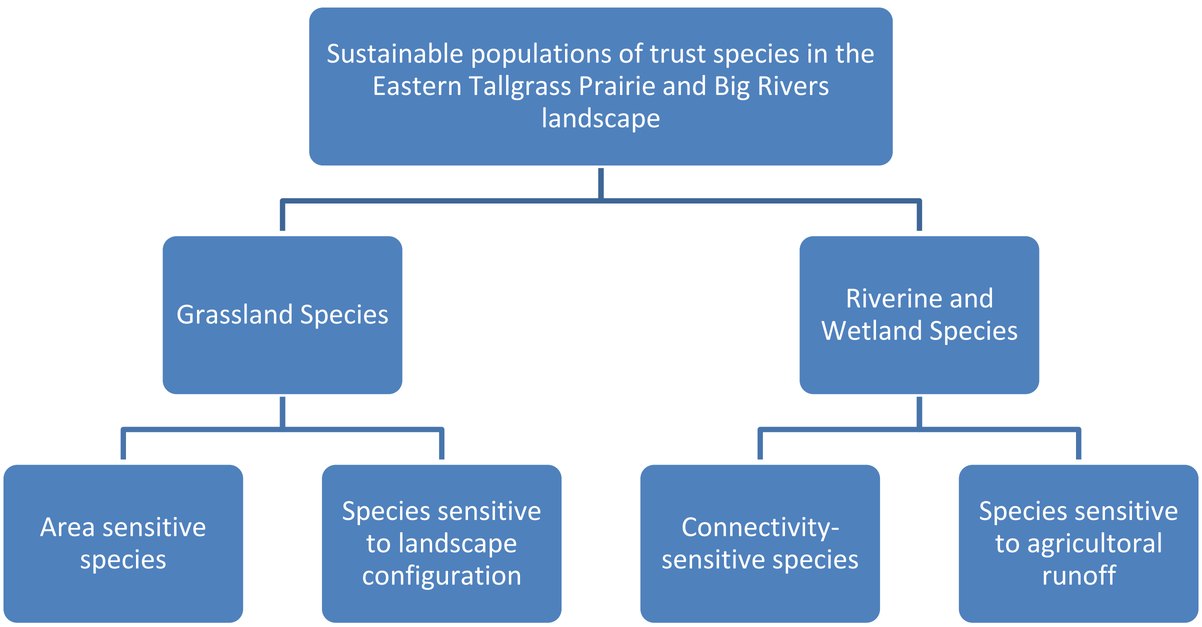


Figure A4. Reduced Objectives Hierarchy for the Eastern Tallgrass Prairie and Big Rivers Landscape

Once we decided to refine and narrow our objectives for identifying surrogate species the process became much clearer and easier to implement. The Technical Team struggled with the scope and magnitude of trying to define a functional landscape for an entire LCC landscape. The concept of functional landscapes was problematic for some team members as well and really muddled the discussions. In future efforts to identify surrogate species, we recommend that this step should be approached iteratively with the geographic scale.

Identify Geographic (and Temporal) Scale

The issue of geographic scale was an area of much debate within the Technical Team. The guidance in the SHC Handbook (USFWS 2008) recommends using a homogeneous ecological unit, something likely smaller than an LCC (i.e., surrogate zone *sensu* Weins et al. 2008).

For Version 1.0, we selected a suite of species to cover the entire Eastern Tallgrass Prairie and Big Rivers Landscape Conservation Cooperative (ETBR LCC) landscape (figure 1). This landscape is the most homogenous from a terrestrial standpoint and is comprised of a single Bird Conservation Region (BCR

22) (Salmon & White 2013). The landscape is more complex from an aquatic perspective comprising portions of two major basins in North America (Mississippi and Ohio Rivers). Although, we focused on the ETBR landscape, the selection process is generic enough that it can be transferred to expand to other landscapes.

Temporal scale is not currently addressed in the SHC Handbook (2008) or the draft technical guidance. The list of surrogate species is intended to be a living list in that it will be revisited over time as knowledge is gained through the adaptive management cycle of SHC. We considered two temporal aspects in selecting surrogate species. First, we considered the timing of our management actions that will be directed through the SHC process. The nexus of annual budget planning, planning cycles within the conservation community, and discrete management actions requires further consideration. Second, we considered how species needs on the landscape change through the annual cycle and the species life history. However, this issue of temporal scale and links to anticipated changes in the typical planning cycles within the conservation community requires more consideration.

Determine Species to Consider

A simple NatureServe query of the number of species that exist in the 12 states that comprise the ETBR LCC reveals that about 14,800 species are recorded within the landscape. Expanding this to include the states and provinces of the Upper Midwest and Great Lakes LCC as well, there are about 26,500 potential species (i.e., potential surrogates). To reduce this overwhelming number, we reviewed over 50 conservation plans by the Service, state and provincial agencies, and non-governmental organizations to develop a preliminary list of approximately 2,900 species of conservation interest in the Midwest Region.

From this comprehensive list of species of conservation concern, we evaluated only those species that are considered federal trust species (Migratory Birds, Federal Threatened and Endangered Species, and interjurisdictional fish) within the ETBR landscape as potential surrogate species. Some States were concerned that selection of a state managed species as a surrogate species could affect funding and have unforeseen implications. Given these concerns, we limited the initial species pool to federal trust species for the Version 1.0 list. The resulting pool contained 475 species.

For the purposes of choosing surrogate species, we defined interjurisdictional fish as species that occurred in multiple states and could potentially cross state borders. The Service often uses the term trust resources broadly in the context of Interjurisdictional fisheries based on a broad range of statutory authorities, treaties, interstate compacts, and court orders (Fishman and Adamcik 2011). The Service's Government Performance and Results Act (GPRA) Plan defines interjurisdictional fisheries as "populations that are managed by two or more States, nations, or Native American Tribal governments because of geographic distribution or migratory patterns of these populations." For the Mississippi River, we relied on the list of 76 species produced by the Mississippi Interstate Cooperative Resource Association (MICRA 2009). For the Ohio River basin states (Illinois, Indiana, and Ohio), we had to generate a list of interjurisdictional fish. Sam Finney, Jeff Stewart (USFWS, Carterville Fisheries Office) and Jeff Thomas (Ohio River Valley Water Sanitation Commission) identified watersheds that crossed the state borders (Wabash and Great Miami) and identified species that occurred now or in the past throughout those watersheds. This exercise identified an additional 51 interjurisdictional fish species (table A2).

Table A2. Interjurisdictional Fish of the Ohio River Basin States (Illinois, Indiana, and Ohio) in the Midwest Region

Common Name	*Scientific Name*	Common Name	*Scientific Name*
American brook lamprey	*Lampetra appendix*	Redear sunfish	*Lepomis microlophus*
Bigeye chub	*Hybopsis amblops*	Redfin shiner	*Lythrurus umbratilis*
Bigeye shiner	*Notropis boops*	Ribbon shiner	*Lythrurus fumeus*
Blacknose dace	*Rhinichthys atratulus*	River chub	*Nocomis micropogon*
Blacknose shiner	*Notropis heterolepis*	Rosyface shiner	*Notropis rubellus*
Blackstripe topminnow	*Fundulus notatus*	Sand shiner	*Notropis stramineus*
Bluntnose minnow	*Pimephales notatus*	Shoal chub	*Macrhybopsis hyostoma*
Brindled madtom	*Noturus miurus*	Silver chub	*Macrhybopsis storeriana*
Brook silverside	*Labidesthes sicculus*	Silver lamprey	*Ichthyomyzon unicuspis*
Bullhead minnow	*Pimephales vigilax*	Silver shiner	*Notropis photogenis*
Central mudminnow	*Umbra limi*	Silverjaw minnow	*Ericymba buccata*
Channel shiner	*Notropis wickliffi*	Slender madtom	*Noturus exilis*
Creek chub	*Semotilus atromaculatus*	Slenderhead darter	*Percina phoxocephala*
Dusky darter	*Percina sciera*	Smallmouth redhorse	*Moxostoma breviceps*
Emerald shiner	*Notropis atherinoides*	Southern redbelly dace	*Chrosomus erythrogaster*
Fathead minnow	*Pimephales promelas*	Stargazing darter	*Percina uranidea*
Freckled madtom	*Noturus nocturnus*	Stonecat	*Noturus flavus*
Ghost shiner	*Notropis buchanani*	Striped shiner	*Luxilus chrysocephalus*
Golden shiner	*Notemigonus crysoleucas*	Suckermouth minnow	*Phenacobius mirabilis*
Green sunfish	*Lepomis cyanellus*	Warmouth	*Lepomis gulosus*
Hornyhead chub	*Nocomis biguttatus*	Yellow bass	*Morone mississippiensis*
Ironcolor shiner	*Notropis chalybaeus*	Yellow bullhead	*Ameiurus natalis*
Logperch	*Percina caprodes*		
Mountain madtom	*Noturus eleutherus*		
Northern brook lamprey	*Ichthyomyzon fossor*		
Northern madtom	*Noturus stigmosus*		
Ohio lamprey	*Ichthyomyzon bdellium*		
Orange-spotted sunfish	*Lepomis humilis*		
Pumpkinseed	*Lepomis gibbosus*		

DECIDE WHICH CRITERIA TO USE IN DETERMINING SURROGATE SPECIES

The Technical Team encountered several areas of uncertainty and disagreement about the species selection process during the June workshop. At the workshop, we prototyped our selection process based on decisions made during previous online meetings and identified major constraints and needs to implement the process across a broad scale. To explore the major uncertainties and resolve our disagreements, we used rapid prototyping, or informally called “test rockets.” We quickly (e.g., several hours to several days) worked through three alternative ways of selecting surrogate species (table A3).

The learning objectives below summarize the points of discussion and uncertainty at the June workshop. They also helped to structure the comparison among test rockets.

1. Geographic scale – How does the choice of scale affect the choice of surrogate species and setting of landscape functions (fundamental objectives)? How do we integrate across scales? How do we integrate among different geographies? What are the pros and cons of using smaller geographies (e.g., watersheds, ecoregions, biomes) to inform surrogate species selection? How to integrate across terrestrial and aquatic systems? How do limiting factors for a surrogate species change across its range?
2. Potential surrogate species pool – What is our starting pool of species? All species occurring within a geography? Start with species of conservation concern or include species of management interest? Restrict to species of conservation concern? How do we deal with a list of ~14,000+ or ~2900 species? What are the appropriate preliminary filters? Does the starting pool of species affect the outcome of species selection?
3. Information needs – What additional information do we need to make decisions about species and functional landscapes? What information do we have? What information do we feel we still need (e.g., limiting factors for species, species-habitat associations at the broad level), why we need it, and how we will use it?
4. Information gathering – Where do we gather key information? Who does this? How much time does it take? What is the information quality? When and how do we integrate expert opinion to build and expert review of outcomes?
5. Transparency – How do we maintain focus on this important strategic objective through the selection process? How and when do we elicit information from experts ? (For example, what are criteria that experts use to link surrogate species to landscape functions and how do we capture that information?) How do we determine and connect landscape functions (fundamental objectives), landscape features, and desired surrogate approach?

For each set of questions related to a topic, we also developed a set of questions with a scoring scale to help us quantitatively evaluate each test rocket using a Simple Multi-attribute Ranking Technique (SMART) (table A4). SMART is a multi-objective decision analysis technique that calculates a single weighted, normalized score for all alternatives based on all objectives (Goodwin and Wright 2011).
In combination, the qualitative insights and the specific questions about and comparisons among the test rockets helped to resolve points of uncertainty and stimulated further discussion. Evaluating these alternatives helped the Technical Team ultimately decide on the surrogate species selection process used to generate Version 1.0 (figure A3).

Table A3. Alternative "Test Rockets" During the Technical Team's Rapid Prototyping Process to Decide on Selection Criteria and Refine Selection Process to use for Version 1.0

#	Alternative Name	Alternative Description	Key Insights & Reasons
1	Coon-Yellow watershed (a HUC8 watershed in southwestern Wisconsin) with birds	Learning areas of emphasis: This was our first test of the selection approach as of June based on interviews conducted by Ryan Drum with Tom Will & Bob Russell (USFWS, Migratory Birds) Time estimate: ~2 hrs. Selection process: Default Starting data set • Geography: Coon-Yellow watershed • Species pool: Birds from NatureServe & species database filtered by geography • Limiting factors: SWAP by broad habitat • Landscape functions (objectives): Derived from SWAP limiting factors • Landscape features (means objectives/sub-habitats): None to start • Surrogate approaches: None specified, to be derived from SWAP limiting factors	• Experts resistant to starting with a short list of species. Felt useful species were not available (e.g., the starting pool was missing important species). • If want to use a small geography, then need experts with local knowledge. • Experts have a difficult time with limiting factor approach. Why is this? • Knowing ahead of time what surrogate approach is desired is very important to help the experts select appropriate surrogate species. (Not sure why they didn't like that – was it because they did not know what job the species was expected to perform?) • Do we need to have a more free-form discussion, probing experts to articulate the criteria they are using, and then summarize the criteria that the experts used to select species for each habitat and approach? • Species will differ in utility as surrogates at different scales (e.g., umbrella at LCC scale vs. indicator at watershed scale). • A free-form preliminary focus group might help better structure our information needs and process.
2	Entire ETBR LCC with birds (or subset of well-known birds)	Learning areas of emphasis: Potential surrogate species pool and large geography • What is our starting pool of species? • How do we filter to help deal with a list of ~14,000+ or ~2900 species?	Starting Pool • For a broad geography, NatureServe appears to work well for basic presence and absence of a species on a state scale (smaller scales result in a significant loss of accuracy) but QA/QC of the merged data set between NatureServe output and ETBR starting pool is needed to capture database entry errors (e.g., false omissions due to extra spaces, differing taxonomic names, etc.). • The species pool will require review of species by experts. (1) Review for occurrence in geography and importance of that geography to the species life history. (2) Species

		• What are the appropriate preliminary filters? Does it affect the outcome of species selection to limit the preliminary pool? Estimated time spent: ~24 hrs Selection process: Default Starting data set • Geography: ETBR LCC • Species pool: Birds from NatureServe & species database filtered by geography • Limiting factors: Identify using SWAPs by broad habitat • Landscape functions (objectives): Derived from SWAP limiting factors • Landscape features (means objectives/sub-habitats): None to start, generate as needed following recommendations from Alt. 1 • Surrogate approaches: None specified, to be derived from SWAP limiting factors	will also need to be reviewed for the broad habitat associations. (3) Species will also need to be reviewed for the limiting factor associations. Limiting Factors from NatureServe for these Taxa • Approximately 60% of our species had "None defined" as a limiting factor. Need to determine what species have no limiting factor identified vs. blank entries in the NatureServe database. Data Gathering Exercise • No single ideal source appears to be available for all species within a taxa group. All used Birds of North America for information on limiting factors. • For 309 species, time spent on data entry regarding limiting factors and population trends based on NatureServe profiles averaged about 1 to 4 minutes per species. Total population was completed in about two days. • Bob Russell (USFWS Migratory Bird Program), Mike R. & Ken D. all used the Patuxent Breeding Bird Survey website for estimates of trend data and recommended that we not use Birds of North America for trend information. • Difficult to collect information on exact patch size and landscape configuration measurable attributes. Is this more appropriate to gather this detailed information in the biological planning phase? The team recommended rewording the questions to simply ask is the information available for the species in the reduced pool. Surrogate Selection Process Step 10: Scoring based on 15 questions • Individuals applied 15 draft evaluation questions for surrogates species (14 Aug. draft) and ranked species based on the number of positive responses to the questions. Revisions needed: (1) Not all questions were relevant to this test rocket. (2) A weighting system should be developed for the questions. (3) Current wording and scoring can be very subjective depending. Recommend we rephrase the criteria questions and conduct scoring in small groups to reduce subjectivity and bias. Developing a guidance document for the questions could be useful also. Add a neutral answer for scoring. (4) Consider additional questions about species to aid in tiebreaking and selecting complementary species. (Do they overlap habitat needs? Is one more detectable than the other? Does one species have more well defined attributes/metrics than the other? How mobile is the species? How widely distributed is the species in the geography? How abundant is the species in the geography? • Quality of list needs to be evaluated and compared with other similar efforts (e.g., Midwest Wind Habitat Conservation Plan identified surrogates via expert workshops).

			• Top ranked species did not occur across the entire ETBR LCC in all cases. Need a process for covering the entire geography. • The scoring process is manageable time wise (e.g., 6 hrs to score grasslands). Scoring is almost as time consuming as initial data gathering. Surrogate Selection Process Step 12: Optimal species selection • A suite of surrogate species is likely necessary to cover the full geography given the ranges of the remaining species and our metrics of interest. • Need to discuss and identify considerations for selecting optimal set of species with full TT. Consider adding social relevance.
3	Coon-Yellow watershed with herps & fish/mussels	<u>Learning areas of emphasis:</u> Information needs • What additional information do we need to make decisions about species and functional landscapes? • What information do we have? • What information do we feel we still need (e.g., limiting factors for species, species-habitat associations at the broad level), why we need it, and how we will use it? Information gathering • Where do we gather key information? • Who does this? • How much time does it take? • What is the information quality? • When and how do we integrate experts? <u>Estimated time spent:</u> ~24 hrs. <u>Selection process:</u> Default <u>Starting data set</u> • Geography: Coon-Yellow	Starting Pool • For a smaller geographic extent, we need a process to transparently get to the starting species pool. • Depending on the data source, the boundaries are not clearly or easily defined. • Initial QA/QC of the merged data set between NatureServe output and ETPBR starting pool. • Insight question: Need to proof and eliminate species not in the smaller geography. Recommend to do this based on expert opinion at expert review of limiting factors, measurable attributes, and surrogate rankings for each limiting factor/habitat group. Is there a better process for this that won't require engaging experts twice if we use a small geographic extent? Limiting Factors from NatureServe for these Taxa • Approximately 80% of our species had "None defined" as a limiting factor. • Task addressed with data gathering exercise: Determine what species have no limiting factor identified vs. blank entries in the NatureServe database. Data Gathering Exercise • There's an upfront investment in time to identify a resource where limiting factor information can come from. • Sources of information – IUCN red list, books that have compiled species summaries, agency species summaries. Data interpretation and entry has to be done manually. • For 126 species, it took ~7-8 minutes/species to review and verify limiting factors. Total of 15 hrs 45 min. Scales out to 9.6 weeks (40 hours per week) to address the 2900 species in the ETBR database. • Hit rate for addressing "None defined" limiting factor to identifying some limiting factor in data gathering exercises was about 78%.

		watershed • Species pool: ROCSTAR filtered by geography • Limiting factors: Identify using SWAPs by broad habitat • Landscape functions (objectives): Derived from SWAP limiting factors • Landscape features (means objectives/sub-habitats): None to start, generate as needed following recommendations from Alt. 1 • Surrogate approaches: None specified, to be derived from SWAP limiting factors	Scoring based on 9 evaluation questions • Before scoring reduced species pool by looking at occurrence in geography, if habitat is a key part of the species life history, and if the limiting factor was one of the primary ones listed for that species. • Group limiting factors based on IUCN classification of threats (http://www.conservationmeasures.org/initiatives/threats-actions-taxonomies) • Scoring is almost as time consuming as initial data gathering with an avg. of 7 min/spp to conduct scoring (riverine-water quality species pool = 64 spp in 5 hr 10 min or ~5 min/species; lacustrine-habitat loss species pool = 20 spp in 3 hrs or ~9 min/species). Total of 8 hr 10 min to score 84 spp. • Difficulty with interpretation of scoring questions due to different sources of information, lack of information on local geography, identical information on entire taxa (e.g., mussels), relevance of habitat to the species. Reduce variability with clarification document to aid in interpretation for different for different taxa groups and habitats. Optimal species selection • Need to discuss and identify considerations for selecting optimal set of species with full TT. Potential considerations are: Species distribution in the geography and importance of the geography for the species life cycle (e.g., stopover habitat for birds).

Table A4. Quantitative Evaluation Questions Used to Assess Each Test Rocket in a SMART Analysis

#	Fund. Obj	Means Obj	Objectives	Goal	Units
1	Process	Scale	For the same measurable attribute, could the species selected in your test process likely be the same ones selected if it considered a broader or finer geographic extent (e.g., ETBR LCC geography vs. Driftless Area sub-region)?	MAX	No=1, Yes=2
2			Were species chosen that could be indicators of a common measurable attribute for both terrestrial and aquatic habitats?	MAX	1 = No, no common measureable attributes, 2 = No, a relationship exists among measurable attributes but different species were chosen, 3 = Yes
3		Species Pool	Can the species parameters be accurately and precisely estimated?	MAX	% of species in the list of surrogate species
4			Is the species' status likely to reflect changes in the landscape due to management actions (e.g., habitat protection, restoration, enhancement)?	MAX	% of species in the list of surrogate species
5			Will a change in the species status assist in directing management actions? Examples: A fish hatchery monitors a stock of walleye to set fry production and stocking rates. Wetland management districts in Iowa and Minnesota monitor mallard nest success to allocate habitat management efforts across the prairie pothole region.	MAX	% of species in the list of surrogate species
6			Can the species serve as an umbrella species? In other words, is the species sensitive to the total aggregate of protected habitat across the landscape or sensitive to individual patch size?	MAX	% of species in the list of surrogate species
7			Can the species serve as an indicator species? In other words, is the species sensitive to environmental contaminants, changes in the physico-chemical environment (e.g., dissolved oxygen, excess nutrient concentrations), or changes in the hydro-morphological environment (e.g., flooding regime, presence of riverine sand bars)?	MAX	% of species in the list of surrogate species
8			Is the species within the geography of the test rocket declining?	MAX	% of species in the list of surrogate species
9			Do the key limiting factors for the species' populations change across the range of the species?	MAX	% of species in the list of surrogate species
10			Is the species currently monitored?	MAX	% of species in the list of surrogate species
11			Is the species vulnerable to climate change impacts?	MAX	% of species in the list of surrogate species
12		Info needs &	What was the primary source used to gather key information?	MAX	1 = Expert opinion, 2 = Gray literature with no citations, 3 = Gray literature with primary

		gathering			citations, 4 = Peer reviewed literature, 5 = Combination
13			What was the average time that gathering information to address information needs for all species pool specific to a limiting factor (e.g., sum of time for habitat loss for grassland habitat, habitat degradation for grassland habitat, etc. divided by total # of hours)?	MAX	1 = < 1 hr, 2 = 1-5 hrs, 3 = 5-10 hrs, 4 = >10 hrs
14	Strategic Obj.	Realism	Can the process result in a list of surrogate species?	MAX	No=1, Yes=2
15		Strategic Obj.	Does the process meet with the technical team's transparency strategic objective?	MAX	No=1, Yes=2
16			Does the process meet with the technical team's replicable strategic objective?	MAX	No=1, Yes=2
17			Does the process meet with the technical team's inclusiveness strategic objective?	MAX	No=1, Yes=2

SUMMARY OF SURROGATE SPECIES SELECTION CRITERIA

In addition to helping the Technical Team to generate and evaluate the selection process, the test rockets (i.e., prototyping process) helped the team to settle on the three measurable attributes, nine selection criteria, and the definitions for how to collect the information needed to answer each of these questions (table A5). These criteria were used to calculate a weighted umbrella score and an environmental indicator score for each species and assess which species could serve as an umbrella or environmental indicator for the limiting factors of interest for the ETBR landscape. During the prototyping process, the team realized all the questions were not equally important. Weights for each question were elicited and discussed using a modified Delphi process (Kahneman 2011). The umbrella and indicator questions were used interchangeably (e.g., the umbrella question was only used to calculate the umbrella score). For each question in table A5, a "?" was used to indicate that the answer was not known or no information found for this species. Although we attempted to gather information on the actual response of the species to the measureable attributes for each limiting factor (e.g., mathematical population response curve to turbidity), species were allowed to remain in the analysis if an informal response had been postulated in the scientific literature.

Table A5. Surrogate Species Selection Criteria, Weights, and Definitions on how to Respond to Each Question During the Information Gathering Process

Selection Criteria	Weight	"Yes" Response	"No" Response
Is data available on the chosen limiting factor?			
Minimum Patch Size (Acres) OR Connectivity	NA	Terrestrial species: this species has a minimum patch size requirement documented in the literature and that size is provided in this column. If more than one minimum patch size is documented, the range of patch sizes and the references for each are provided. Aquatic species: connectivity requirement, does not tolerate impoundment, is impacted by dams, culverts, road crossings etc.	Terrestrial species: not sensitive to patch size or does not apply in LCC (migrant or generalist). Aquatic species: not impacted by dams or obstructions to passage in waterways.
Landscape Configuration	NA	Terrestrial species: this species has known landscape configuration requirements. (e.g., adjacent water is required by a grassland breeding species or a different habitat type requirement for young of the year.) The required habitat juxtaposition is noted here. Aquatic species: differing breeding and foraging habitats required (ex: Paddlefish, sturgeon need backwaters and channel habitat; northern pike need emergent wetlands for spawning; some require temporary pools for spawning).	Both terrestrial and aquatic species: this species has no known requirement for juxtaposed habitats within the LCC.
Nitrogen-based fertilizers (only assessed for aquatic species)	NA	Aquatic species: y,1 = primary sensitivity to nitrogen levels; y,2 = sensitive to secondary effect of nitrogen pollution (eutrophication etc.).	Aquatic species: not sensitive to primary or secondary effects of elevated nitrogen levels.
Umbrella environmental indicator scoring questions			
Can or have the species parameters	0.19	Both terrestrial and aquatic species: species parameters include reproductive rate, survival rate, population changes etc. For both terrestrial and	Both terrestrial and aquatic species: this species is poorly studied; there are many

be/been accurately and precisely estimated?		aquatic species: for this species we know one or more accurately and precisely measureable parameters that could serve to indicate change in species abundance or distribution in the LCC. Or, vital parameters are measured by some monitoring program (all Long Term Resource Monitoring Program [LTRMP] species are monitored and growth, age, distribution, reproduction are measurable).	unknowns about its parameters or no monitoring programs adequate to measure parameters is in place.
Is the species sensitive to management actions (e.g., protection, restoration, enhancement)?	0.22	Terrestrial species: management actions within the LCC can potentially benefit species population as a whole, i.e., this species is not primarily limited by factors outside LCC boundaries (e.g., deforestation in Neotropical wintering sites) or this migrant species can be potentially benefited by managing significant stopover habitat. Aquatic species: sensitive and responsive to manageable aquatic quality or hydrology.	Both terrestrial and aquatic species: management actions within LCC are unlikely to benefit species population as a whole, i.e., this species is primarily limited by factors outside the LCC or this species is ubiquitous and would not benefit from habitat improvement (e.g., AMRO will breed just about anywhere)
Is this species a harvested or potentially harvested species?	0.01	Terrestrial species: this species is a harvested or potentially harvested species. Aquatic species: appears on at least one state fish regulations harvest list or a commercial species (LTRMP recreational or commercial list).	Terrestrial species: this species is not a harvested or potentially harvested species. Aquatic species: not a normal sport species, not listed in any DNR regulations.
Can the species serve as an umbrella species?	0.27	Terrestrial species: this species has a minimum patch size or it has a required landscape configuration. Aquatic species: species is either sensitive to connectivity or requires more than one habitat juxtaposed; or there is evidence that this species acts as umbrella for a genus or other guild of species.	Terrestrial species: this species is documented to not have a minimum patch size or a required landscape configuration. Aquatic species: this species has neither a connectivity requirement nor differing juxtaposed habitat requirement.
Can the species serve as an indicator species? (Only assessed for aquatic species.)	0.27	Aquatic species: y,1 = primary sensitivity to nitrogen levels; y,2 = sensitive to secondary effect of nitrogen pollution (eutrophication etc.).	Aquatic species: not sensitive to primary or secondary effects of elevated nitrogen levels.
Is the species within the geography of the test rocket (ETBR?) declining?	0.08	Both terrestrial and aquatic species: species population within the LCC is declining.	Both terrestrial and aquatic species: species population within the LCC is stable or increasing.
Is the species currently monitored?	0.16	Terrestrial species: species is adequately monitored within the LCC to detect changes in population *or* adequate protocols are available to monitor this	Both terrestrial and aquatic species: species is not adequately monitored within

		species within the LCC. Aquatic species: nearly all species had a "Yes", unless too rare or inaccessible to monitor can be monitored.	the LCC and adequate protocols are not available.
Do the key limiting factors for the species' populations change across the range of the species?	0.03	Terrestrial species: key limiting factors for a species differ within the LCC; limiting factors may differ across the LCC by geography or by seasonal use (e.g., waterfowl nesting habitat vs. brood rearing habitat vs. migration habitat within the LCC). Aquatic species: species is limited by differing limiting factors in different watersheds.	Both terrestrial and aquatic species: key limiting factors for a species are consistent across LCC landscape and do not vary with species locations or with seasons. (Key limitations that occur outside the LCC are not considered here.)
Is the species vulnerable to climate change impacts?	0.03	Terrestrial species: this species or guild of species has been documented affected by, or vulnerable to climate change impacts within the LCC (e.g., severe weather events, local flooding extremes, drought; documented de-synchronization of food source/nesting times for insectivorous Neotropical migrants; range shift linked to climate change); climate change threat and resource documentation is provided. Aquatic species: documented range shift or other impact due to climate change.	Both terrestrial and aquatic species: this species has not been documented affected by or vulnerable to climate change impacts within the LCC.

Establish Surrogates

General Selection Process

To transparently select surrogate species focused on the "properties and elements" of our functional landscape (figure A4), we used a similar theoretical approach used to target management actions in population management (For more detail, see Blomquist et al. 2013; Appendix C). To help organize our potential pool of species, we grouped the species pool by the most common limiting factors (i.e., threats) affecting the species and broad habitat associations of the species (Steps 1–4 in Fig. 4). The limiting factors dictated which objectives were set for the landscape as well as the surrogate approach required to best address those limiting factors on the landscape. For Version 1.0, we focused on habitat loss and water quality degradation from agricultural land use. This grouping also reduced our species pool from 475 to a more manageable number for review (table A6). A preliminary review of this species pool ensured that the species occurred in the ETBR landscape and used each broad habitat for a key part of their life history (e.g., breeding habitat for waterfowl). We reviewed these points later with a panel of taxonomic experts (Step 6 in Fig. 4). Species that did not fit these considerations were removed from the potential species pool.

Table A6. The Habitat-limiting Factor Species Sub-Pools, Surrogate Approaches, and Measurable Attributes Assessed for the ETBR Landscape

Broad Habitat	Limiting factor (Fundamental Objective)	Surrogate Approach	Measureable Attributes	# of Potential Surrogates
Aquatic	Habitat loss	Umbrella	Connectivity	7
	Water quality	Environmental indicator	Nitrogen pollution	9
Lacustrine	Habitat loss	Umbrella	Connectivity	4
	Water quality	Environmental indicator	Nitrogen pollution	6
Riverine	Habitat loss	Umbrella	Connectivity	66
	Water quality	Environmental indicator	Nitrogen pollution	42
Palustrine	Habitat loss	Umbrella	Connectivity	4
	Water quality	Environmental indicator	Nitrogen pollution	1
Subterranean	Habitat loss	Umbrella	Connectivity	2
	Water quality	Environmental indicator	Nitrogen pollution	2
Barrens	Habitat loss	Umbrella	Minimum patch size	0
	Habitat loss	Umbrella	Landscape configuration	1
Forest	Habitat loss	Umbrella	Minimum patch size	13
	Habitat loss	Umbrella	Landscape configuration	7
Grassland	Habitat loss	Umbrella	Minimum patch size	9
	Habitat loss	Umbrella	Landscape configuration	7
Riparian	Habitat loss	Umbrella	Minimum patch size	1
	Habitat loss	Umbrella	Landscape configuration	6
Shrubland	Habitat loss	Umbrella	Minimum patch size	3
	Habitat loss	Umbrella	Landscape configuration	1

The selection criteria for surrogate species were based on the limiting factors (i.e., threats), the functions (i.e., surrogate approaches) that we want from our suite of surrogate species (e.g., umbrella, indicator), and the desired characteristics of our selected surrogate species (i.e., the nine questions to assess the quality of a surrogate). Using these three sets of criteria (i.e., landscape measurable attributes, surrogate approach, and surrogate characteristics), we set up a spreadsheet exercise to select an efficient, yet comprehensive suite of surrogate species from our pool of potential surrogate species. At the heart of the species selection approach is the surrogate species score. For the species in each limiting factor and broad habitat sub-pool, we collected data on the response of the species to the measureable attributes chosen for each limiting factor. We collected data to answer the nine questions that delineate how well each species could achieve the requirements for our desired surrogate (table A5). Criteria questions were structure so the answer yields a binary response where any species with a "Yes" response was scored a "1" and any other answer ("No" or "?") was scored a "0." This resulted in a matrix of nine or ten binary variables for each species for assessment as an environmental indicator or umbrella respectively. We selected surrogates following the flowchart shown in figure A5 and the following equation:

$$S_a = \sum_{i=1}^{I} k_i \sum_{j=1}^{J} w_j \gamma_j$$

Where, S_a is the environmental indicator score or the umbrella score, *k* is the availability of data on the limiting factors, *w* weights the surrogate question based on its importance to the Technical Team (table

A5), and γ is the response to the surrogate question. This equation resulted in a surrogate score for each species in the limiting factor and broad habitat sub-pools, and the flowchart simply provides a visual elaboration on how the equation implemented steps 4-6 in the process diagram (figure A3). This process reduced the species pool from 475 to 57 potential environmental indicator species and 187 potential umbrella species, and the resulting matrix of scores and available data was a powerful visualization tool to see which species were related to a given landscape measure or desired species characteristic.

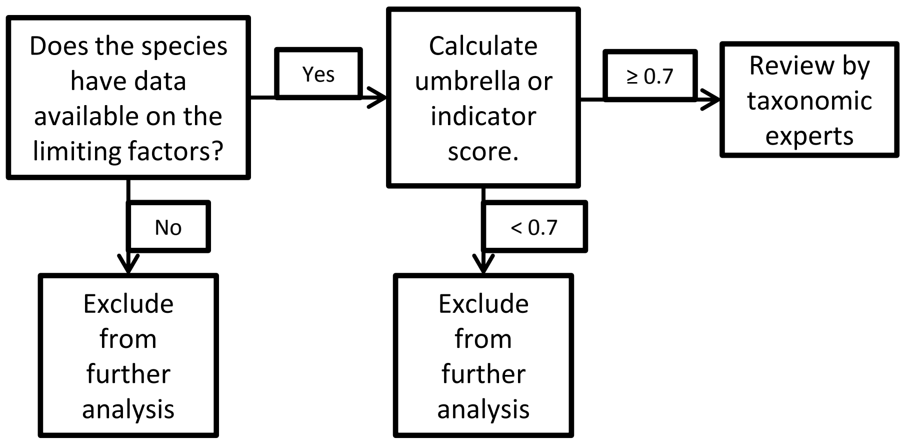


Figure A5. Flowchart for Organizing the Species, Habitat, and Limiting Factor Sub-Pools for Review by Taxonomic Experts

We arrived at our threshold of surrogacy by looking at a plot of the umbrella and indicator scores by the number of species. For both environmental indicator and umbrella scores, thresholds were present at both 0.8 and 0.7 (figure A6). The Technical Team agreed to keep a more comprehensive number of surrogates for the experts to review based on the troubles encountered with overly reduced species pools in our prototyping process, and species with a surrogate score ≥ 0.7 were reviewed by an expert panel as potential surrogate species.

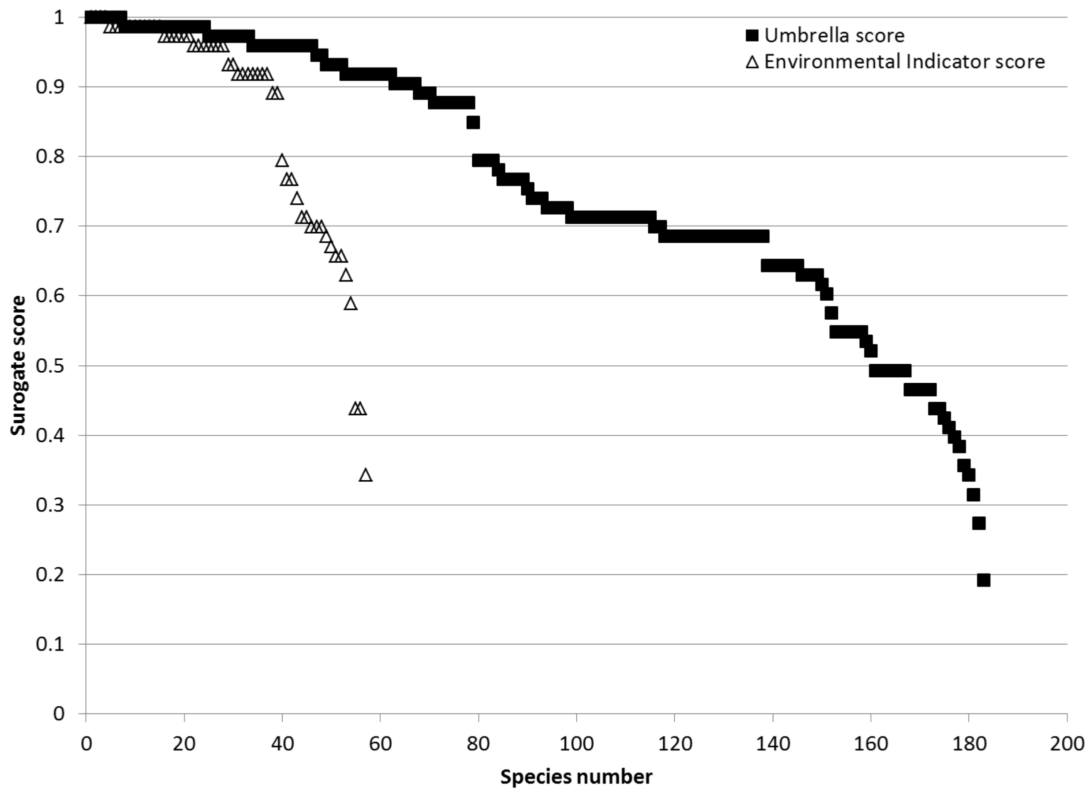


Figure A6. Plot of Sorted Surrogate Scores by Species

EXPERT REVIEW AND CONSIDERATIONS FOR IMPLEMENTATION IN SHC

The sub-pools formed by grouping species by taxonomic group, broad habitat category and limiting factor were reviewed by taxonomic experts. Each review was conducted with a panel of experts in an online meeting that lasted approximately 1–2 hours. During each review, we used the example questions below to facilitate the discussion. These questions address points where the Technical Team felt it was essential to have expert input into the selection process diagram (figure A3).

- Process diagram Step 4: Please identify species that should be removed from the sub-pool.
    - Is the habitat association correct?
    - Is the limiting factor association correct?
    - Is the ETBR landscape important for any part of the species life history?
- Process diagram Step 6: Please identify the species from this list that can act as an **umbrella species** for **grassland minimum patch size**.
    - Of the species we sent you, which species has the best ability to represent the remaining species in this cover type? For management? For monitoring?
    - Which species is most sensitive to patch size?
    - If you had to pick a top 3 umbrella species, what would they be and why?
- What species are missing from the list that would be a better surrogate and why?

- Process diagram Steps 8–10: Please consider the following questions about the species you have identified as possible umbrella species for discussion:
  - Biological planning (objectives & strategy, why).
    - Does it occur in a broad habitat that occurs across the entire LCC?
    - Is it feasible to set population objectives?
  - Conservation design (where, how, when to do it and predicting possible outcomes).
    - Have tools/maps been developed to help focus work to a particular geographic area for this species?
  - Monitoring and evaluation (how did we do).
    - Is monitoring the species across the LCC cost prohibitive?

SELECTING AND FOCUSING VERSION 1.0

After the expert review, the Technical Team considered two approaches to removing redundancy in the remaining reduced sub-pools and selecting the final list of species (steps 7–10 in the process diagram, figure A3). Initially, an optimal selection approach was used to aid the team in identifying potential pitfalls with selecting surrogates strictly based on the data for the species in the database and facilitate discussion about improvements. These improvements were incorporated in the more comprehensive list and Version 1.0.

SELECTION APPROACH 1: AN OPTIMAL SELECTION APPROACH TO IDENTIFY DESIRED IMPROVEMENTS

To select a suite of species from our pool of potential surrogates (table A6), we used a threshold approach that allowed the use of linear programming to solve for an optimal suite of surrogate species (Kent 1989, Haight et al. 2002). In this approach, we required the surrogate species selection fulfill three additional thresholds beyond those considered above:

1. Habitat overlap threshold
2. Comprehensiveness threshold
3. Expert threshold

First, we ensured that species that could serve multiple surrogate approaches in different habitats were represented in the selected suite of surrogates. This was our habitat overlap threshold, and it is intended to promote efficiency across the habitat-limiting factor pools (e.g., species occurring in ≥2 sub-pools get preference). Second, we ensured that all objectives for selecting species were represented by at least a minimum number of surrogate species (e.g., one surrogate per sub-pool). This was our comprehensiveness threshold. This comprehensiveness threshold ensures that all landscape measures and habitats are covered by multiple species, and can serve as a proxy for a spatial analysis of species distributions. It will be important to set this threshold higher when dealing with larger geographic areas to allow for greater redundancy in the species pool. Ideally, this concept will be supplemented with a spatial analysis of species distributions (as mentioned previously). Third, we ensured that we used at least one species from each sub-pool chosen by the experts. This was our expert threshold. Ideally, we would have the experts review all of the input data to fully incorporate their input through the process.

We selected a suite a surrogate species that had the fewest species given that all of the above three thresholds were met. This optimal selection was conducted using the Solver add-on's GRG Nonlinear engine in Excel and resulted in an optimally-selected suite of surrogate species (table A7).

Table A7. Optimally-Selected List of Surrogate Species to Cover Ten Broad Habitat Categories in the ETBR Landscape

#	Common Name	*Scientific Name*	Habitat	Surrogate Approach	Hypothesized # of Species Represented
1	Iowa Pleistocene snail	Discus macclintocki	Barrens, Forest	Umbrella	110
2	Red-eyed Vireo	*Vireo olivaceus*	Forest	Umbrella	106
3	American Redstart	*Setophaga ruticilla*	Forest, Riparian	Umbrella	136
4	Bobolink	*Dolichonyx orizivorus*	Grassland	Umbrella	68
5	Sedge Wren	*Cistothorus platensis*	Palustrine	Umbrella	83
6	Eastern massasauga	*Sistrurus catenatus catenatus*	Palustrine, Grassland, Shrubland, Riparian	Umbrella	30
7	Yellow-breasted Chat	*Icteria virens*	Shrubland	Umbrella	39
8	Brown Thrasher	*Toxostoma rufum*	Shrubland, Forest	Umbrella	145
9	Field Sparrow	*Spizella pusilla*	Shrubland, Grassland	Umbrella	107
10	Indiana bat	Myotis sodalis	Subterranean, Forest	Umbrella	115
11	Yellow perch	*Perca flavescens*	Lacustrine	Umbrella	58
12	Blackside darter	*Percina maculata*	Riverine	Umbrella	192
13	Greater redhorse	*Moxostoma valenciennesi*	Riverine	Umbrella	
14	Pallid sturgeon	*Scaphirhynchus albus*	Riverine	Umbrella	
15	Topeka shiner	*Notropis topeka*	Riverine	Umbrella	
16	Black redhorse	Moxostoma duquesnei	Riverine, Aquatic	Umbrella	238
17	River redhorse	*Moxostoma carinatum*	Riverine, Aquatic	Umbrella	
18	Northern pike	*Esox lucius*	Riverine, Lacustrine, Aquatic	Umbrella	296
19	Black redhorse	*Moxostoma duquesnei*	Riverine, Aquatic	Environmental Indicator	238
20	Pugnose minnow	*Opsopoeodus emiliae*	Riverine, Aquatic	Environmental Indicator	
21	Largemouth bass	*Micropterus salmoides*	Riverine, Lacustrine, Aquatic	Environmental Indicator	296

Optimal selection is only one approach to selecting a suite of surrogate species, but it has several key benefits. This approach of selecting species optimally given the objectives should result a reasonable number of species for future monitoring. Additionally, the approach would be clear to anyone interested in the process and link explicitly to measures of landscape function. The characteristics of the species and the species pool can be used to generate other suites of species as well and build upon the basic demonstration we used here. These alternative suites could be analyzed using a Pareto efficiency analysis (Keeney and Raiffa 1993). This approach involves generating multiple lists of species, plotting the resulting suites based on the management benefit the suite as a whole could provide against the potential costs of managing for that suite of species. This approach would allow Technical Team members to explore different suites of species in an effort to look for a suite that is an adequate compromise for the Service staff from different programs and partners.

One key issue with the optimal selection approach that was unsatisfactory to the Technical Team members and the taxonomic experts was that the habitat categories did not adequately represent the diversity of the landscape needed to choose a representative set of surrogate species. This issue was especially relevant for the choice of umbrella species. Similarly, the issues of migration timing and the annual cycle of the species being considered were identified as a needed improvement.

Selection Approach 2: Generating a Comprehensive List of Surrogate Species

The Technical Team made the decision to compile a list of surrogate species that (1) covered all habitat categories, (2) covered key times in the life history of species groups (e.g., migration or spawning times), and (3) covered the entire geographic area of the ETBR landscape with a species (table A8). The resulting list contained 41 species in 33 groups. Black redhorse and river redhorse can serve as umbrella species and environmental indicator species. These decisions came after discussions with the expert panels and review of the optimal list of species indicated that finer resolution than was incorporated in the optimal selection approach was needed to adequately cover a habitat category and key times in the annual cycle.

For the barrens and subterranean habitat, we did not identify a surrogate. Several bat species (e.g., Indiana Bat, Eastern Small-footed Myotis) were mentioned as umbrella species for the subterranean habitat, but the occurrence of white-nosed syndrome is the predominant limiting factor rather than habitat for bat populations. No other federal trust species or suite of species had an adequate distribution to cover the ETBR landscape’s subterranean systems. Patch size may be an unimportant attribute of barrens systems, as barrens are naturally patchy on the landscape. Only one species, Iowa Pleistocene snail, was a federal trust species for barrens, and it has a very limited distribution on algific talus slopes in the Driftless Area of Iowa and Illinois.

Table A8. Comprehensive List of Surrogate Species to Cover Eight Broad Habitat Categories in the ETBR Landscape

#	Common Name	*Scientific Name*	Habitat	Surrogate Approach	Hypothesized # of Species Represented
1	Red-eyed Vireo	*Vireo olivaceus*	Forest	Umbrella	106
2	Ovenbird	*Seiurus aurocapilla*	Forest	Umbrella	
3	Wood Thrush	*Hylocichla mustelina*	Forest	Umbrella	
4	Bobolink	*Dolichonyx orizivorus*	Grassland	Umbrella	68
5	Grasshopper Sparrow	*Ammodramus savannarum*	Grassland	Umbrella	
6	Upland Sandpiper	*Bartramia longicauda*	Grassland	Umbrella	
7	Henslow's Sparrow	*Ammodramus henslowii*	Grassland	Umbrella	
8	Green-winged Teal	*Anas crecca*	Palustrine	Umbrella	83
9	Mallard	*Anas platyrhynchos*	Palustrine	Umbrella	
10	Pied-billed Grebe	*Podilymbus podiceps*	Palustrine	Umbrella	
11	Pectoral Sandpiper	*Calidris melanotos*	Palustrine	Umbrella	
12	Sedge Wren	*Cistothorus platensis*	Palustrine	Umbrella	
13	Virginia Rail	*Rallus limicola*	Palustrine	Umbrella	
14	Marsh Wren	*Cistothorus palustris*	Palustrine	Umbrella	
15	Eastern massasauga	*Sistrurus catenatus catenatus*	Riparian	Umbrella	30
16	Wood Duck	*Aix sponsa*	Riparian	Umbrella	
17	American Redstart	*Setophaga ruticilla*	Riparian	Umbrella	
18	Acadian Flycatcher	*Empidonax virescens*	Riparian	Umbrella	
19	Prothonotary Warbler	*Protonotaria citrea*	Riparian	Umbrella	
20	Bell's Vireo	*Vireo bellii*	Shrubland	Umbrella	39
21	Brown Thrasher	*Toxostoma rufum*	Shrubland	Umbrella	
22	Yellow-breasted Chat	*Icteria virens*	Shrubland	Umbrella	
23	Field Sparrow	*Spizella pusilla*	Shrubland	Umbrella	
24	Yellow perch Northern pike	*Perca flavescens* *Esox lucius*	Lacustrine	Umbrella Umbrella	58
25	Paddlefish Bluegill	*Polyodon spathula* *Lepomis macrochirus*	Aquatic	Umbrella Umbrella	46
26	Black redhorse	*Moxostoma duquesnei*	Riverine, Aquatic	Umbrella	192
27	Weed shiner Topeka shiner Blackside darter	*Notropis texanus* *Notropis topeka* *Percina maculata*	Riverine	Umbrella	
28	Greater redhorse River redhorse Shoal chub Pallid sturgeon	*Moxostoma valenciennesi* *Moxostoma carinatum* *Macrhybopsis hyostoma* *Scaphirhynchus albus*	Riverine	Umbrella	

	Shovelnose sturgeon	*Scaphirhynchus platorynchus*			
29	Smallmouth bass	*Micropterus dolomieu*	Riverine	Environmental Indicator	192
30	Bluegill Largemouth bass	*Lepomis macrochirus* *Micropterus salmoides*	Lacustrine, Aquatic	Environmental Indicator	58
31	Walleye	*Stizostedion vitreum*	Lacustrine	Environmental Indicator	
32	Black redhorse	*Moxostoma duquesnei*	Aquatic	Environmental Indicator	46
33	River redhorse Pugnose minnow	*Moxostoma carinatum* *Opsopoeodus emiliae*	Aquatic	Environmental Indicator	

Selection Approach 3: Focusing Version 1.0

To help refine Version 1.0 even further, we looked to the ETBR LCC draft Strategic Plan (Salmon and White 2013). We focused on the species that would aid in assisting the Service to work with the objectives set forth by the ETBR LCC steering committee. The LCC is focusing on restoration of two natural habitats within its geographic boundary: grasslands and rivers and their associated wetlands, and our Version 1.0 list reflects the focus of the LCC's objectives (table 1, located in the report section). We reduced the comprehensive list (table A8) by eliminating all surrogates chosen for habitats other than grassland, riverine, aquatic (i.e., backwater wetlands), and palustrine wetlands. Additionally, we focused the list of palustrine species by eliminating some redundancy in sub-habitat use identified during the review with the expert panel (Pied-billed Grebe, Pectoral Sandpiper, Sedge Wren).

Identify Species Requiring Special Attention

See the section Identify Knowledge Gaps and Uncertainty.

Identify Population Objectives

We relied heavily on the following sources for population objectives that were recommended in the draft technical guidance. The citations for many of these are available in the species database on the Technical Team's Basecamp site.

For migratory birds, we obtained existing objectives from continental plans for waterfowl, land birds, water birds and shore birds as well as Joint Venture or Bird Conservation Region implementation plans. The population objectives for Bobolink, Grasshopper Sparrow, Upland Sandpiper, Henslow's Sparrow, Green-winged Teal, Mallard, Virginia Rail, Marsh Wren can be obtained from these sources. Utilizing existing efforts will be useful making the most of predating work. For example, the Service recently started a Status Assessment and Conservation Plan for the Bobolink in partnership with the Vermont Center for Ecosystem Studies. One issue with these objectives is that they are not specific to the ETBR landscape and will have to be stepped down to the LCC scale.

For the 12 fish species identified as umbrella or environmental indicator species, a thorough review of existing population objectives still needs to be performed. The draft technical guidance recommends using objective set in management plans by stocks or sites and the National Fish Habitat Action Plan partnerships. Weed Shiner, Blackside Darter, Shoal Chub, Pugnose minnow, Greater Redhorse, River Redhorse, and Black Redhorse may have Species of Greatest Conservation Need status or be listed State Wildlife Action Plans and have planning documents supporting these efforts. Topeka Shiner and Pallid Sturgeon are federally listed under the Endangered Species Act, so will potentially have Recovery Plans, Spotlight Species Action Plans, and 5-Year Reviews. Shovelnose Sturgeon, Paddlefish, and Smallmouth Bass will likely have population objectives in state management plans and management plans for the Mississippi River. As for migratory birds, one issue with these objectives is that they will not be specific to the ETBR landscape and will have to be stepped down/up to the LCC scale.

Test for Logic and Consistency

This step in the draft technical guidance is an initial assessment of the response of the selected surrogates and the species they represent. The draft technical guidance recommends a modeling exercise that identifies alternative conservation or management scenarios, projecting the conditions associated with each scenario in the planning area, and assessing how well the resulting conditions meet the needs of the surrogate species and of other species within the represented group in relation to the management objectives. For a hypothetical set of surrogates and management actions, we developed an approach to score and assess progress toward a functional landscape at the January workshop that could be used to address this step in the draft technical guidance (Blomquist et al. 2013; Appendix C). This approach could be adapted and re-run for the species on Version 1.0 and a set of management actions that the Service programs enact currently within the ETBR landscape.

Identify Knowledge Gaps and Uncertainty

Hypotheses about Surrogacy

The key uncertainty that should be tested as the technical guidance is implemented is the many-to-many or one-to-many relationships among the species chosen as umbrella and environmental indicator species and the species they represent. To build on the hypothesized relationships in table 1 (located in the report section), table A9 shows the 324 species in our species pool that use the four broad habitat categories for some portion of their life history or annual cycle and the surrogate species. Testing these hypothesized relationships will identify species occupying these habitat categories that are not covered by the surrogate species. The Service will have to continue management and implementation of SHC for these species independent of the surrogate species process (see Identify Species Requiring Special Attention section in the draft technical guidance).

Two key areas deserve attention through research or monitoring. (1) We relied on habitat categories to choose surrogates that represent different parts of the landscape, but the habitat relationships of species vary greatly from specialist to generalist. The expert panel review indicated that some consideration of sub-habitats and changes through the annual cycle in habitat use were important to choosing surrogates that were acceptable to the expert panel as well as members of the Technical Team. (2) The response of the surrogate and the species they represent to management actions should be documented. For example, if the umbrella species population increases in response to habitat management in the breeding range of that species, do the species represented also increase in response to those management actions?

Table A9. Species Represented by the Surrogates in Each Habitat Category Covered Under Version 1.0. Species in Hold are Umbrella Species and Species with an * are Environmental Indicators

Common Name	*Scientific Name*	Common Name	*Scientific Name*
Aquatic (n = 47)			
Black buffalo	*Ictiobus niger*	Northern pike	*Esox lucius*
Black bullhead	*Ameiurus melas*	**Paddlefish**	***Polyodon spathula***
Black crappie	*Pomoxis nigromaculatus*	Pirate perch	*Aphredoderus sayanus*
Black redhorse*	***Moxostoma duquesnei****	Pugnose minnow*	*Opsopoeodus emiliae**
Blackstripe topminnow	*Fundulus notatus*	Pumpkinseed	*Lepomis gibbosus*
Bluegill	*Lepomis macrochirus*	Redear sunfish	*Lepomis microlophus*
Bluntnose minnow	*Pimephales notatus*	Redfin shiner	*Lythrurus umbratilis*
Brassy minnow	*Hybognathus hankinsoni*	River chub	*Nocomis micropogon*
Brindled madtom	*Noturus miurus*	River darter	*Percina shumardi*
Brook silverside	*Labidesthes sicculus*	River redhorse*	*Moxostoma carinatum**
Bullhead minnow	*Pimephales vigilax*	Sauger	*Stizostedion canadense*
Central mudminnow	*Umbra limi*	Silver chub	*Macrhybopsis storeriana*
Dusky darter	*Percina sciera*	Silver shiner	*Notropis photogenis*
Gizzard shad	*Dorosoma cepedianum*	Silverjaw minnow	*Ericymba buccata*
Golden redhorse	*Moxostoma erythrurum*	Smallmouth redhorse	*Moxostoma breviceps*
Golden shiner	*Notemigonus crysoleucas*	Southern redbelly dace	*Chrosomus erythrogaster*
Green sunfish	*Lepomis cyanellus*	Spotted sucker	*Minytrema melanops*
Highfin carpsucker	*Carpiodes velifer*	Stonecat	*Noturus flavus*
Lake chubsucker	*Erimyzon sucetta*	Striped shiner	*Luxilus chrysocephalus*
Lake sturgeon	*Acipenser fulvescens*	Tadpole madtom	*Noturus gyrinus*
Largemouth bass	*Micropterus salmoides*	Weed shiner	*Notropis texanus*
Long-ear sunfish	*Lepomis megalotis*	Yellow bass	*Morone mississippiensis*
Mud darter	*Etheostoma asprigene*	Yellow bullhead	*Ameiurus natalis*
Northern madtom	*Noturus stigmosus*		
Riverine (n = 192)			
American Coot	*Fulica americana*	Northern hogsucker	*Hypentelium nigricans*
American White Pelican	*Pelecanus erythrorhynchos*	Northern madtom	*Noturus stigmosus*
American Wigeon	*Anas americana*	Northern pike	*Esox lucius*
Black Tern	*Chlidonias niger*	Ohio lamprey	*Ichthyomyzon bdellium*
Bonaparte's Gull	*Chroicocephalus philadelphia*	Orange-spotted sunfish	*Lepomis humilis*
Bufflehead	*Bucephala albeola*	Ozark minnow	*Notropis nubilus*
Canada Goose	*Branta canadensis*	**Paddlefish**	***Polyodon spathula***
Canvasback	*Aythya valisineria*	Pallid shiner	*Hybopsis amnis*
Caspian Tern	*Sterna caspia*	**Pallid sturgeon**	***Scaphirhynchus albus***
Common Goldeneye	*Bucephala clangula*	Pirate perch	*Aphredoderus sayanus*
Common Loon	*Gavia immer*	Plains minnow	*Hybognathus placitus*
Common Merganser	*Mergus merganser*	Pugnose minnow	*Opsopoeodus emiliae*
Common Tern	*Sterna hirundo*	Pumpkinseed	*Lepomis gibbosus*

Double-crested Cormorant	*Phalacrocorax auritus*	Redear sunfish	*Lepomis microlophus*
Eared Grebe	*Podiceps nigricollis*	Redfin shiner	*Lythrurus umbratilis*
Herring Gull	*Larus argentatus*	Ribbon shiner	*Lythrurus fumeus*
Hooded Merganser	*Lophodytes cucullatus*	River carpsucker	*Carpiodes carpio*
Horned Grebe	*Podiceps auritus*	River chub	*Nocomis micropogon*
Least Tern, Interior	*Sternula antillarum*	River darter	*Percina shumardi*
Lesser Scaup	*Aythya affinis*	**River redhorse**	***Moxostoma carinatum***
Osprey	*Pandion haliaetus*	River shiner	*Notropis blennius*
Red-breasted Merganser	*Mergus serrator*	Rock bass	*Ambloplites rupestris*
Redhead	*Aythya americana*	Rosyface shiner	*Notropis rubellus*
Ring-billed Gull	*Larus delawarensis*	Sand shiner	*Notropis stramineus*
Ring-necked Duck	*Aythya collaris*	Sauger	*Stizostedion canadense*
Ruddy Duck	*Oxyura jamaicensis*	Scioto madtom	*Noturus trautmani*
Thayer's Gull	*Larus glaucoides thayeri*	**Shoal chub**	***Macrhybopsis hyostoma***
Trumpeter Swan	*Cygnus buccinator*	Shorthead redhorse	*Moxostoma macrolepidotum*
Tundra Swan	*Cygnus columbianus*	Shortnose gar	*Lepisosteus platostomus*
Western Grebe	*Aechmophorus occidentalis*	**Shovelnose Sturgeon**	***Scaphirhynchus platorynchus***
Illinois cave amphipod	*Gammarus acherondytes*	Sicklefin chub	*Macrhybopsis meeki*
Alabama shad	*Alosa alabamae*	Silver chub	*Macrhybopsis storeriana*
Alligator gar	*Atractosteus spatula*	Silver lamprey	*Ichthyomyzon unicuspis*
American brook lamprey	*Lampetra appendix*	Silver redhorse	*Moxostoma anisurum*
American eel	*Anguilla rostrata*	Silver shiner	*Notropis photogenis*
Arkansas darter	*Etheostoma cragini*	Silverband shiner	*Notropis shumardi*
Banded darter	*Etheostoma zonale*	Silverjaw minnow	*Ericymba buccata*
Banded sculpin	*Cottus carolinae*	Skipjack herring	*Alosa chrysochloris*
Bigeye chub	*Hybopsis amblops*	Slender madtom	*Noturus exilis*
Bigeye shiner	*Notropis boops*	Slenderhead darter	*Percina phoxocephala*
Bigmouth buffalo	*Ictiobus cyprinellus*	Slough darter	*Etheostoma gracile*
Black buffalo	*Ictiobus niger*	Smallmouth bass*	*Micropterus dolomieu**
Black bullhead	*Ameiurus melas*	Smallmouth buffalo	*Ictiobus bubalus*
Black redhorse	***Moxostoma duquesnei***	Smallmouth redhorse	*Moxostoma breviceps*
Blacknose dace	*Rhinichthys atratulus*	Southern redbelly dace	*Chrosomus erythrogaster*
Blacknose shiner	*Notropis heterolepis*	Speckled chub	*Macrhybopsis aestivalis*
Blackside darter	***Percina maculata***	Spotted bass	*Micropterus punctulatus*
Blackstripe topminnow	*Fundulus notatus*	Spotted gar	*Lepisosteus oculatus*
Blue catfish	*Ictalurus furcatus*	Spotted sucker	*Minytrema melanops*
Blue sucker	*Cycleptus elongatus*	Stargazing darter	*Percina uranidea*
Bluegill	*Lepomis macrochirus*	Stippled darter	*Etheostoma punctulatum*
Bluntnose darter	*Etheostoma chlorosoma*	Stonecat	*Noturus flavus*
Bluntnose minnow	*Pimephales notatus*	Striped shiner	*Luxilus chrysocephalus*
Brassy minnow	*Hybognathus hankinsoni*	Sturgeon chub	*Macrhybopsis gelida*

Brindled madtom	*Noturus miurus*	Suckermouth minnow	*Phenacobius mirabilis*
Brook silverside	*Labidesthes sicculus*	Tadpole madtom	*Noturus gyrinus*
Brook trout	*Salvelinus fontinalis*	**Topeka shiner**	***Notropis topeka***
Bullhead minnow	*Pimephales vigilax*	Walleye	*Stizostedion vitreum*
Channel catfish	*Ictalurus punctatus*	Warmouth	*Lepomis gulosus*
Channel shiner	*Notropis wickliffi*	**Weed shiner**	***Notropis texanus***
Chestnut lamprey	*Ichthyomyzon castaneus*	Western sand darter	*Ammocrypta clara*
Creek chub	*Semotilus atromaculatus*	Western silvery minnow	*Hybognathus argyritis*
Crystal darter	*Crystallaria asprella*	White bass	*Morone chrysops*
Dusky darter	*Percina sciera*	White sucker	*Catostomus commersoni*
Emerald shiner	*Notropis atherinoides*	Yellow bass	*Morone mississippiensis*
Fathead minnow	*Pimephales promelas*	Yellow bullhead	*Ameiurus natalis*
Flathead catfish	*Pylodictis olivaris*	Copperbelly water snake	*Nerodia erythrogaster neglecta*
Flathead chub	*Platygobio gracilis*	Eastern hellbender	*Cryptobranchus a. alleganiensis*
Freckled madtom	*Noturus nocturnus*	Ozark hellbender	*Cryptobranchus a. bishopi*
Freshwater drum	*Aplodinotus grunniens*	Hungerford's crawling water beetle	*Brychius hungerfordi*
Ghost shiner	*Notropis buchanani*	Clubshell	*Pleurobema clava*
Gilt darter	*Percina evides*	Cracking pearlymussel	*Hemistena lata*
Gizzard shad	*Dorosoma cepedianum*	Curtis pearlymussel	*Epioblasma florentina curtisii*
Golden redhorse	***Moxostoma erythrurum***	Fanshell	*Cyprogenia stegaria*
Golden shiner	*Notemigonus crysoleucas*	Fat pocketbook	*Potamilus capax*
Goldeye	*Hiodon alosoides*	Higgins' eye pearlymussel	*Lampsilis higginsi*
Gravel chub	*Erimystax x-punctatus*	Mapleleaf	*Quadrula quadrula*
Greater redhorse	*Moxostoma valenciennesi*	Neosho mucket	*Lampsilis rafinesqueana*
Green sunfish	*Lepomis cyanellus*	Northern riffleshell	*Epioblasma rangiana*
Greenside darter	*Etheostoma blennioides*	Orangefoot pimpleback	*Plethobasus cooperianus*
Highfin carpsucker	*Carpiodes velifer*	Ouachita rock pocketbook	*Arkansia wheeleri*
Hornyhead chub	*Nocomis biguttatus*	Pink mucket	*Lampsilis abrupta*
Ironcolor shiner	*Notropis chalybaeus*	Purple cat's paw pearlymussel	*Epioblasma obliquata obliquata*
Lake chubsucker	*Erimyzon sucetta*	Purple wartyback	*Cyclonaias tuberculata*
Lake sturgeon	*Acipenser fulvescens*	Rabbitsfoot	*Quadrula cylindrica cylindrica*
Largemouth bass	*Micropterus salmoides*	Rayed bean	*Villosa fabalis*
Leopard darter	*Percina pantherina*	Ring pink mussel	*Obovaria retusa*
Logperch	*Percina caprodes*	Rough pigtoe	*Pleurobema plenum*
Long-ear sunfish	*Lepomis megalotis*	Scaleshell mussel	*Leptodea leptodon*
Longnose gar	*Lepisosteus osseus*	Sheepnose	*Plethobasus cyphyus*
Mountain madtom	*Noturus eleutherus*	Snuffbox	*Epioblasma triquetra*
Mud darter	*Etheostoma asprigene*	Spectaclecase	*Cumberlandia mondonta*

Muskellunge	*Esox masquinongy*	Tubercled-blossom pearlymussel	*Epioblasma torulosa torulosa*
Neosho madtom	*Noturus placidus*	White cat's paw pearlymussel	*Epioblasma obliquata perobliqua*
Niangua darter	*Etheostoma nianguae*	White wartyback	*Plethobasus cicatricosus*
Northern brook lamprey	*Ichthyomyzon fossor*	Winged mapleleaf	*Quadrula fragosa*
Palustrine (n = 83)			
Alder Flycatcher	*Empidonax alnorum*	Palm Warbler	*Setophaga palmarum*
American Bittern	*Botaurus lentiginosus*	**Pectoral Sandpiper**	***Calidris melanotos***
American Black Duck	*Anas rubripes*	Pied-billed Grebe	*Podilymbus podiceps*
American Coot	*Fulica americana*	Purple Martin	*Progne subis*
American White Pelican	*Pelecanus erythrorhynchos*	Red Knot (roselaari ssp.)	*Calidris canutus*
American Woodcock	*Scolopax minor*	Red Knot (rufa ssp.)	*Calidris canutus*
Baird’s Sandpiper	*Calidris bairdii*	Red-necked Phalarope	*Phalaropus lobatus*
Black Rail	*Laterallus jamaicensis*	Red-winged Blackbird	*Agelaius phoeniceus*
Black Tern	*Chlidonias niger*	Ross's Goose	*Chen rossii*
Black-crowned Night-Heron	*Nycticorax nycticorax*	Ruddy Duck	*Oxyura jamaicensis*
Black-necked Stilt	*Himantopus mexicanus*	Rusty Blackbird	*Euphagus carolinus*
Blue-winged Teal	*Anas discors*	Sandhill Crane	*Grus canadensis*
Chestnut-sided Warbler	*Setophaga pensylvanica*	Sedge Wren	*Cistothorus platensis*
Common Gallinule	*Gallinula galeata*	Semipalmated Plover	*Charadrius semipalmatus*
Common Yellowthroat	*Geothlypis trichas*	Semipalmated Sandpiper	*Calidris pusilla*
Dunlin	*Calidris alpina*	Short-billed Dowitcher	*Limnodromus griseus*
Eared Grebe	*Podiceps nigricollis*	Snow Goose	*Chen caerulescens*
Forster’s Tern	*Sterna forsteri*	Snowy Egret	*Egretta thula*
Franklin’s Gull	*Leucophaeus pipixcan*	Solitary Sandpiper	*Tringa solitaria*
Gadwall	*Anas strepera*	Sora	*Porzana carolina*
Great Blue Heron	*Ardea herodias*	Spotted Sandpiper	*Actitis macularius*
Great Egret	*Ardea alba*	Stilt Sandpiper	*Calidris himantopus*
Green Heron	*Butorides virescens*	Swamp Sparrow	*Melospiza georgiana*
Green-winged Teal	***Anas crecca***	Trumpeter Swan	*Cygnus buccinator*
Hooded Merganser	*Lophodytes cucullatus*	**Virginia Rail**	***Rallus limicola***
Hudsonian Godwit	*Limosa haemastica*	Western Sandpiper	*Calidris mauri*
Killdeer	*Charadrius vociferus*	Whimbrel	*Numenius phaeopus*
King Rail	*Rallus elegans*	White-rumped Sandpiper	*Calidris fuscicollis*
Le Conte’s Sparrow	*Ammodramus leconteii*	Whooping Crane	*Grus americana*
Least Bittern	*Ixobrychus exilis*	Willet	*Tringa semipalmata*
Least Sandpiper	*Calidris minutilla*	Willow Flycatcher	*Empidonax traillii*
Lesser Yellowlegs	*Tringa flavipes*	Wilson's Phalarope	*Phalaropus tricolor*
Little Blue Heron	*Egretta caerulea*	Wilson's Snipe	*Gallinago delicata*
Long-billed Dowitcher	*Limnodromus scolopaceus*	Wood Duck	*Aix sponsa*
Mallard	***Anas platyrhynchos***	Yellow Rail	*Coturnicops noveboracensis*

Marbled Godwit	*Limosa fedoa*	Yellow-crowned Night-heron	*Nyctanassa violacea*
Marsh Wren	***Cistothorus palustris***	Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*	Copperbelly water snake	*Nerodia erythrogaster neglecta*
Northern Harrier	*Circus cyaneus*	Eastern massasauga	*Sistrurus catenatus catenatus*
Northern Pintail	*Anas acuta*	Hine's emerald dragonfly	*Somatochlora hineana*
Northern Shoveler	*Anas clypeata*	Red wolf	*Canis rufus*
Osprey	*Pandion haliaetus*		
Grassland (n = 68)			
American Golden Plover	*Pluvialis dominica*	Long-eared Owl	*Asio otus*
American Goldfinch	*Carduelis tristis*	Mallard	*Anas platyrhynchos*
American Kestrel	*Falco sparverius*	Mourning Dove	*Zenaida macroura*
American Tree Sparrow	*Spizella arborea*	Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*
Bachman's Sparrow	*Peucaea aestivalis*	Northern Bobwhite	*Colinus virginianus*
Barn Owl	*Tyto alba*	Northern Flicker	*Colaptes auratus*
Barn Swallow	*Hirundo rustica*	Northern Harrier	*Circus cyaneus*
Bell's Vireo	*Vireo bellii*	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Blue Grosbeak	*Guiraca caerulea*	Orchard Oriole	*Icterus spurius*
Bobolink	***Dolichonyx orizivorus***	Palm Warbler	*Setophaga palmarum*
Brewer's Blackbird	*Euphagus cyanocephalus*	Prairie Warbler	*Setophaga discolor*
Broad-winged Hawk	*Buteo platypterus*	Red-tailed Hawk	*Buteo jamaicensis*
Brown-headed Cowbird	*Molthrus ater*	Ring-necked Pheasant	*Phasianus colchicus*
Burrowing Owl	*Athene cunicularia*	Savannah Sparrow	*Passerculus sandwichensis*
Cattle Egret	*Bubulcus ibis*	Short-eared Owl	*Asio flammeus*
Chipping Sparrow	*Spizella passerina*	Smith's Longspur	*Calcarius pictus*
Common Nighthawk	*Chordeiles minor*	Swainson's Hawk	*Buteo swainsoni*
Common Yellowthroat	*Geothlypis trichas*	Turkey Vulture	*Cathartes aura*
Dickcissel	*Spiza americana*	**Upland Sandpiper**	***Bartramia longicauda***
Eastern Bluebird	*Sialisa sialis*	Vesper Sparrow	*Pooecetes gramineus*
Eastern Meadowlark	*Sturnella magna*	Western Kingbird	*Tyrannus verticalis*
Eskimo Curlew	*Numenius borealis*	Western Meadowlark	*Sturnella neglecta*
Field Sparrow	*Spizella pusilla*	Copperbelly water snake	*Nerodia erythrogaster neglecta*
Gadwall	*Anas strepera*	Eastern massasauga	*Sistrurus catenatus catenatus*
Golden Eagle	*Aquila chrysaetos*	Dakota skipper	*Hesperia dacotae*
Grasshopper Sparrow	***Ammodramus savannarum***	Karner blue	*Lycaeides melissa samuelis*
Greater Prairie-Chicken	*Tympanuchus cupido*	Mitchell's satyr butterfly	*Neonympha mitchellii mitchellii*
Harris's Sparrow	*Zonotrichia querula*	Poweshiek skipperling	*Oarisma powesheik*
Henslow's Sparrow	***Ammodramus henslowii***	Regal fritillary	*Speyeria idalia*

Horned Lark	*Eremophila alpestris*	Swamp metalmark	*Calephelis mutica*
Hudsonian Godwit	*Limosa haemastica*	Gray wolf	*Canis lupus*
Killdeer	*Charadrius vociferus*	Red wolf	*Canis rufus*
Le Conte's Sparrow	*Ammodramus leconteii*	Prairie Bush Clover	*Lespedeza leptostachya*
Loggerhead Shrike	*Lanius ludovicianus*	Western prairie fringed orchid	*Platanthera praeclara*

BASE INFORMATION ABOUT THE SPECIES POOL

All base information gathered in our spreadsheet would benefit from a review by taxonomic experts. Information about occurrence within the ETBR landscape, habitat relationships, limiting factors, population trends, and answers to the surrogacy questions require thorough review by taxonomic experts. The Technical Team identified a panel of potential experts to aid in this review (table A10).

If the selection process used to generate Version 1.0 is used more widely, we recommend a crowd-sourcing exercise, wherein specialists are invited to review and revised data in the spreadsheet. Upon complete review and revision of the base data, the filtering process could be run again and the resulting version 1.1 compared to version 1.0.

Table A10. Potential Pool of Experts That Could Participate in Review of the Base Information for the ETBR Landscape

Expert Name	Expertise	Affiliation	Email	Phone
Louise Mauldin	fish	USFWS	lousie_mauldin@fws.gov	608-783-8407, 608-498-0395 (c)
Brant Fisher	fish & mussels - IN	Indiana DNR	bfisher@dnr.in.gov	812-350-5004
Bob Russell	birds	USFWS	robert_russell@fws.gov	612-713-5437
Melinda Knutson	birds	USFWS	melinda_knutson@fws.gov	608-781-6339
Brian Ickes	fish	USGS	bickes@usgs.gov	608-781-6298
Teresa Newton	mussels	USGS	tnewton@usgs.gov	608-781-6217
Jeff Kiefer	T&E	USFWS	jeffrey_kiefer@fws.gov	812-334-4261 ext 1212
Tom Watters	mussels	Ohio State University	watters.1@osu.edu	614-292-6170
Mike Redmer	herps	USFWS	mike_redmer@fws.gov	847-381-2253 ext 16
Keith Gido	fish - MO, IA, KS prairies	Kansas State University	kgido@k-state.edu	785-532-5088
Andy Forbes	birds	USFWS	andrew_forbes@fws.gov	612-713-5364
Jeff Janvrin	fish	Wisconsin DNR	jeff.janvrin@wisconsin.gov	608-785-9005
Craig Paukert	fish - MO	University of Missouri	paukertc@missouri.edu	573-882-3524
John Lyons	fish - WI	Wisconsin DNR	John.Lyons@Wisconsin.gov	608-221-6328
Scott Yess	fish	USFWS – La Crosse	scott_yess@fws.gov	608 783-8432
Rich Zweifel	fish - OH	Ohio DOW	Richard.Zweifel@dnr.state.oh.us	740-928-7034 ext 223

Scott Hale	fish - OH	Ohio DOW	Scott.Hale@dnr.state.oh.us	614-265-6554
Doug Aloisi	mussels	USFWS - Genoa Fish Hatchery	doug_aloisi@fws.gov	608-792-0190 (c)
Nathan Eckert	mussels	USFWS - Genoa Fish Hatchery	nathan_eckert@fws.gov	608-689-2605
Cloyce Hegde	plants - IN	Indiana DNR	chedge@dnr.in.gov	317-232-4078
Pauline Drobney	plants	USFWS – Neal Smith NWR	pauline_drobney@fws.gov	515-994-3400
Ryan Brady	birds	Wisconsin DNR	ryan.brady@wisconsin.gov	715-685-2933
Katie Koch	birds	USFWS	katie_koch@fws.gov	906-226-1249
Paul McMurry	invertebrates - aquatic	Indiana Dept Env Mgt	pmcmurra@idem.in.gov	317-308-3210
Jennifer Szymanski	T&E	USFWS	jennifer_szymanski@fws.gov	608-783-8455
Matt Combes	fish - MO, KS streams	MO Dept of Conservation	Matthew.Combes@mdc.mo.gov	660-785-2424 ext 6530
Mark Eberle	fish - Central US prairies	Ft Hayes State University	meberle@fhsu.edu	785-628-5264
Rick Stasiak	fish - MO, NE	University of Nebraska-Omaha	rstasiak@unomaha.edu	402-554-2295, 402-498-0650
Ed Peters	fish - MO, NE	University of Nebraska-Lincoln	epeters2@unl.edu	402-499-0106 or 715-266-2550
William P. McCafferty	inverts - mayflies	Purdue	mccaffer@purdue.edu	
Arwin Provonsha	inverts - mayflies	Purdue		
Robert Waltz	inverts - beetles, caddisflies, springtails	Indiana State Chemist, Purdue	rwaltz@purdue.edu	765-494-1492
Ralph Hellenthal	inverts - caddisflies, chironomid	Notre Dame		
Ed DeWalt	inverts - stoneflies	Illinois Natural History Survey		
Mark Pyron	inverts - aquatic snails	Ball State University		
Jim Curry	inverts - dragonflies	Franklin College		

INTERJURISDICTIONAL FISH

We recommend revisiting the definition of "interjurisdictional" for fish in the Upper Mississippi River and the Ohio River Basins. The list generated for the Ohio River needs further review. Generating these interjurisdictional fish lists could serve as a tangible starting point for collaborating with state partners. As implementation proceeds, a consistent definition of this term is needed to facilitate implementation. Additionally, these lists will need to be generated for other basins as we expand to the Upper Midwest and Great Lakes as well as Plains and Prairie Pothole landscapes.

Monitor Effectiveness (of the Surrogate Approach)

Monitoring at this step of the draft technical guidance is planning for monitoring the effectiveness of the surrogate approach, not the effectiveness of the management actions for meeting our biological outcomes. A suite of species should be selected to test the relationship between the selected surrogate and the response of a priority set of the represented species. The suite of species should be chosen for both the hypothesized umbrella and environmental indicator species pools with consideration for those species that could be better addressed with a shorter term research project (see the section Identify Knowledge Gaps and Uncertainty). We recommend hypothesized relationships among population trends and the suites of species be identified during a review process with taxonomic experts. The key considerations to address when assessing effectiveness of both surrogate approaches are reviewed in Caro (2010) and Favreau et al. (2006).

Recommendations and Implementation Within SHC

Selection of surrogate species is only the first step in working through SHC toward a functional landscape. Our group briefly discussed how the species could be used in the landscape design process, how different programs and agencies might work together to take action, and how effectiveness monitoring might be implemented by expanding existing surveys or creating new ones. Effectiveness monitoring in this sense is about learning how well management actions are doing with regard to meeting our desired biological outcomes. In the following sections, we make specific recommendations regarding the next steps in the process and summarize the key insights and needs for further development made throughout the document.

Expanding Version 1.0: Integrating Other Surrogate Approaches

An important component in measuring the success of the Service's work is to engender understanding and support from the public. Once we created our draft list, we briefly discussed the value of selecting flagship species that the public can identify or connect with. We were looking for a species that could help raise awareness about the loss of native grasslands, for example, or serve as an icon of other goals that we hope to achieve.

Flagship species provide value to conservation as a communication tool. Before selecting a flagship for the ETBR landscape, we recommend that the Service clearly articulate what message it wants to share with the public. For example, the ETBR landscape has undergone a near complete conversion of native grasslands to primarily agriculture. The loss of native grasslands has resulted in declines in many grassland associated species. Showcasing a species like the Bobolink could capture the imagination of the public creating a desire to help restore grassland and bring Bobolinks back. The team recommends that further consideration of the purpose of and target audience for one or more flagship species is undertaken in the near future. In doing so, the Technical Team recommends such an effort include the following considerations:

- What message do we want the species to carry to the public?
- What component of the public are we trying to reach (e.g., hunters, fishermen, bird watchers, etc.)?
- Is the species easily identifiable to the American public?

- Can the species serve as a rallying point for public interest, awareness and support due to its innate charismatic qualities, cultural significance, and/or economic importance to a specific region or segment of the American public?
- Can the story of conservation for this species and its habitat be potentially representational of other related species or ecosystems? (For example, the umbrella effect of as species X goes, so goes species Y and Z.)
- Could the species be linked with an important state(s) species (e.g., non-federal trust) resulting in an even more effective campaign?

Examples briefly identified by the team included the paddlefish and pallid sturgeon with a potential story line about over-harvest, poaching for caviar, and the damming of big rivers for commerce. Further, the Bobolink, a bird with striking plumage and thrilling breeding behavior, could be an icon of large rolling expanses of tallgrass prairies. Other species briefly considered included the smallmouth bass, Mallard and Blue-winged Teal because of their associations with hunters and fishers.

Expanding Version 1.0: Application to Strategic Habitat Conservation

One of our major concerns in selecting surrogate species is the common misperception that priority species are one and the same as surrogate species. Priority species may or may not be surrogates depending on why and how they were selected. This misconception occurred regularly even within the Technical Team over the months we worked together, causing occasional re-evaluation and definition of the selection purpose. Thus, the surrogate species we have selected through our initial process may or may not include priority species identified by other conservation groups. It is likely that the species we selected serve, hypothetically, as surrogates for many priority and non-priority species (table A9). Definitions of priority and the many surrogate approaches are provided in the draft technical guidance (pp. 26 & 29, USFWS 2012) and are available in the Key Definitions section.

For this exercise, we identified three landscape features or conditions (limiting factors) that are lacking in the current environment and through restoration are considered the primary means by which we can change the trajectory of current populations of our surrogates. In addition, we restricted the scope of our exercise to the ETBR landscape, because it encompassed a fairly homogenous system within which to develop and test our selection process. Although we considered ten broad habitat categories within the landscape, we focused our efforts on the three historically dominant habitat categories that were identified by the ETBR LCC as priorities (grasslands, rivers, and wetlands).

Our resulting list is a list is of regional surrogate species whose job it is to tell us about habitat restoration efforts in terms of gaining enough restored acres or river miles in large enough patches that contain the important juxtaposition of habitats necessary to support both breeding and pass-through migrants. Directing habitat work toward landscape designs based on surrogate species should provide a stronger context for local priority species. It will be important to remain cognizant of scale and context as planning and management decisions are made.

How Can the List be Used? Assessing Progress Toward a Functional Landscape

One of the most important uses of the list is the development of a conservation design for the ETBR landscape. This design entails creation of mapping and other decision tools tailored to the design and to how the agency makes decisions about where, when, and how to deliver conservation actions. A conservation design linked to surrogate species and population objectives set for those species provides a picture of how the surrogates chosen for a landscape could help focus work at local scales. Armed with design and decision tools, the Service can work with its partners to visualize where existing protected areas could be increased in size, where new protected areas could be established, and where management on multiple use lands or private lands could benefit desired population levels of surrogate species. Further, linking decisions to expected outcomes (in terms of population change) will allow the Service to track its progress and make adjustments. A draft of one possible conservation design tool based on an objectives hierarchy and measureable attributes (i.e., the surrogates chosen to represent those attributes) was developed at the January workshop (Blomquist et al. 2013; Appendix C). A key aspect of a conservation design is that monitoring information can be used to test the predictions of the design in a formal adaptive management framework (Williams et al. 2007).

HOW CAN THE SERVICE BETTER WORK TOGETHER?

We recommend that the Oversight Team explore the use of LCC-based teams for conservation design and delivery tools that will allow future conservation actions to be tied to expected population responses. In this way, an effectiveness monitoring program can be developed that explicitly links the species, their limiting factors, and proposed management actions needed to ameliorate the limiting factor.

A potential mechanism for such cross-programmatic collaboration was described within the context of science communications within the Service (Lor et al. 2011; Appendix B – Alternative 2: Forums), and this possible mechanism can easily be expanded to include partners (figure A7). Generally, program representatives (designated by Assistant Regional Director for each program) gather information directly from field staff within smaller forums (ecoregions within and LCC). At the field level, field station representatives (project leader and biologists), regardless of program, provide input at the request of sub-LCC (ecoregional), cross-programmatic science teams. The idea of these forums is to hear from all stations with equal representation and help resolve conservation needs internally or take their needs to other collaborators (universities, ecoregional RFPs, USGS science centers, etc., but not LCCs or to other entities where the Service gets one vote). Conservation priorities and science needs from each "subteam" are reviewed by the ARDs for each program and passed along to a regional cross-programmatic Science Team. The Science Applications-ARD leads the regional Science Team in prioritizing among the needs presented by the ecoregional teams and leads the RDT in reviewing the priority recommendations of the SA-ARDs Science Team.

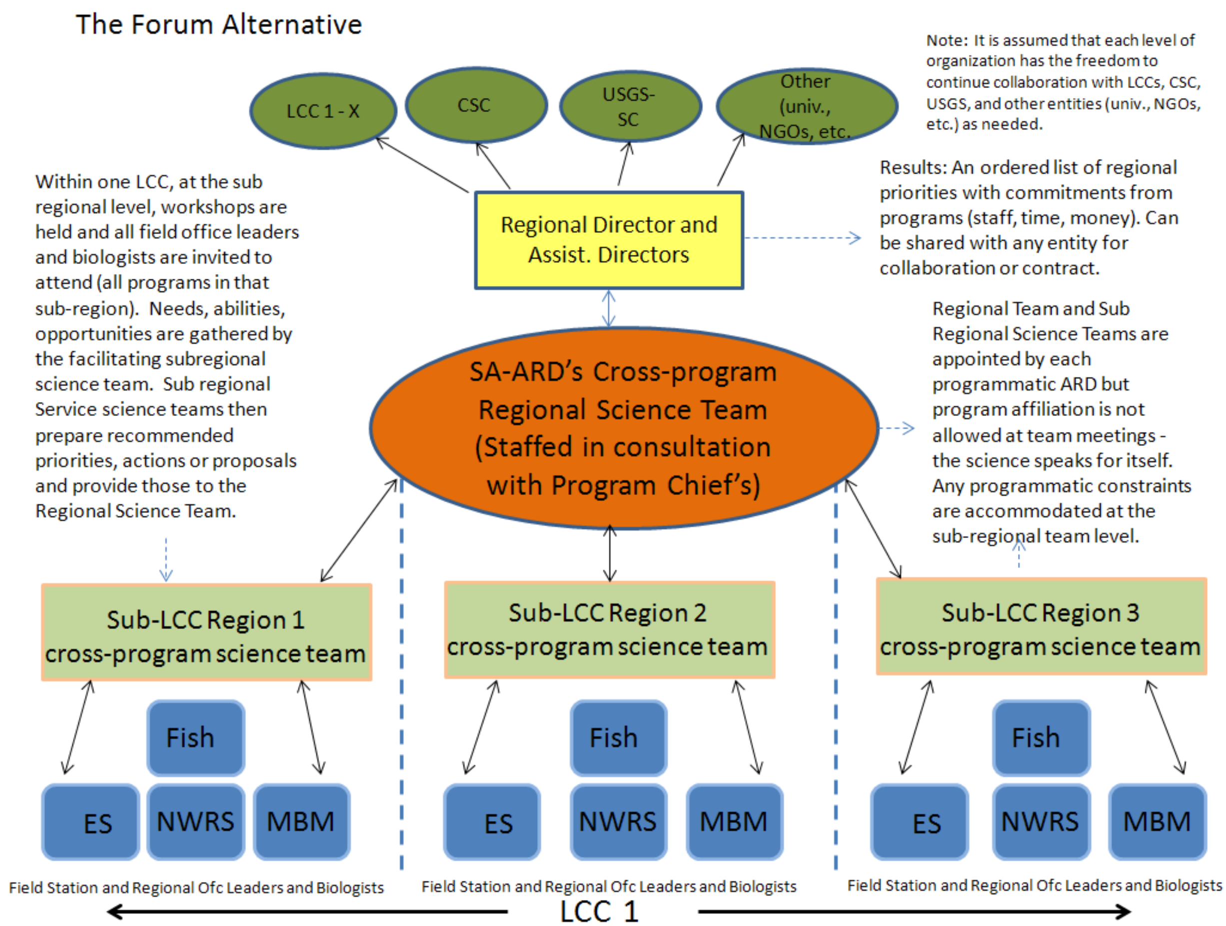


Figure A7. Forum Approach to Foster Communication and Collaboration on Science Needs Within the Service (Taken From Lor et al. 2011, figure A2)

Key Insights, Needs for Additional Consideration, and Recommendations

1. **Use Version 1.0 in SHC.** Use the Version 1.0 surrogate species list to test implementation of SHC at the LCC scale before expanding the list to other habitats or landscapes. Implementation may yield great insights into the effectiveness of this process for selecting surrogate species, especially for non-bird species, and may help realize efficiencies in developing subsequent iterations of the list. Additionally, the Version 1.0 list provides a mechanism for understanding Service priorities in the ETBR landscape and can help focus partnerships with states, tribes and other conservation entities to better align collaborative and complementary work. Initial discussion should identify which state (e.g., SWAP) and Tribal priority species align with each of the surrogate species or groups. Initial discussion should also identify where and how management actions are currently being taken to promote conservation of these species. It is important to note that our resulting list is a list of regional surrogate species whose job it is to tell us about habitat management efforts in terms of gaining enough restored acres or river miles in large enough patches that contain the important juxtaposition of habitats necessary to support populations at that scale, and it will be important to remain cognizant of scope and context as implementation proceed.

2. **Reviewing and establishing monitoring programs to complete SHC.** Species were scored based on whether or not they were currently monitored. Many species, particularly birds, are monitored by some existing survey. However, it is highly likely that some alternative monitoring design and field methods will need to be developed for the surrogate species that will explicitly link species measures related to population objective directly to management actions. As a first step, we recommend developing a process for gathering, reviewing, and scaling of existing monitoring programs to the regional or LCC scale.
3. **Fostering communication and collaboration through the SHC cycle.** One of the most important uses of the list is the development of conservation design for the ETBR landscape and in the creation of mapping and other decision tools. We recommend that the Oversight Team explore the use LCC-based teams for conservation design and delivery tools that will allow future conservation actions to be tied to expected population responses and will allow the Service and partners to track progress and make adjustments.
4. **Scope of Version 1.0.** We generated two lists for the ETBR LCC, a comprehensive list that covers eight broad habitat categories for the limiting factors of interest (agricultural runoff issues and habitat loss) and a LCC-focused list that emphasizes the three habitat categories of interest to the LCC. The focus on federal trust species resulted in both of these lists being comprised of fish and birds. Entire taxonomic groups were not chosen as surrogates including, mussels, invertebrates, mammals, plants, reptiles, and amphibians. This result is in part an artifact of scoping and the restriction of these groups of species to federally threatened and endangered species.

   Through the final review of the list, the taxonomic experts occasionally recommended a non-trust species from one of these taxa groups that could serve as a better surrogate. Some state managed species have the potential to serve as excellent surrogates and selecting the “best” set would provide the greatest efficiency for conservation design, delivery, monitoring, and evaluation. Initial engagement of Tribal partners was initiated just prior to our final workshop to test and review our process. We suggest that in the next phase of the surrogate species process a new team explore options for including state and Tribal resources of concern (e.g., SWAP). In doing so, the Service needs to communicate clearly and upfront its intent for surrogate selection.

   Several state partners repeatedly voiced concerns over the implications of selecting surrogate species on states abilities to manage their own wildlife populations. To avoid or minimize these concerns in future efforts, the Service should consider upfront and regular communication with state partners to alleviate their concerns. In particular, the decision regarding the starting pool of species will need review as we expand to the Upper Midwest and Great Lakes as well as Plains and Prairie Pothole landscapes. Similarly, we recommend revisiting the decision to limit the scope of the list to the three major habitat categories identified by the LCC partnership. Exploring the focus of adjacent LCCs could help with this decision. Finally, we recommend revisiting the decision to focus on the limiting factors of habitat loss (e.g., minimum patch size, habitat configuration) and water quality issues related to agricultural runoff (e.g., nitrogen-based fertilizer pollution). The base dataset holds species-habitat-limiting factor information for more habitat categories and limiting factors that will be very useful in this endeavor.

5. **Integrating landscape variation.** The issues of geographic and temporal scale are still problematic and challenging. Our selection process explicitly covered the entire spatial extent of

the LCC. To account for variation in our broad habitat categories across the LCC and important times in the annual cycle (breeding and migration) of the species pool, we had to group species that could serve as surrogates for the same sub-habitat or migration window. These groups were a necessity of working at a spatial scale of the entire LCC. We recommend considering sub-habitats (or small geographic areas) and important temporal windows more formally as implementation in other landscapes progresses. We also recommend formally considering the link among planning cycles (e.g., budget), management actions, and the life history needs of surrogate species.

6. **Flagship species.** We discussed candidates for flagship species after generating our list of umbrella and environmental indicator species. The resulting six potential flagship species could suffice and these species should be evaluated for how well they meet the flagship objectives. Limiting the potential for public engagement to species chosen for another surrogate approach will limit the ability to choose the species with the highest public appeal. If the species do not meet flagship objectives, we recommend considering flagship species in a separate selection process.
7. **Selection process and species database review.** The species surrogacy database also provides opportunities for additional input from taxonomic experts. Similarly, the selection process itself deserves review by expert decision analysts. If the Midwest Region proceeds with implementation of the process that resulted in the Version 1.0 list, we recommend further vetting and peer review by experts. The base data tool provides great flexibility to rerun the analyses as new information is gathered, and transparency is retained as sources for new information are added in support of changes. The database contains information on all factors known or assumed to be limiting federal trust species populations, and this can be used to expand the surrogates chosen to cover limiting factors beyond habitat loss and water quality issues related to agricultural fertilizer. We also recommend the Midwest Region invest in creating an Access database of the species information that is currently contained in an Excel spreadsheet to facilitate future analyses and reporting. One mechanism to accomplish this is a crowd sourcing exercise using the experts identified to participate in the November workshop (table A10). Upon complete review and revision of the base data, the filtering process could be run again and the resulting Version 1.1 compared to Version 1.0.
8. **Interjurisdictional fish and aquatic species.** We recommend revisiting the definition of “interjurisdictional” for fish in the Upper Mississippi River and the Ohio River Basins. The list generated for the Ohio River needs further review, and similar lists will need to be generated for other basins as we expand to the Upper Midwest and Great Lakes as well as Plains and Prairie Pothole landscapes. Similarly, we recommend revisiting the use of LCC boundaries for aquatic species. The ETBR landscape includes portions of the Mississippi River and the Ohio River Basins, which made generating a species list difficult because of the artificial nature of the ETBR LCC boundary to these riverine systems. This difficultly may persist as implementation proceeds.
9. **Population objectives.** For migratory birds and threatened and endangered species, population objectives were readily, available although these were often at scales other than the ETBR landscape. For fish species, population objectives were more difficult to obtain a consistent source. We recommend developing a process for gathering and scaling existing population objectives to the regional or LCC scale.
10. **Testing the surrogate hypotheses.** Version 1.0 (table 1 located in the report section, table A9) contains hypotheses of the number of species that are represented by the umbrella and environmental indicator species we selected. These relationships need to be tested. We

recommend selecting a subset of species to test these relationships. One potential approach is to gather existing data and models for species identified as priorities by Service programs to begin to explore the relationships among the 21 surrogates and these priority species. At a minimum, identify a set of priority species for each of the 12 groups in Version 1.0 that will help to explore these relationships. This initial exploration can help to develop the effectiveness monitoring detailed in Step 10 of the draft technical guidance.

KEY DEFINITIONS

(Adapted from the draft technical guidance, pp. 26 & 29, USFWS 2012 and Caro 2010)

Environmental Indicator Species: A species used to assess extent of disturbance or environmental change. These species are typically used in an aquatic ecosystems and pollution studies.

Priority Species: Species demanding extra time and resource commitments due to legal status, management need, vulnerability, geographic areas of importance, financial or partner opportunity, political sensitivity, or other factors.

Surrogate Species: Defined by Caro (2010) and adopted by the Service species used to represent other species or aspects of the environment (e.g., water quality, sagebrush or grasslands, etc.). Surrogate species are used for comprehensive conservation planning that supports multiple species and habitats within a defined landscape or geographic area.

Umbrella Species (Local): One or a few species used to identify smaller areas important for conservation (location, size and shape of a reserve) at the regional or national scale.

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APPENDIX B: A DECISION AND COMMUNICATION STRUCTURE FOR IDENTIFYING CONSERVATION PRIORITIES AND SCIENCE NEEDS ACROSS AGENCY PROGRAMS

A case study from the Structured Decision Making Workshop
October 17-21, 2011

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EXECUTIVE SUMMARY

This report is the result of workshop held in Sacramento, California in October 2011 as part of a training course in Decision Analysis provided by the National Conservation Training Center. Several case studies were selected to the workshops and teams were selected to address each case study. For this problem, a team membership was carefully constructed to provide representation from all natural resource programs within the agency, all regions, and to have participants who were in leadership positions within the agency. Our final report provides guidelines for how regions can develop and address conservation priorities and science needs that cut across programs and reflect the most relevant needs in the field, regional, and national offices. The framework is flexible but yet provides clear guidance on the best process. By setting and addressing our highest conservation priorities as an agency, all areas of the U.S. Fish and Wildlife Service (FWS, Service), and our partners will benefit. This report details the process we used to create a flexible framework. We suggest that each region consider adopting and implementing the recommendations in this report and that are highlighted below.

1. The "winning" alternative was Alternative #2: Forum followed closely by Alternative #1: Science Team. Given that they ranked out fairly closely, there may be practical advantages to going with one over the other. Our team recommends that regions look closely at their situations and choose one or the other. There may be practical implementation reasons for going with one alternative for one portion of a region or LCC geography and with the other in another situation. What is important is learning more about how each alternative performs with regard to the fundamental objectives, ease of implementation, transparency of process, and equitable elicitation of needs.
2. Each region and program needs to commit to the identified priorities through assignment of staff, time, or funding to priorities (i.e., in performance standards) regardless of whether the priorities are relevant to the specific program or to the greater conservation goal as a whole. This is where the Service would benefit the most from the selected alternative. It is also then conducting business under the new business model – Strategic Habitat Conservation. We cannot stress enough how integral this criterion is to successful implementation of the selected framework.
3. Each program needs to develop and document a fair and unbiased process to identify conservation priorities and science needs. The process could be directed by a regional science team or the SA-ARD. It is important that the elicitation process is comprehensive, fair, unbiased and transparent.
4. The SA-ARD could bring regional science needs to the national level for consideration across LCCs and for consideration of internal action through the Washington Office.
    a. At the national level there needs to be a similar cross-programmatic science panel to rank national priorities. This could be the existing Science Team that Dr. Gaby Chavarria put together (they come to the table without their programmatic affiliations and let the science speak for itself), or the Service could create some different entity.
5. The Regional Directors should charge each cross-programmatic science team with developing a scope of work and a prioritization process that further fleshes out the detail of how they will function BEFORE any scoping or prioritization of science needs begins and the process should be reviewed and approved by ARDs (Regional Directorate Teams).

a. Each program and/or cross-program science team will need a process for eliciting needs from the field and for setting programmatic and cross-programmatic conservation science needs at all levels in the organization. We brainstormed a few but this is the subject for **another structured decision-making workshop**:

Possible criteria for prioritizing conservation priorities and needs within each FWS program:

b. Conservation issue is a widespread problem.

c. Benefits multiple programs.

d. Priority can be alleviated with policy or management.

e. Priority addresses the most important ecological/anthropogenic driver.

6. Information needs should be captured in a regional or national database (e.g., Fish and Wildlife Information Needs System (FWINS)); this task links with Visions Recommendation 9 – Research agenda for the NWRS.

7. Finally, the members of our structured decision making workshop are committed to learning and to conservation success. We have all agreed to serve as a review panel for how the process has worked for each region after 12 to 18 months of implementation. Our team will collate and review each region's scope of work, information elicitation process, prioritization process, and any feedback regions will provide. We will provide results from our review to the Regional Directorate.

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Decision Problem

The problem: Currently, there is no cohesive mechanism for the different U. S. Fish and Wildlife Service programs (Ecological Services, Fisheries, Migratory Bird Management, and Refuges) to communicate and collaborate cross programmatically to develop common conservation priorities and science needs. Because we lack an integrated process to communicate and collaborate, and a process to reach consensus on decisions across programs, there is no clear pathway for communicating shared conservation priorities and science needs with partners (e.g., Landscape Conservation Cooperatives [LCCs]). Therefore, we risk the inefficiencies inherent in independent, ad hoc collaborations with partners without a unified purpose best serving the agency's needs. We propose to develop guidelines for cross-program identification of conservation priorities and science needs among the field, regional, and national offices. The framework will be flexible but yet provide clear guidance on the best process for identifying and communicating conservation priorities among programs and for collaborating with our conservation partners. By setting and addressing our highest conservation priorities as an agency, all areas of the Service will benefit.

Path to a solution: We employed Structured Decision Making (SDM) to develop a framework for 1) determining how program-specific conservation priority and science needs can be elicited, prioritized and shared across programs and 2) how cross-programmatically priorities and needs can be shared and prioritized within regions and shared across regions, and 3) how the FWS perspective of conservation priorities and science needs can be conveyed to LCCs or used for other partnership opportunities, and 4) how these priorities and needs can be transmitted back to the field staff. Under this framework, Service employees at all levels will have an opportunity to contribute to and participate in the development of a common understanding of the science needs and priorities of the Service. Each individual should be able to see how the priorities are relevant to them and to our conservation partners. The scope and scale of the problem is at multiple levels, from the local (field station) to the region, to ecoregion or landscape, and, when appropriate, the national level.

The decision to implement the framework is at the Regional Director level and it is a one-time decision. Once the decision has been made to implement the framework, its application may vary because each region is organized or operates slightly differently. Our goal is to create a framework with sufficient flexibility for regional adaptation. The framework will provide guidelines or a menu of strategies to meet the specific objectives defined in our initial objectives hierarchy (figure B1) or new objectives that arise. Modifications made by a region in the application of the framework will be documented, all outcomes of the prioritization process will be collated and outcomes of conservation actions reported on so that the agency can learn what worked and what did not and adjust accordingly. Essentially, the final version of the framework will include features that allow for learning over time.

Other decision-makers will play a role in implementing the framework including:

A. Members of the Regional Directorate are the decision-makers as well as the leads for endorsing and championing implementation of the framework. The Regional Directorate will request conservation priorities and science needs from each of the program directors. Each program director must obtain science needs from their field stations and from their regional office staff and then, using these needs, identify priorities for their program area. The programmatic priorities are then shared with their regional Science Team or their Assistant Regional Director (ARD) for Science Applications, and;

B. Each Regional ARD for Science Applications (SA-ARD), through leadership of regional cross-programmatic science teams, decides how programmatic priorities are translated into regional conservation priorities and science needs and then transmitted to partners and back to the field. The SA-ARDs would be responsible for communicating the disposition of Service priorities and partner priorities and how they benefit the larger conservation community as well as field stations. SA-ARDs would also be responsible for coordinating the monitoring of the involvement and commitments of the Service and reporting on the outcomes of landscape scale conservation actions. Additionally, the SA-ARD is responsible for documenting the progress of conservation planning and delivery based on using the framework.

Background

Protecting the nation's natural and cultural resources and landscapes is essential to sustaining our quality of life and economy. Native fish and wildlife species depend on healthy rivers, streams, wetlands, forests, grasslands and coastal areas in order to thrive. Managing these natural and cultural resources and landscapes, however, has become increasingly complex. Environmental and land-use change (e.g., soil erosion, poor water quality, increasing human population growth and distribution, climate, etc.) can threaten human populations as well as native species and their habitats. To address these challenges our agency needs to have a firm understanding of our priorities and then reach out to our partners to see where we share common ground and can leverage our collective interests. Below we outline one example of how the Service can reach out to partners once we have a clear understanding of our priorities. We recognize that there are many other partnership opportunities wherein we can share our interests with others and engage in collaborative research and more effective conservation efforts.

CURRENT STRUCTURE:

LCC Organization: Landscape Conservation Cooperatives (LCCs) are regional partnerships of federal, state, Tribal, international, and non-governmental organizations working together to sustain natural and cultural resources in the face of accelerating global change. LCCs transcend political and jurisdictional boundaries and are structured to facilitate a collaborative approach to conservation. Generally, an LCC is governed by a Steering Committee that is administratively and logistically supported by a Technical Committee appointed by the Steering Committee. Thus each partner agency may have one representative on the Steering Committee and one representative appointed to the Technical Committee. The Technical Committee may establish ad hoc subcommittees to assist with specific tasks. Given that each partner agency is represented by *one individual* it is important that partners have a framework in place to identify information needs and priorities *for their agency* that can be brought forward to the LCC partnership for consideration. The challenge for the USFWS is in how the various programs within the USFWS interact and collaborate to identify and communicate common priorities and science needs to the LCCs or other partners. Without a framework we are at risk of developing independent, ad hoc collaborations with LCCs without a clear purpose best serving the agency's needs.

USFWS Program organization: The USFWS operates in a decentralized manner where each of the eight regions has autonomy. Further, the various programs and divisions under those programs also operate independently. In some instances, programs and divisions do collaborate to serve the needs of the field stations; for example, under the National Wildlife Refuge System Program, the divisions of Conservation Planning and Biological Resources collaborate along with staff from Migratory Bird Management, Fisheries, and Ecological Services to develop quality Comprehensive Conservation Plans. The same USFWS program elements also often collaborate during Federal Energy Regulatory Commission relicensing processes to identify operational effects on trust resources and design adaptive plans to explore and address them (e.g., Gaston-Roanoke Hydropower Project on the Roanoke River in Virginia and North Carolina). Although these efforts are commendable, more collaboration among programs can greatly benefit field stations and regional resources by leveraging staffing talents and financial resources to serve the greatest needs.

USFWS Engagement with Partners: Based on the decentralized management of the different regions and programs, engagement with partners is also a fairly independent endeavor. Notable exceptions include the Upper Mississippi River Restoration – Environmental Management Program and the Great Lakes Restoration Initiative. Additionally, USFWS participation in Interstate Fisheries Management Commissions and Federal Fishery Management Councils, the National Fish Habitat Partnership, and the Eastern North Carolina-Southeastern Virginia Strategic Habitat Conservation Team are endeavors that are fairly well-coordinated activities and reviewed internally prior to engagement with the respective partnerships. As such, we recognize that functional partnerships exist, where conservation priorities and science needs are identified, communicated across partnerships and the partnerships work well to address those needs. This framework is not intended to disrupt or override those partnerships. Rather, this framework is meant to facilitate and improve internal communication and decision-making with the Service.

In summary, there is no formal Service-wide (internal) process for elicitation of needs, setting priorities, coordinating among programs, and for cross-programmatic decision making. As a result, it is often the staff or initiatives with the most persuasive argument, or willingness to step into an opportunistic position, or number of individuals lobbying for an idea, that results in action without context. We believe that developing a formal process for eliciting science needs/concerns from all levels and working cross-programmatically to identify shared needs to help set priorities will result in more effective, coordinated, and efficient conservation actions.

Ecological Context

"At the dawn of the 21st century, we find our commitment and resolve and our passion and creativity being called upon once again as we face what portends to be the greatest challenge to fish and wildlife conservation in the history of the Service: The Earth's climate is changing at an accelerating rate that has the potential to cause abrupt changes in ecosystems and increase the risk of species extinctions. In turn, these changes will adversely affect local, State, Tribal, regional, national and international economies and cultures; and will diminish the goods, services, and social benefits that we Americans are accustomed to receiving, at little cost to ourselves, from ecosystems across our nation. Given the disruption that a changing climate implies for our mission, our nation, and our world, we in the Service and the Department cannot afford to go on about business as usual. We are at a crossroads in our nation's conservation history. We must rise up and respond to a 21st century conservation challenge with 21st century organizational, managerial, and scientific tools and approaches. To address climate change and its effects, we must position the Service more strategically. We must build shared scientific and technical capabilities with others and work more collaboratively than ever before with the conservation community, in particular, our State and Tribal partners, who share direct responsibility for managing our nation's wildlife resources. To do this, we need to first look inward to evaluate, understand and deploy our internal resources and priorities (based on our Mission) and then bring these to the cooperative table with our partners."

*From **Rising to the Urgent Challenge** (2010)*

Decision Structure

Building a framework for arriving at and communicating shared conservation priorities and science needs across programs within the Service and with partners and the LCCs includes numerous Service decision-makers at various geographic scales and organizational levels. Developing this framework will involve several decision solutions, all of which will be made under multiple sources of uncertainty.

Objectives

Our group identified a small set of fundamental objectives that arise from the mission and vision of the Service which state that we will work with partners to conserve, protect, and enhance fish, wildlife and plants and their habitats and that we will be a trusted partner in fish and wildlife conservation. Understanding our internal priorities and having a well-documented process for selecting them will allow us to take a self-organized approach, be forth-coming with our staff and partners, and help us to seek common ground internally and with our external partners. Further, understanding our internal priorities will allow the Service to focus limited resources to affect conservation and will allow us to measure our success. We also present ways to achieve these fundamental objectives. These "ways" are called *means objectives* throughout the rest of this report.

Our fundamental objective is to provide and maintain ***high quality*** habitats for fish, wildlife, and resources by coordinating and implementing ***landscape scale*** conservation to address existing and future challenges. To that end, a second level of fundamental objectives included:

Fundamental Objective 1: select, coordinate, and implement cross-program conservation priorities and science.

Means objectives:

a. Facilitate strategic and science-based management;
b. Establish shared cross-programmatic conservation priorities and actions; and
c. Improve efficient use and leveraging of resources and information;

Fundamental Objective 2: collaborate with and support partners.

Means objectives:

a. Recognize the unique role of FWS,
b. Maximize collaborative opportunities that result in measurable outcomes that transcend regions and LCCs.

We organized these and numerous lower level objectives into a hierarchy (figure B1).

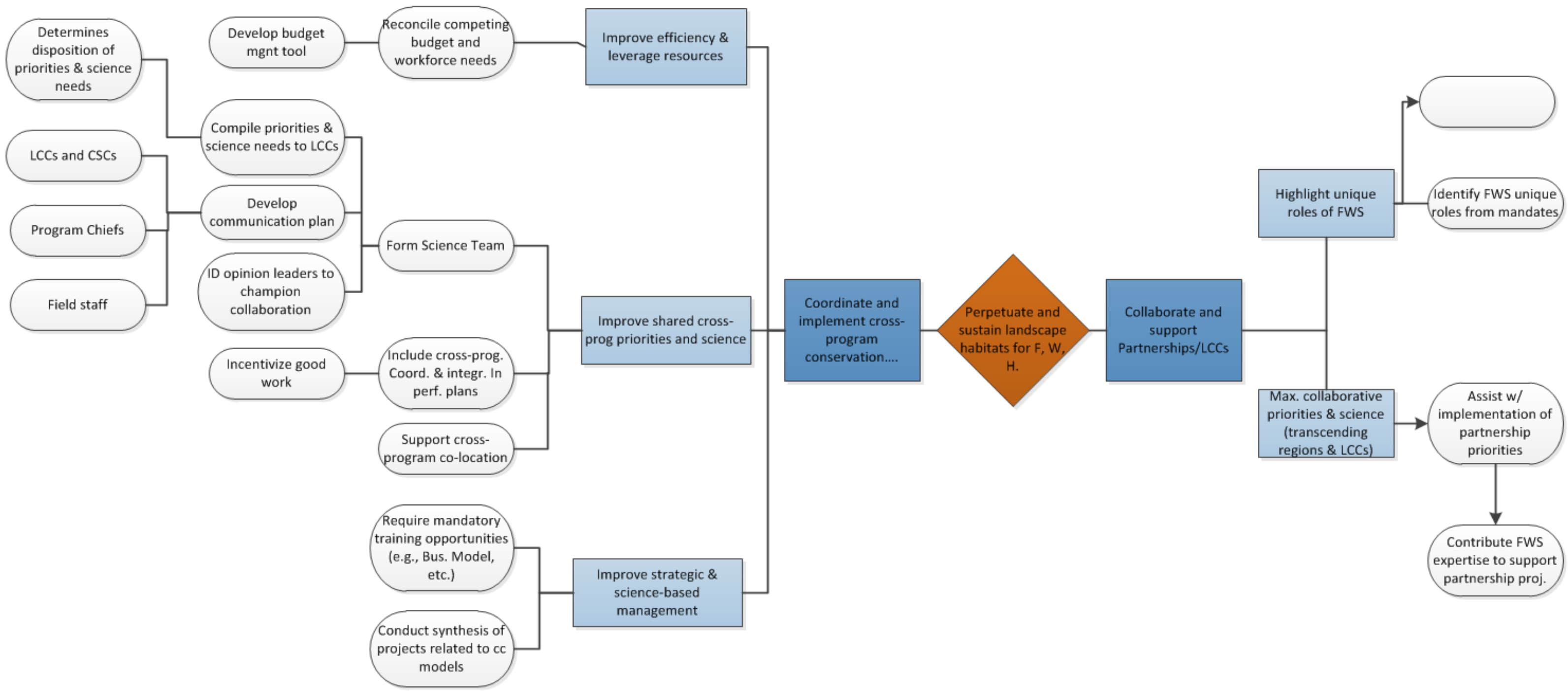

Figure B1. Objectives hierarchy for cross-program collaboration within the U.S. Fish and Wildlife Service and communication with the Landscape Conservation Cooperatives

(NOTE: Orange diamond is the highest level of fundamental objective, dark blue squares are second level fundamental objectives; light blue rectangles are means objectives; white ovals are alternatives or strategies.)

ALTERNATIVES

Workshop participants brainstormed a list of actions or strategies that can be taken to meet the objectives and these actions were categorized into themes and included team formation, engagement (with field stations and partners), legitimizing the field station information needs, LCC coordination, and institutional/cultural change. The alternatives arose, in part, from real-life examples of existing efforts but were modified by the group and are as follows:

1. Science Team
2. Forum
3. Broad-based Partners
4. Special Topics Teams

To help us evaluate the performance of the alternatives and choose which one best met our objectives we created a simple model of each one. We then evaluated and scored each alternative based on our objectives. Each alternative performed differently (i.e., had different consequences; table B1).

Finally, the list of actions or strategies for implementation that was brain-stormed for each theme was reformatted into a portfolio of actions. Our group felt that the action items were robust to the alternative and could be implemented immediately or used to help engage a region once an alternative was recommended. These action items can be found on page 68 of this document.

The three alternatives are described in greater detail below.

1. **Science Team Alternative** (figure B2).

Each region forms cross-programmatic regional science team(s) or panels to identify conservation priorities and science needs brought forward from each Service program. The Science Applications ARD works with each Regional Directorate Team (RDT) to establish a Science Applications Team with representatives from each Service program. The regional cross-program science team members are assigned by programmatic ARDs but work at the direction of the SA-ARD and once on the team, programmatic affiliation goes away and the science speaks for itself. The program representatives work with their ARD and field staff to identify conservation priorities and science needs as they relate to management decisions (Stations identify science needs). The program representative is responsible for collating information needs and providing those to the programs regional leadership team for prioritization; these priorities are then given to the program representative on the Science Applications Team. In turn, the Science Applications Team (SAT) develops a systematic, transparent process to synthesize the collective priorities and needs, establish regional priorities and determines their disposition among potential partnerships. Assistant Regional Directors work internally to address high priority needs or they may seek outside assistance or collaborations. They receive additional benefits from knowing both programmatic and cross-programmatic information needs. Knowing the full range of needs and how they are prioritized will help them develop internal cross-programmatic and programmatic work plans. Programs can also resolve science needs internally (within the Program or through collaboration with one or more programs) or take their needs to other collaborators (Universities, Ecoregional RFPs, USGS Science Centers, etc., but not LCCs or to other entities where the Service gets one vote).

This alternative capitalizes on opportunities for cross-program collaboration to leverage resources under financial constraints by reconciling competing budget and workforce needs in relation to priorities. FWS programs identify their contributions to priority needs (e.g., budget and workforce commitments) and can incorporate these contributions in the development of proposals or scopes of work for collaborations. This alternative fully institutionalizes cross-program collaboration. Tasks for cross-program coordination can be integrated into performance plans, as well as recognized and acknowledged through incentives or performance awards.

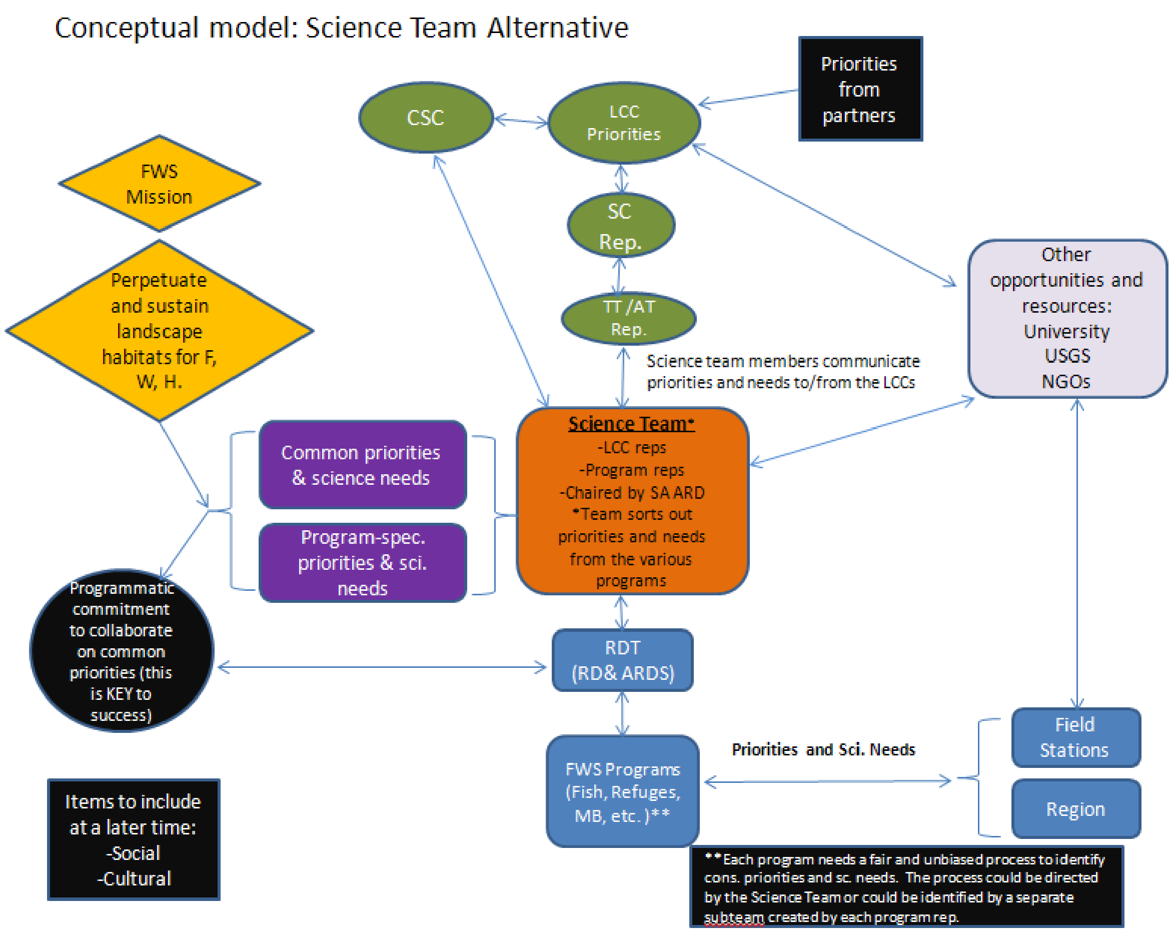

Figure B2. "Science Team" alternative to identify conservation priorities and science needs across FWS programs and communication pathways across FWS and with the LCCs

(NOTE: The gold colored diamonds are the fundamental objectives; blue boxes are internal FWS items; the large orange box depicts the cross-program Science Team; purple boxes indicate common priorities and science needs that are sorted by the Science Team after they are received from each program representative; the green ovals depict LCC/CSC activities; the black boxes are uncertainties that need to be considered and/or defined at a later time; the gray box, upper right, depicts other opportunities and collaboration with partners outside of the LCC network; the black circle on the left contains a point that is the essence of this framework – cross-program collaboration cannot succeed without commitment from each program staff from all levels.) *(NOTE: Each region will need a consistent and repeatable process for eliciting science needs and selecting conservation priorities from within program and across programs. The process(es)s may be developed and directed by the Science Team members (program* *representatives) and could be implemented by the Science Applications Team or by subteams, identified by the program ARDs. This elicitation and prioritization of science needs is outside of the scope of this phase of the framework, but needs to be done as the next step in using this framework.*)

2. **Forum Alternative** (figure B3):

Generally, program representatives (designated by ARD for each Program) gather information directly from field staff within smaller forums (ecoregions within and LCC). At the field level, field station representatives (Project leader and biologist), regardless of program, provide input at the request of Sub-LCC (ecoregional), cross-programmatic science teams. As noted in Alternative 1, the process for eliciting field level input must be worked out by each region but should be similarly applied to all sub-LCC ecoregions. Again, regions want to avoid the loudest voice being heard in favor of hearing from all stations with equal representation.). Ecoregions can also resolve conservation needs internally (within the ecoregion) or take their needs to other collaborators (Universities, Ecoregional RFPs, USGS Science Centers, etc., but not LCCs or to other entities where the Service gets one vote). Conservation priorities and science needs from each "subteam" are reviewed by the ARDs for each Program (the RDT or their designees) and passed along to a regional cross-programmatic Science Team whose role is to take all the sub-LCC (ecoregional) priorities and look for commonalities and put them through a prioritization process. (To be determined by each region.) The regional Science Team is composed of one representative from each program and selected by the program ARD in consultation with the SA-ARD. Once on the Science Team, programmatic affiliation goes away and the science speaks for itself.

The SA-ARD leads the regional Science Team in prioritizing among the needs presented by the ecoregional teams. SA-ARD leads the RDT in reviewing the priority recommendations of the SA-ARDs Science Team. Regional priorities can be tackled internally (within the Service) or provided to partners for assistance with resolution (LCCs, CSC, Universities, USGS, etc.).

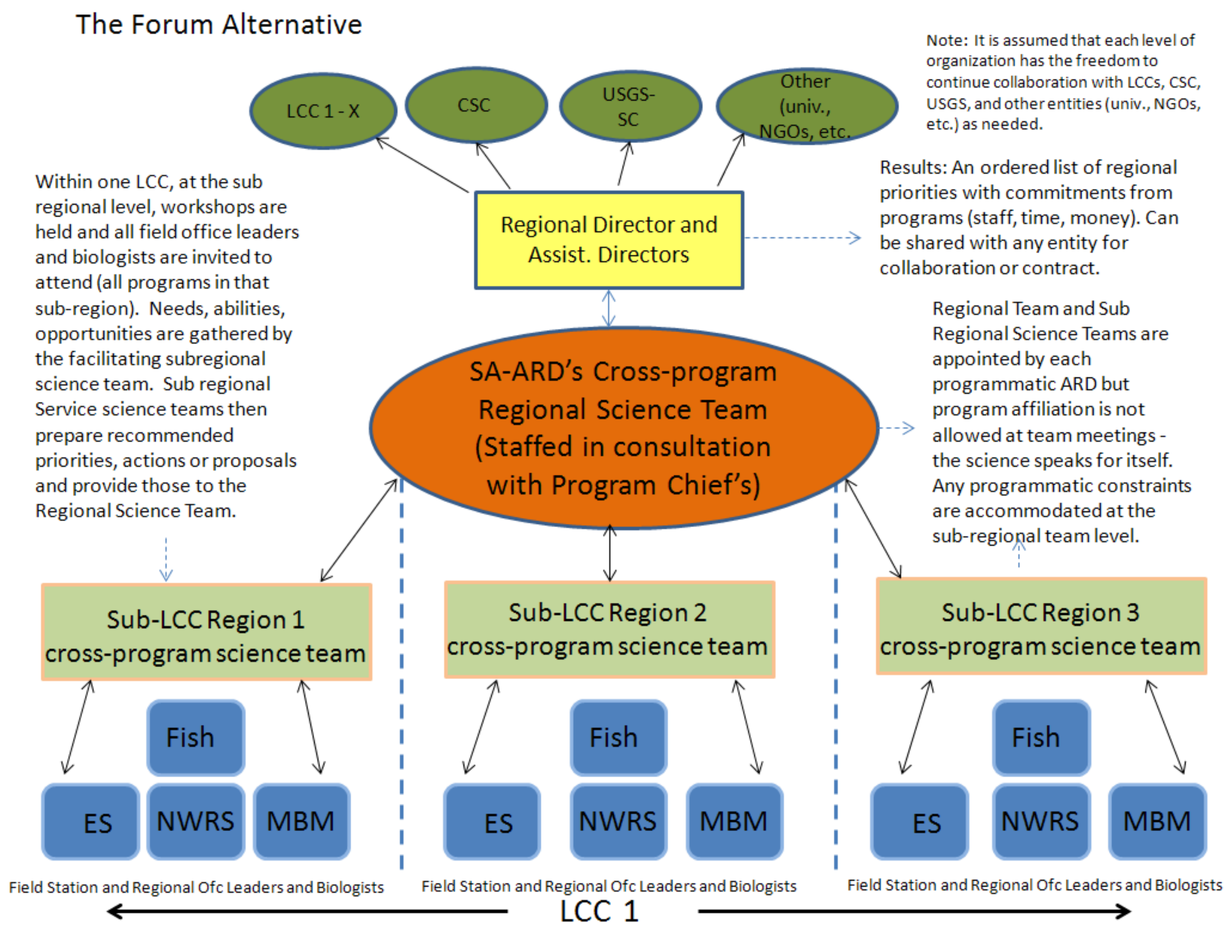

Figure B3. The Forum Alternative: This diagram shows only one LCC geography, as an example, but the effort is not lead by the LCC

This is internal to the Service (at this point but could be grown to include external partners). Each region has more than one LCC geography, and so there will be multiple sub-ecoregional science teams feeding information to a cross-program regional science team. The blue boxes at the bottom depict all program field offices within an ecoregion providing science or conservation needs to the eco-regional science team who then assemble and rank needs. Elicitation of needs can be done via forums or via surveys, etc. At the ecoregional level, programs discuss their constraints and their needs/issues/opportunities among one another through forums or information exchanges facilitated by the ecoregional science team. The ecoregional science team works with the larger group to establish priorities and then brings those to the SA-ARD's regional Science Team—at the orange center oval; this is where program representative should come in ready to commit people, time or money to one or more priorities. This diagram illustrates an example of only one LCC but this region may have one or more LCCs and the ecoregional (Green and Blue boxes) science teams would all be feeding priorities into the orange oval in the center. Once regional priorities are understood then those can be shared with multiple LCCs, with Climate Science Centers, USGS, Universities, etc. Alternatively, there is nothing precluding programs from working together on priorities at any of the levels.

3. **Broad-based Participation Alternative** (figure B4):

This alternative is similar to the Forum Alternative (#2), but 1) is not broken into Sub-regions, 2) SA-ARD one or more Advisory Groups composed of cross-programmatic staff with expertise in a particular LCC. These people are assigned by their program ARD in consultation with the SA-ARD, but once on the cross-program team, they do not advocate for their program but rather let the science speak for itself. The Science ARD can still elevate LCC-Geographic needs to entities other than LCC partnerships. Participation is voluntary for field stations but required at the Advisory Group level. Advisory groups (AGs) correspond to LCC geographies within regions and provide a forum for information sharing, dialogue, priority setting, and feedback to FWS LCC steering/technical committee (SC/TC) staff. The AGs prioritize the science needs for their geography and bring those to the LCC steering/technical committees for consideration. All staff working or interested in the LCC geography are welcome to attend AG meetings. Strategically, they should occur prior to LCC meetings (after agendas have been developed and distributed to the entire SC/TC) to prepare FWS SC/TC staff for upcoming meetings. Because AGs cover all geographies within a region (i.e., combined scope is region wide), they could expand foci beyond the scope of individual LCCs and help facilitate discussion and science needs prioritization and implementation for their FWS region.

This alternative supports the direct connection of the field stations and individual staff in the region with each LCC. It is up to the individual or field station whether to engage or not engage with the FWS LCC SC/TC members. As AGs initiate priority setting within their LCC geography, a systematic process is employed to ensure that regional priorities for that geography are identified and vetted through appropriate program leaders and RDTs. In this manner, the Service will have an understanding of priorities for each LCC geography.

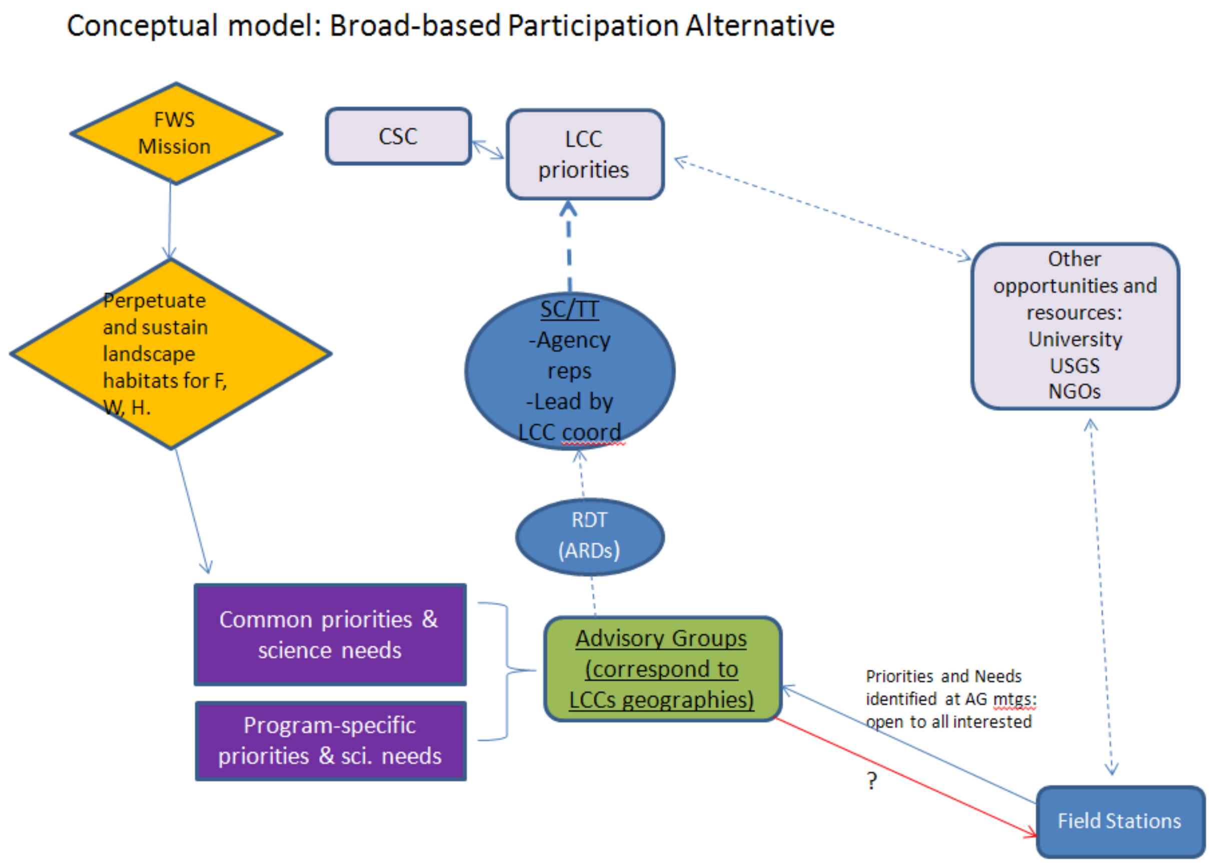

Figure B4. "Broad-based Participation" – a process to identify conservation priorities and science needs across FWS programs and with LCCs

4. **Special Topics Alternative** (figure B5).

All FWS staff are encouraged to participate in LCC "special topics teams" (i.e., Inventory and Monitoring Team, Endangered Species Team, Water Team, etc.). The teams are established by an LCC partnership and chaired by the LCC Coordinator or Science Coordinator. Individuals on the respective teams are selected by their program ARD in collaboration with and organized by the SA-ARD. Members are expected to bring the issues that represent their program or agency of interest to the team and can share team priorities with the regions and field stations. As such, conservation priorities and science needs from each "special topics team" are passed on to the ARD for each program (If they have a representative on the team) and to the LCC Coordinator or Science Coordinator.

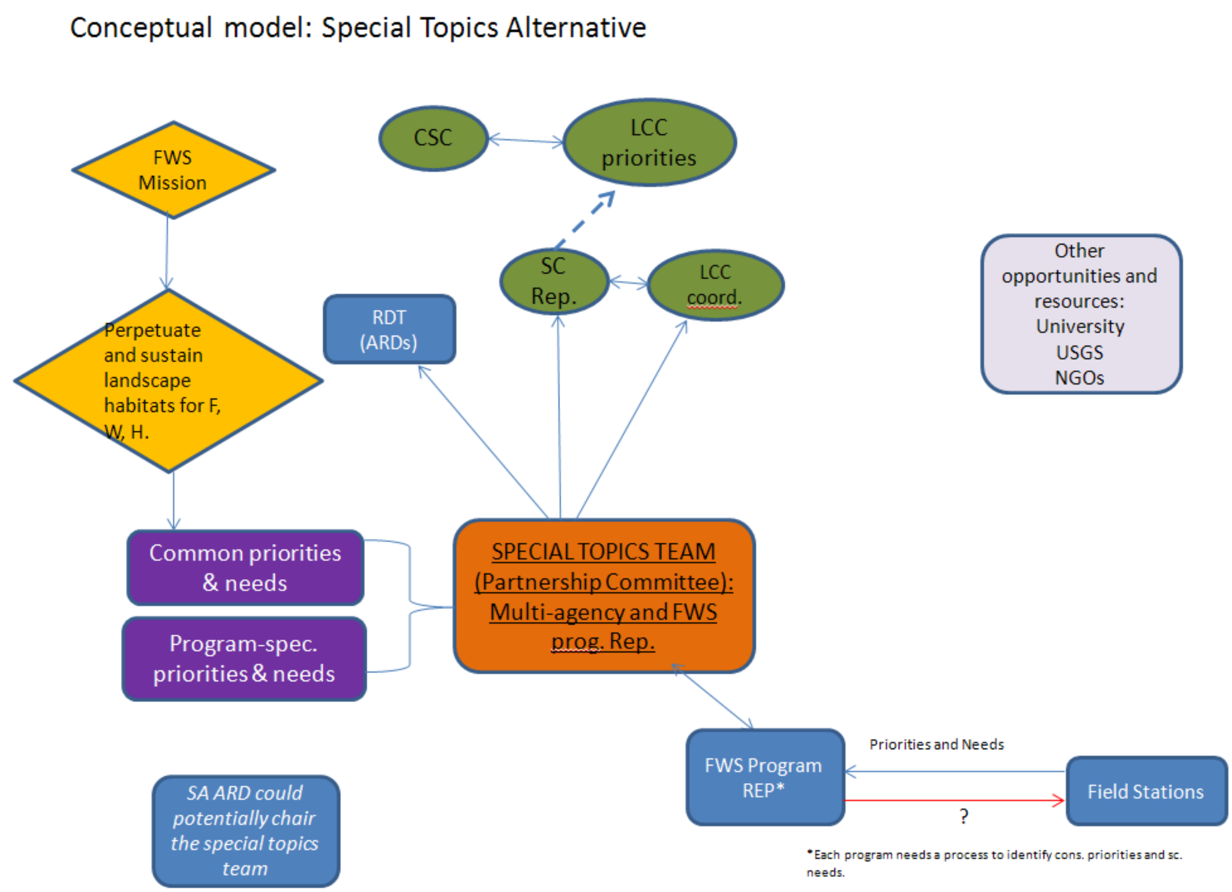

Figure B5. "Special Topics" alternative – a process to identify conservation priorities and science needs across FWS programs and with LCCs

EVALUATION OF ALTERNATIVES

We built a simple model that allows us to evaluate the four alternatives against our objectives. As a group we performed a scoring exercise that allowed us to compare the four alternatives against the fundamental and means objectives stated above and additional criteria that could potentially be important to the function of the framework:

Modeling Criteria and Their Definitions:

Unbiased needs:

- All Service staff have a chance to provide input; fair (equal opportunity) for all programs to participate:
  - Minimize the influence of the strongest voice from being dominant; we believe that the more multiple ways or unlimited ways that an individual can provide input, the more biased the process – this prevents the squeaky wheel from getting the grease (1 point).
  - Comprehensive survey (threats to resources and science needs) of all programs; all branches within a program has the opportunity to provide input (1 point).

Scale: 0-2

Efficient process:

- A process that allows the information to be used at multiple scales (1 point),
- Information is gathered once, filtered twice but still retains the quality that can be shared internally and externally at multiple scale (this minimizes redundancy and do-overs; prevents having to go back to field stations or customers to ask about some other aspects) sharing and committing to work on internal problems, e.g., MBO and Refuges working together to inventory birds at a refuge – avoids redundancy) (1 point);
- Has an **overarching body** (i.e., Science Team) that coordinates input from and provides a structured process for prioritizing among programmatic inputs (1 point).

Scale=0-3

Maximizes opportunities for internal collaboration and communication flow: the alternative takes advantage of the potential collaborative opportunities among programs. The alternative provides a forum that promotes consensus building: 1-Regional Director, 2-RD and ARDs, 3-Science Team, 4-Science Team with input from and to the field stations; clear pathway that illustrates the line of communication; there are opportunities for the information to be transmitted to external entities: 1-Field station→Program Rep. →, 2-Program Rep. →RDT, 3-Program Rep. →Structured Forum (i.e., Science Team), 4-Structured Forum →TT/AT, 5- TT/AT →SC, 6- SC →back to Program Rep., 7-Program Rep. →Field stations.

Scale 0-7

Transparent process:

- The process of obtaining input (1 point),
- decision making process (1 point),
- are clearly articulated and documented (1 point).

Scale 0-3

Evaluating a framework or process by using the above criteria is a way to ensure that the process will allow us to identify and prioritize comprehensive conservation priorities and science needs within the Service and also create effective communication pathways within the Service and with our conservation partners. However, regardless of the criteria and which alternative framework ranks out the highest and is selected for implementation, one additional criterion, essentially a fatal flaw if not enacted, is that each region and program needs to commit to the identified priorities through assignment of staff, time or funding to priorities (i.e., in performance standards) regardless of whether the priorities are relevant to the specific program or to the greater conservation goal as a whole. This is where the Service would benefit the most from the selected alternative. It is also then conducting business under the new business model—Strategic Habitat Conservation. We cannot stress enough how integral this criterion is to successful implementation of the selected framework.

Decision Analysis

Once we identified the criteria, we determined that a constructed scale to rank the criteria would work well on this first prototype and to the best of our abilities. All but one workshop participant scored each alternative against the criteria in his/her own consequence table, as shown in the example in table B1. To determine which alternative framework maximizes the opportunities to identify conservation priorities and science needs, within the U. S. Fish and Wildlife Service, and for effective communication within the Service and with our partners, we applied a simple multi-attribute rating technique (SMART), by first evaluating the utility of each alternative with respect to each objective (consequence table) and then determining the overall weighted average by using individually scored objective weights (example in table B2). We then pooled the final score (sum of weighted scores/sum of weights) from each participant and took the average score to obtain the final ranking of alternatives (figure B6).

Table B1. Consequence table with mock scores that evaluate the four alternatives against the objectives for a framework to identify conservation priorities and science needs, and to provide an efficient communication pathway across programs and with conservation partners

				ALTERNATIVES			
Objectives/Criteria	**Attributes**	**Type of Scale**	**Goal**	**Science Team**	**Forum**	**Broad-based participation**	**Special Topics**
Unbiased needs	0-2	constructed scale	Max	2	1	1	1
Efficient process	0-3	constructed scale	Max	3	2	2	2
Max. Opportunities and communication flow	0-7	constructed scale	Max	7	6	7	6
Transparent process	0-3	constructed scale	Max	3	3	2	1
SUM				**15**	**12**	**12**	**10**

Table B2. An example of the simple multi-attribute rating technique (SMART) table showing scores of alternatives against objectives, normalizing the scores and the weighted scores for each objective and the final score in bold, for one participant

SMART RANKING (S.M.A.R.T = Simple, Multi-attribute Ranking Technique)						
SIMPLIFIED MATRIX			Alternatives			
Objectives/criteria	**Goal**	**Attribute**	**Science Team**	**Forum**	**BB participation**	**Special Topics**
Unbiased needs	Max	0-2	2	2	1	1
Efficient process	Max	0-3	3	3	2	1
Max. Opportunities and communication flow	Max	0-7	6	4	3	1
Transparent process	Max	0-3	2	3	1	1
Sum			13	12	7	4
NORMALIZED SCORES			Alternatives			
Objectives	**Goal**		**Science Team**	**Forum**	**BB participation**	**Special Topics**
Unbiased needs	Max	0-2	1.0	1.0	0.0	0.0
Efficient process	Max	0-3	2.0	2.0	1.0	0.0
Max. Opportunities and communication flow	Max	0-7	1.7	1.0	0.7	0.0
Transparent process	Max	0-3	0.5	1.0	0.0	0.0
WEIGHTED SCORES			Alternatives			
Objectives	**Goal**	**Weight**	**Science Team**	**Forum**	**BB participation**	**Special Topics**
Unbiased needs	Max	25	25.0	25.0	0.0	0.0
Efficient process	Max	10	20.0	20.0	10.0	0.0
Max. Opportunities and communication flow	Max	25	41.7	25.0	16.7	0.0
Transparent process	Max	40	20.0	40.0	0.0	0.0
Sum of Weights (for all objectives)		100				
Sum of weighted scores (for each alternative)			106.67	110.00	26.67	0.00
Final Score (sum of weighted scores/sum of weights)			**1.07**	**1.10**	**0.27**	**0.00**

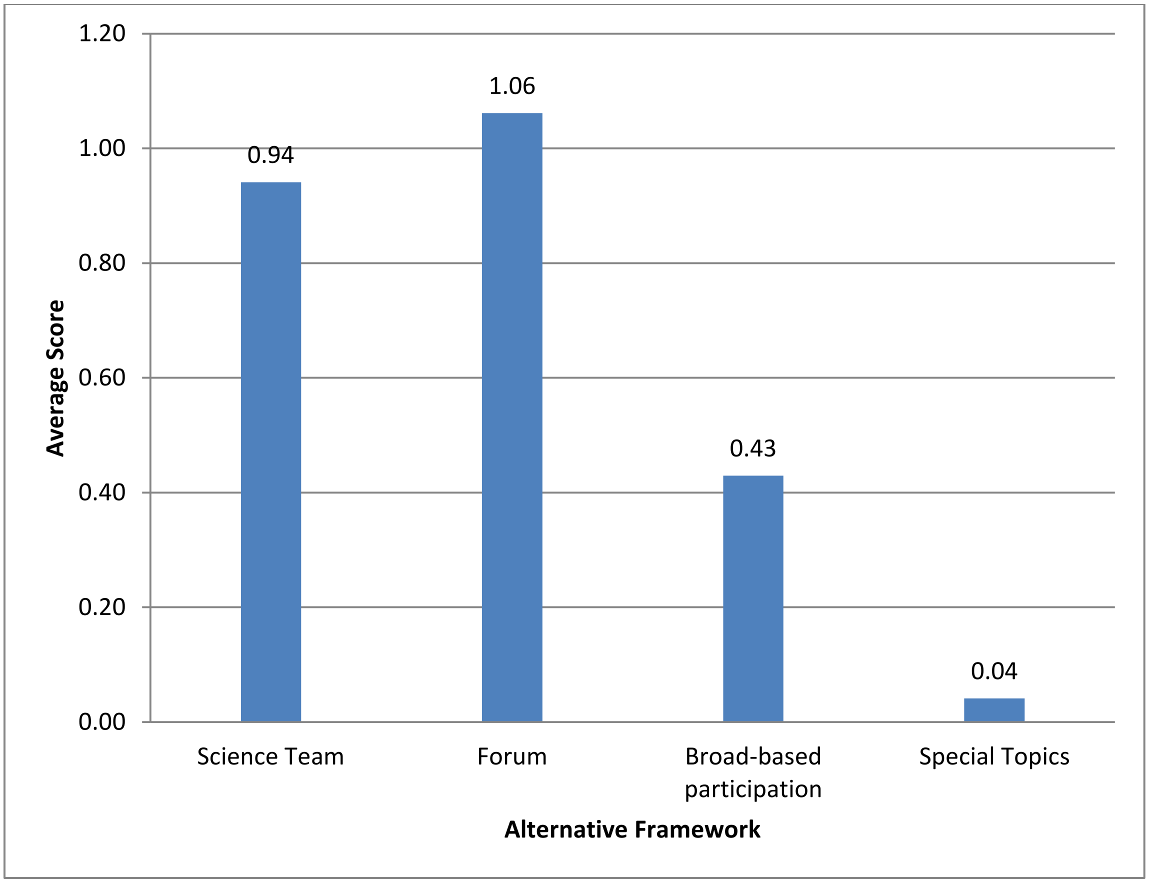

Figure B6. Results of tradeoff analysis between four different alternative frameworks to identify conservation priorities and science needs, and communication pathways within the U. S. Fish and Wildlife Service (see text for details on alternatives)

Results

The Forum alternative received the highest score (1.06), followed closely (0.96) by the Science Team alternative. The broad-based participation and the Special Topics alternatives were distant third and fourth. Between the Forum and Science Team alternatives differ in that the Forum alternative elicits information from the field in a cross-programmatic fashion via ecoregional forums whereas the Science Team alternative elicits information needs from the field along program lines and then looks for cross-program common ground at the regional Science Team level. The Forum alternative will require establishing and managing multiple ecoregional science teams to lead the forums and a second, regional science panel to collate and prioritize among ecoregional recommendations. The ecoregional science teams will require the development of a standard process for eliciting information from the field. The Science Team alternative requires the establishment of only one cross-programmatic science team but also requires that elicitation of information from the field be done in a similar fashion across programs. Because of the close scores, our recommendation for implementation is for regions to try one or the other or a hybrid of the two as most appropriate to regional needs. It may be that both alternatives could be used in one region because one may be more suitable for working within an LCC geography than another.

Additional Actions (linked to objectives)

1. Another set of objectives and alternatives we need to address concerns how each program identifies and priorities internal programmatic conservation priorities and science needs. We brainstormed a few, but this is the subject for another structured decision-making workshop:

Potential criteria for prioritizing conservation priorities and needs within each FWS program:

- Conservation priority is a widespread problem.
- Benefits multiple programs.
- Priority can be alleviated with policy or management.
- Priority addresses the most important ecological/anthropogenic driver

2. Present this framework to the Directorate; include program ARDs who serve on LCC steering committees.
3. Request support from the Directorate for this on-going cross-program integration effort, to pilot the selected alternative.
4. When opportunities arise, encourage program managers to co-locate staff among different programs.
5. Form a regional cross-program team comprising field stations and regional programs and also include LCC rep.
6. Synthesize existing climate science and field station projects related to climate change so that the Science Team is informed of past and on-going climate science activities and projects.
7. Develop and require use of a national database that identifies science needs and conservation priorities (e.g., the FWINS database).
8. Science Team prepares clear written description of work or projects that are sent to LCCs and projects that are accepted by LCCs and compiles and catalogues outcomes (using a database such as ServCat, developed and maintained at the Natural Resources Program Center in Ft. Collins, CO.).
9. Implement mandatory training on the new Conservation Business Model (Conservation Management Framework/SHC) for FWS employees.

Information Needs

1. National: Synthesize existing Climate Science Center, LCC, regional, and field station projects related to climate change so that the Office of Science Advisors (OSA) Science Team is informed of past and on-going climate science activities and projects.
2. OSAs – Science Team prepares clear written description of work or projects that were sent to LCCs and projects that are accepted by LCCs. LCC/regional: regional and LCC conservation priorities and science needs. Local: Conservation priorities and science needs to information management decisions – scoped and prioritized within programs.

Uncertainty

Ethological Uncertainty

We don't fully know how our actions, based on the framework, will affect the system or how the system will affect our decisions because of practical, cultural, and social issues within the Service.

Partial Controllability or Implementation Uncertainties

Uncertainties around partial controllability is related to situations where we believe a decision was made by the decision-maker, in this case the decision from a high level post to implement the framework, but the framework may not be implemented by lower level managers unless some controls or guidelines are put in place. Another possibility is that the framework is implemented, but circumstances beyond our control result in the inability to perform a specified action as planned.

Partial Observability

Uncertainties related to partial observability arises because the system being managed is measured or observed indirectly. In implementing the cross-program integration framework, we may miss opportunities to measure, monitor, or learn from the implementation process about what went wrong, what went right, why did the framework work in some situations and not others. This uncertainty is reducible if the framework provides clear guidance on implement strategies, monitoring, and all regions commit to the learning process (follow up) recommended by our team.

Conclusion

Workshop participants felt the most important part of the decision structuring was ensuring the problem statement and objectives were clearly defined and agreed upon by all participants before proceeding further into the process. The decision problem was difficult to define because participants were biologists by training and this problem was one that draws heavily on human dimensions, and on social and cultural issues to which biologists are not accustomed. Because of social and cultural differences with the agency, we believed the structured decision making process helped us deconstruct the various components of the problem into smaller, more manageable parts. Therefore, we need to keep in mind that we measure progress and accomplishments by component pieces rather than by the finished product. Furthermore, we believe and have received feedback that the framework will be applicable and valuable beyond the FWS programs. There has been early feedback from partners indicating that they would like to see a similar process in place within their own agency or NGO. We believe the outcome of our process will foster "buy-in" by all Service staff. We also believe that the initial framework provides a transparent process that will encourage constructive criticism and suggestions to refine the framework. We believe that once refined, the framework will transcend programmatic and agency boundaries and help provide sound guidance for collaboration and integration of resources and expertise to achieve our highest priority conservation goals.

Next Steps

1. We will proceed with the goal of piloting the selected alternative(s) in several, if not all regions by:

   a. Reaching out to staff of the Office of Science Advisor and to the Regional Directorate.
   b. Sending the report to and present an update to the Science Committee at the Oct. 2012 meeting in Arlington, VA.
   c. Sending report to and present to the Science Application ARDs in each region.
   d. Sending report to and present to LCC coordinators and LCC science coordinators.
   e. Via the Science Application ARDs, presenting to regional directorate.
   f. Developing factsheet and distributing along with report to interested entities.
   g. Building upon and refine the framework.
   h. Obtaining feedback from pilot effort.
2. The "winning" alternative was Alternative #2: Forum followed closely by Alternative #1: Science Team. Our team recommends that regions look closely at their situations and choose either Alternative 1 or 2 or develop a hybrid of the two. There may be practical reasons related to implementation for going with one alternative or another. A region may see value in using both alternatives for different portions of their region or LCC geography. What is important is learning more about how each alternative performs with regard to the fundamental objectives, ease of implementation, transparency of process, and equitable elicitation of needs.
3. Each region and program needs to commit to the identified priorities through assignment of staff, time, or funding to priorities (i.e., in performance standards) regardless of whether the priorities are relevant to the specific program or to the greater conservation goal as a whole. This is where the Service would benefit the most from the selected alternative. It is also then conducting business under the new business model – Strategic Habitat Conservation. We cannot stress enough how integral this criterion is to successful implementation of the selected framework.
4. Each region needs to develop and document a fair and unbiased process to identify conservation priorities and science needs whether the elicitation is done within a program or via a cross-program forum. The process could be directed by a regional science team or the SA-ARD. It is important that the elicitation process is comprehensive, fair, unbiased, and transparent.
5. Similarly, each region needs to develop a prioritization process that can be used at multiple levels within the agency, and we recommend that this be done using the structured decision-making process.
6. The SA-ARD can bring regional science needs to the national level for consideration across LCCs and for consideration of internal action through the Washington Office.
   a. At the national level there would need to be a similar cross-programmatic science panel to rank national priorities. This could be the existing Science Team that Dr. Gaby Chavarria put together (they come to the table without their programmatic affiliations and let the science speak for itself), or the Service could create some different entity.
7. The Regional Directors should charge each cross-programmatic science team with developing a scope of work and a prioritization process that further fleshes out the detail of how they will function BEFORE any scoping or prioritization of science needs begins and the process should be reviewed and approved by ARDs (Regional Directorate Teams).

a. Each program and/or cross-program science team will need a process for eliciting needs from the field and for setting programmatic and cross-programmatic conservation science needs at all levels in the organization. We brainstormed a few but this is the subject for **another structured decision-making workshop**:

Possible criteria for prioritizing conservation priorities and needs within each FWS program:

a. Conservation issue is a widespread problem.
b. Benefits multiple programs.
c. Priority can be alleviated with policy or management.
d. Priority addresses the most important ecological/anthropogenic driver.

8. Information needs should be captured in a regional or national database (e.g., Fish and Wildlife Information Needs System (FWINS)).
9. Finally, the members of this structured decision making workshop are committed to learning and have agree to serve as a review panel for how the process has worked for each region after a year of implementation. This team will collate and review each regions scope of work, information elicitation process, prioritization process, and any feedback regions will provide. We will provide results from our review to the Regional Directorate.

Literature Cited

Williams, B. K. 1997. Approaches to the management of waterfowl under uncertainty. Wildlife Society Bulletin 25:714-720.

APPENDIX C: DEFINING, RESTORING, AND EVALUATING FUNCTIONAL LANDSCAPES USING THE SURROGATE SPECIES CONCEPT

January 28-February 1, 2013

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Executive Summary

This report is the result of workshop held at the National Conservation Training Center to consider the first two steps of the surrogate species guidance (see USFWS, Draft guidance on selecting species for design of landscape-scale conservation, July 20, 2012), and define what a functional landscape is and how surrogate species can be used to evaluate our effectiveness in achieving U.S. Fish and Wildlife Service (FWS, Service) conservation goals. Additionally, we developed a modest prototype for steps 3–6 and step 8 (selecting surrogate species and checking logic) of the guidance (USFWS 2012).

Our first prototype of a solution, presented in this report, will benefit from additional prototyping of the process prior to implementation. The workshop participants recommend the development of a project management prospectus that outlines several options for required staffing and expertise, timeline, cost (based on the options), and communication strategy prior to implementation. The decision to accept the prospectus (including which option) and implementing the framework lies with the Regional Director. The outcomes of implementation (maps, monitoring strategies, reporting devices, etc.) will be used by managers throughout the organization to determine where, when, and how to direct conservation actions or revise policy to achieve the objectives set forth in the framework and to monitor progress toward our conservation goals.

Participants

Dr. Eric Lonsdorf, from the Chicago Botanic Garden, served as the Decision Analyst. Sean Blomquist from Region 3 – NWRS served as the Surrogate Species Coach, and Lori Nordstrom, Region 3 – NWRS served as the Workshop Coordinator.

Workshop participants included: Region 3: Sean Blomquist (NWRS), Dean Granholm (NWRS; Member of the NWRS Planning Implementation Team), Patricia Heglund (NWRS; Member of the National Ecological Assessment Team and co-author of the NEAT report (USFWS and USGS 2006) and the SHC Handbook (USFWS 2008), Cathy Henry (NWRS; Member of the NWRS Planning Implementation Team), Mark Holey (Fisheries), Lori Nordstrom (NWRS), Tom Magnuson (Ecological Services), Dave Scott (Migratory Birds), and Gwen White (Science Coordinator for the ETP-BR LCC). Region 5: Julie Slacum (Ecological Services); Region 4: Bill Uihlein (Science Applications: Member of the National Ecological Assessment Team and co-author of the NEAT report (USFWS and USGS 2006) and the SHC Handbook (USFWS 2008).

Dr. Melanie Steincamp, Office of the Science Advisor, Craig Czarnecki and Mike Millard, USFWS, Assistant Regional Directors for Science Applications for regions 3 and 5, respectively, served as observers during portions of the workshop.

INTRODUCTION

The Service has trust responsibility for migratory birds, threatened and endangered species, marine mammals, inter-jurisdictional fish, the National Wildlife Refuge System (NWRS), and a consultation requirement for Tribal interactions. These diverse responsibilities require a strategic means of planning, designing, delivering, and assessing the success of the agencies conservation actions. Strategic Habitat Conservation (SHC) was adopted in 2006 as the FWS business model for setting and achieving conservation objectives at multiple scales. SHC relies on an adaptive management framework to identify information gaps, develop species-habitat models, provide recommendations for conservation delivery, and structure monitoring to achieve desired conservation outcomes. In both the 2006 National Ecological Assessment Team Report (USFWS and USGS 2006) and the 2008 SHC Technical Implementation Guide (USFWS 2008), a surrogate species approach (i.e., "focal species") was suggested as one method for use in biological planning. Following a surrogate species approach would allow the Service to select a smaller number of species from a larger pool of trust resources representing important landscape functions or the sustainability of other species populations within the larger pool. Using the surrogates, the Service's landscape-scale conservation actions can be directed to benefit multiple species and habitats. In addition, progress toward our conservation goals could be effectively tracked using a manageable number of species. The main assumption underlying the surrogate species approach is that by implementing management strategies that support the ecological conditions favored by the smaller set of species within a prescribed area, the needs of the larger set of species characteristic of the area will be met. Thus, surrogate species allows managers to more effectively direct their conservation actions and the Service can more easily communicate with the American public about our goals and achievements.

The draft Guidance on Selecting Species for Design of Landscape-scale Conservation states the Service's conservation 'objective' is to characterize and maintain functional landscapes capable of supporting self-sustaining fish, wildlife, and plant populations (the goal is sustainable populations). Functional landscapes are defined in the draft guidance as *"…lands and waters with the properties and elements required to support desirable populations of fish and wildlife, while also providing human society with desired goods and services, including food, fiber, water, energy, and living space*" (p. 10 & 36, USFWS 2012). This statement is a vision of what the Service desires of the American landscape to help meet the agency's mission. As with most vision statements, the draft guidance sets a general direction but is vague about the details needed for implementation. Each Regional Director has been asked to interpret and implement the draft guidance beginning this year (FY13). One major decision facing each region and its Regional Director before implementation can begin is to agree on a definition for what constitutes a functional landscape in the eyes of the Service. Other linked decisions needed include defining from the FWS's perspective what are "the properties and elements" of a functional landscape, what are "desirable populations of fish and wildlife," and what are "desired goods and services" that will allow the FWS to meet its "conservation objective."

To address these questions, staff from the USFWS-Region 3, working under a charge from the Regional Directorate Team to the Office of Science Applications, held a workshop at the National Conservation Training Center in Shepherdstown, WV. We used the structured decision-making (SDM) process described by Keeney (2008) to guide our thinking and help us craft a prototype model for selecting surrogate species by articulating Service values in regard to functional landscapes. The SDM process is an organized approach to analyzing and solving complex problems and is used regularly within the Service to help us reach decisions that are focused on achieving our fundamental objectives. Key SDM concepts include ensuring that decision-makers have clearly articulated fundamental objectives, deal explicitly with uncertainty, and respond transparently to legal mandates and public preferences or values in decision making. Every decision consists of several primary elements—management objectives, decision options, and predictions of decision outcomes. By analyzing each component separately and thoughtfully within a comprehensive decision framework, it is possible to improve the quality of decision-making.

Here we report on the process and recommendations resulting from that workshop for the Region 3 – Regional Directorate Team. In this report, we guide the reader through the steps we took (e.g., problem definition, clarifying objectives, creating a portfolio of alternative actions, examining the consequences of and tradeoffs among actions, acknowledging and accounting for uncertainties, and optimizing outcomes) to arrive at a first prototype of a model process for a designing a generic landscape using a surrogate species approach. In addition, we share our first prototype solution for selecting and optimizing the number and kind of surrogate species. Finally, we provide a series of recommendations for next steps toward achieving functional landscapes in Region 3.

THE PATH TOWARD A SOLUTION

The draft guidance document on selecting species for design of landscape-scale conservation (USFWS, Draft guidance on selecting species for design of landscape-scale conservation, July 20, 2012; figure C1) provides a means for entering into the Strategic Habitat Conservation process (USFWS and USGS 2006). We intended to examine only the first two steps in the draft guidance document (figure C2). Strategic Habitat Conservation is about making decisions, "Where do we need more habitat?", "Where can we work with landowners to improve connectivity between protected areas?", and "Where should we be working and on what projects to more effectively reach our conservation goals?" Each decision is predicated on the Service's primary conservation objective as laid out in the draft guidance and the Service's mission statement, which, respectively, are to "characterize and maintain functional landscapes capable of supporting self-sustaining fish, wildlife and plant populations" and "working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people." We brainstormed a list of conservation actions by program to capture the types of decisions that are made by each program on an annual basis that contribute to the Service's mission. The brainstorming process helped us to think about how we could use surrogate species and formulate our goal for the workshop into a decision problem and helped us think about what each program values on the landscape. As a first step, we needed to refine the definition of "functional landscape" to determine how surrogate species concept could help direct conservation activities to better meet the Service's mission.

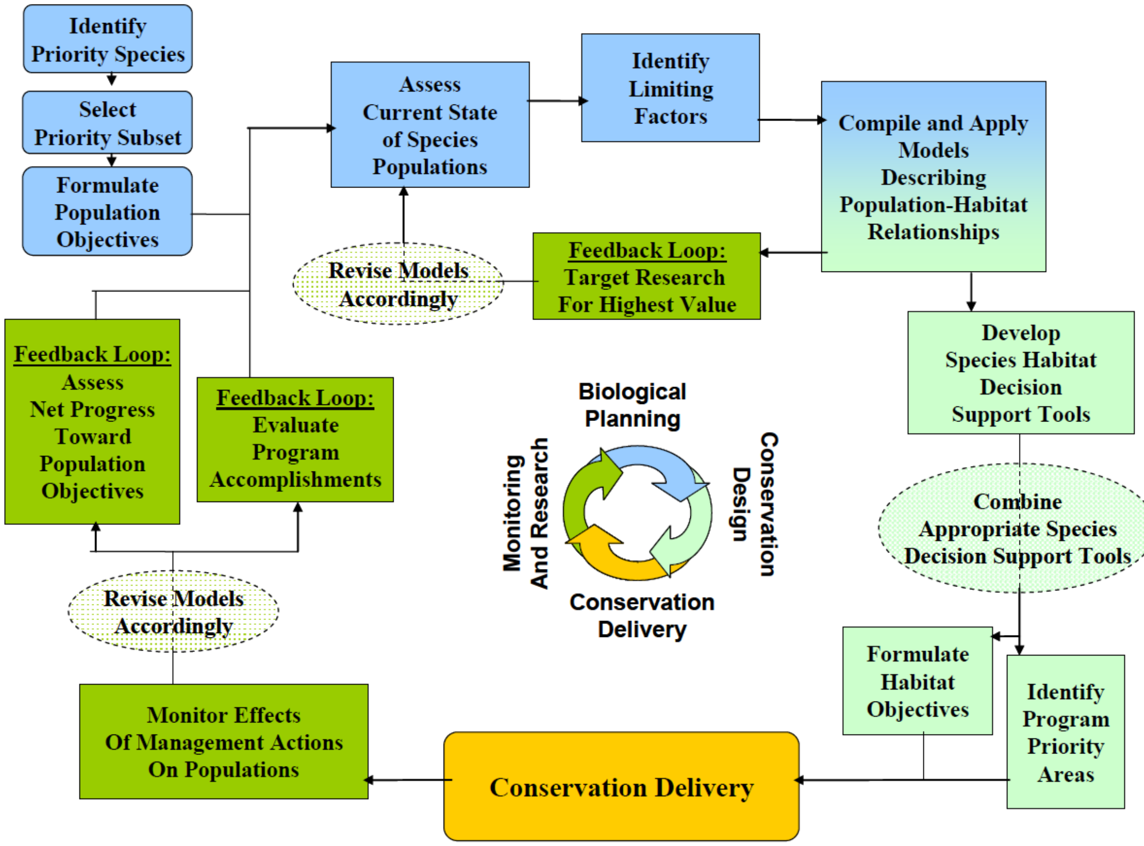

Figure C1. The Strategic Habitat Conservation model from Strategic Habitat Conservation: Final report of the National Ecological Assessment Team (USFWS and USGS 2006)

1. Develop and clearly specify the management or conservation objectives for surrogate species selection approach
2. Identify geographic scale
3. Determine which species to consider
4. Select criteria to use in determining surrogate species
5. Establish surrogates
6. Identify species requiring special attention
7. Identify population objectives
8. Test for logic and consistency
9. Identify knowledge gaps and uncertainties
10. Monitor the effectiveness of the approach

Figure C2. The 10 steps to selecting species for the design of landscape-scale conservation (USFWS 2012)

Definition of a Functional Landscape

From a spatial perspective, a landscape favorable to fish and wildlife is composed of three basic elements: protected or intact wildlife habitat patches, corridors between patches, and the surrounding matrix of other land use. We can visualize a landscape by creating maps that depict the spatial arrangement of the three elements (Forman and Godron 1984; Forman 1995). The extent and configuration of these elements defines the pattern of the landscape. Landscape structure, or spatial heterogeneity, influences the flow of nutrients and materials, animals, energy, and water through the landscape elements of patches, corridors, and matrix (Turner 1989). Landscape features such as patch size and shape, corridor characteristics, and connectivity work together to determine the pattern and process of the landscape. Relations between pattern and process create interdependency between landscape structure and function. Landscape patterns influence process, which in turn affect the patterns (Forman 1995).

One significant challenge we face as a land management agency is understanding the needs of multiple species when thinking about landscapes. More specifically, how we design the system of protected areas (e.g., refuges) and the matrix of public and private lands that surround them. By understanding what is limiting wildlife populations in a particular landscape or geographic area or further, throughout the organisms life cycle, we can begin addressing deficiencies in the landscape (or species range) using the tools at our disposal (e.g., land acquisition, easements, best management practices, policy changes, etc.). Functional landscapes for fish, wildlife, and plants can be created through a shared vision about *how* conservation agencies and the public can affect land use practices and *where* they desire to protect, restore or reconstruct wildlife habitats.

Before the group could share a vision for a prototype landscape, we thought about landscape function from a fish and wildlife perspective. At the most basic level, all species need air, water, food, shelter, cover, and space; and it is the amount and arrangement of food, cover, water, and space in an area that determines species, abundance, and distribution. From an evolutionary perspective, species need to be able to move about a landscape and locate various resources at different times in their life cycle. As the rate of climate change increases, the need for dispersal to and exploration of new locations becomes even more important. Species movement or dispersal mechanisms are influenced by both the distance between patches and the characteristics of the matrix, such as vegetation type, structure, and land use of the lands in between (Wiens et al. 1993). Understanding the amount and configurations of various vegetative features needed to support the life history is species dependent. Spatial scale is especially important when dealing with patches because an area large enough to be a patch to one species, may be a barrier or insignificant to another species. Before we could tackle steps 1 and 2 of the guidance, we needed to examine the definition of a functional landscape provided in the draft guidance:

Functional Landscape (Guidance)

"*Functional landscapes are defined as lands and waters with the properties and elements required to support desirable populations of fish and wildlife, while also providing human society with desired goods and services, including food, fiber, water, energy, and living space*." (pg. 10)

Several phrases in the definition caught our attention, including: "…**properties and elements**…**desirable**…**human society**…**desired goods and services**…" Our goal was to interpret the definition in the draft guidance by clarifying these phrases. To begin, we re-stated the original definition as follows:

Functional Landscape (Restated)

Version 2: *Functional landscapes are large regions meeting societal needs for food, fiber, energy, housing, transportation, etc. in such a way that it also supports sustainable populations of all trust resources commonly expected to occur therein with public awareness and support of conservation efforts*.

We also realized that the "properties and elements" phrase indicated that a set of characteristics could be a way to further define functionality of a landscape for a specific geography. These include characteristics that limit populations of wildlife, fish, and plants within that geography, the three basic elements of a landscape (i.e., intact habitat patches for wildlife, corridors between patches, and the surrounding matrix of other land use), as well as the economic and other societal needs for that landscape.

Ecological Context

Scale

The issue of geographic scale and what scale to target repeatedly arose and was an area of much debate with the group. The guidance in the SHC Handbook (USFWS 2008) recommends using a homogeneous ecological unit, something likely smaller than an LCC. Too small of a unit and the resulting collective of planning units may be too difficult to administer, too large, and there maybe be too much variance among species.

Another kind of scale we considered was time. Temporal scale is not currently addressed in the SHC Handbook (2008) or the guidance. We set our time scale to 10 years but could vary substantially depending on the objectives under consideration.

To help us better visualize and think through our activities as we discussed what each of us considered a functional landscape, and we felt we needed to add some realism to the question. We selected an imaginary landscape loosely based on the Eastern Tallgrass Prairie and Big River Landscape Conservation Cooperative boundary (figure C3). Step two of the draft guidance directed us to select a geographic scale, but we quickly realized that due to the interplay among scale (both space and time), the scale issue would require further consideration beyond the initial prototype we developed at this workshop. For our first prototype, we simply followed the recommendation in the draft guidance document and started within a landscape conservation cooperative boundary. For rapid prototyping, it is more important to move quickly and focus on the process we are developing rather than getting tied up in detail. It is important to recall that after further refinement, a well-constructed process could be applied to any geography at any scale. Thus, we used our modified geography and restated the definition of a function landscape as a decision problem:

"*Across the Eastern Tallgrass Prairie & Big River Landscape Conservation Cooperative [ETB]), the Midwest FWS Regional Director (RD) will determine the characteristics of a functional landscape to direct and unify the habitat, species and regulatory activities of regional FWS programs. The RD will define a set of characteristics to identify program delivery and monitor effectiveness of delivery through selected surrogate species.*

How will the implementation of FWS activities, annual decisions implemented within legal and budgetary constraints, change?

These activities will be evaluated on a 10-year time horizon with the knowledge of imperfect predictions of land-use change over 30 years that are influenced by changing climate and social values."

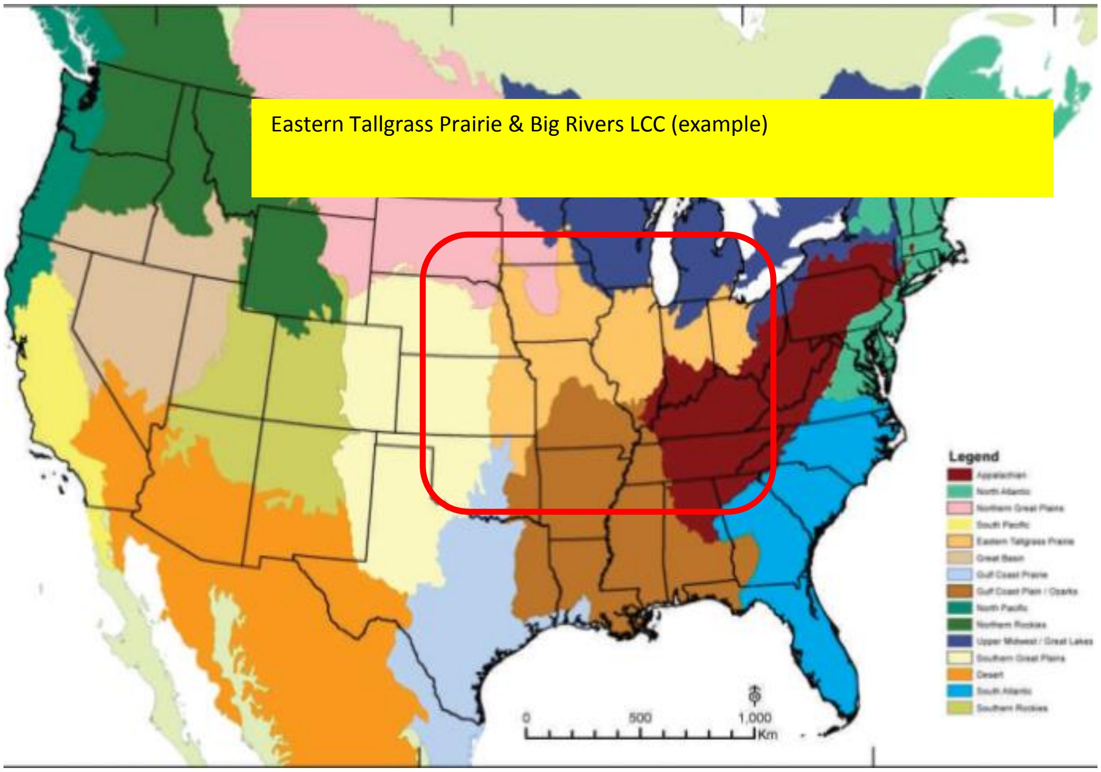

Figure C3. Our decision space – the boundary of the Eastern Tallgrass Prairie and Big Rivers Landscape Conservation Cooperative

Path to a Solution

Decision Structure

A process was framed for creating a conservation landscape design based on surrogate species. We explored, in limited detail, the use of several surrogate species approaches to evaluate the effectiveness of our collective conservation actions. We began by following the format for deconstructing any decision process provided by Hammond et al. (1999) using the following steps: Problem definition, Objectives, Actions, Consequences, and Tradeoffs (e.g., PrOACT). We used these steps to help us quickly but logically think through the problem and create a prototype solution that could be revisited, tested, and improved later. The process of rapid prototyping is often used in engineering as a low investment-high return means of addressing problems. By moving quickly through the steps, you learn and improve the prototype by building it with simple rules and adding in detail as needed. If the first prototype is wrong it can easily be scrapped or revised without risking large investments of time and funding.

For our first prototype we looked to the Eastern Tallgrass Prairie – Big Rivers Landscape Conservation Cooperative (ETP-BR LCC) draft Strategic Plan (Salmon and White 2013) to initiate a brainstorming session on what we *value* about functional landscapes. Stating our values helped us to clarify them. We could then restate our values as objectives. We used our brainstormed ideas to develop an objectives hierarchy that defined our values, categorized in a way to help achieve our goals, and provided measures for evaluating success. Starting with the ETP-BR LCC objectives also helped to limit our first prototype. We focused our brainstorming on the species guilds that would be contained in the ETP-BR LCC objectives: grasslands and rivers.

Definition of a Functional Landscape (Refined for our Model Geography)

To define a functional landscape, we looked at our set of values from our brainstorming session. We restated each value as explicit statements that could be discussed, negotiated, and evaluated. For our first prototype we recognized that our set of objectives may not have captured all potential tradeoffs, but by continuing through the process, we might well discover additional objectives (hidden or otherwise). It was precisely our set of values, stated as objectives, that would drive the rest of the prototyping process. Before we could consider any potential actions to help us meet our objectives, we focused on clarifying and setting our objectives. For our decision problem we identified several objectives (**values** in our functional landscape statement in **bold**) including those stated in the ETP-BR LCC strategic plan we recall:

*A functional Eastern Tallgrass Prairie and Big River landscape can support **sustainable populations of trust species** as well as **economic activities** (e.g., agriculture, forestry, energy production) with **reasonable amounts of** the following "**properties & elements**" (i.e., characteristics)*:

We provided statements about the direction we wanted our values to take (e.g., "maximize" or "minimize") and organized our set of ideas into fundamental and means objectives as follows:

Objectives

Fundamental Objective: Sustainable populations of trust species in ETB geography (as our example universe) that for this exercise, only contains grasslands (including agriculture) and rivers.

A. Maximize self-sustaining/desirable populations of grassland species
    a. Upland grassland species
    b. Lowland grassland species
B. Support maximum amount of wildlife friendly public use of grasslands
C. Maximize self-sustaining/desirable populations of riverine species

Means objectives:

a. Protect patches of existing natural grassland or reconstructed grasslands
    a. Number of protected areas
    b. Surrounding land use

b. Secure an appropriate amount of protected of fish and wildlife habitat
    a. Appropriate patch size (Large)
    b. Appropriate patch quality
        i. Vegetation structure
            1. Vegetation height
            2. Vegetation density
        ii. Soil types
        iii. Fire frequency
        iv. Geologic features
    c. Secure connectivity between patches
        i. Distance between patches (lateral)
c. Provide wildlife friendly working lands practices for grassland habitat and farm diversity
    a. Diversity of crop type (e.g., hay, pasture, row) supportive of species
    b. Timing of disturbance
    c. Frequency of disturbance
    d. Patch size
    e. Buffer width
d. Maximize self-sustaining populations of riverine species
    a. Maximize riparian corridor quality
    b. Maximize public use of rivers (connect people to nature and provide for navigation)
    c. Maximize connectivity (fish passage)
    d. Maximize water quality
    e. Maximize storm water management ability

We portrayed our fundamental and means objectives in figure C4 below. Because the steering committee of the Eastern Tallgrass Prairie – Big River LCC restricted their strategic plan to grasslands and rivers, we did the same. We recognized that such a restriction would require revisiting in future prototypes, but for now we kept our landscape simple.

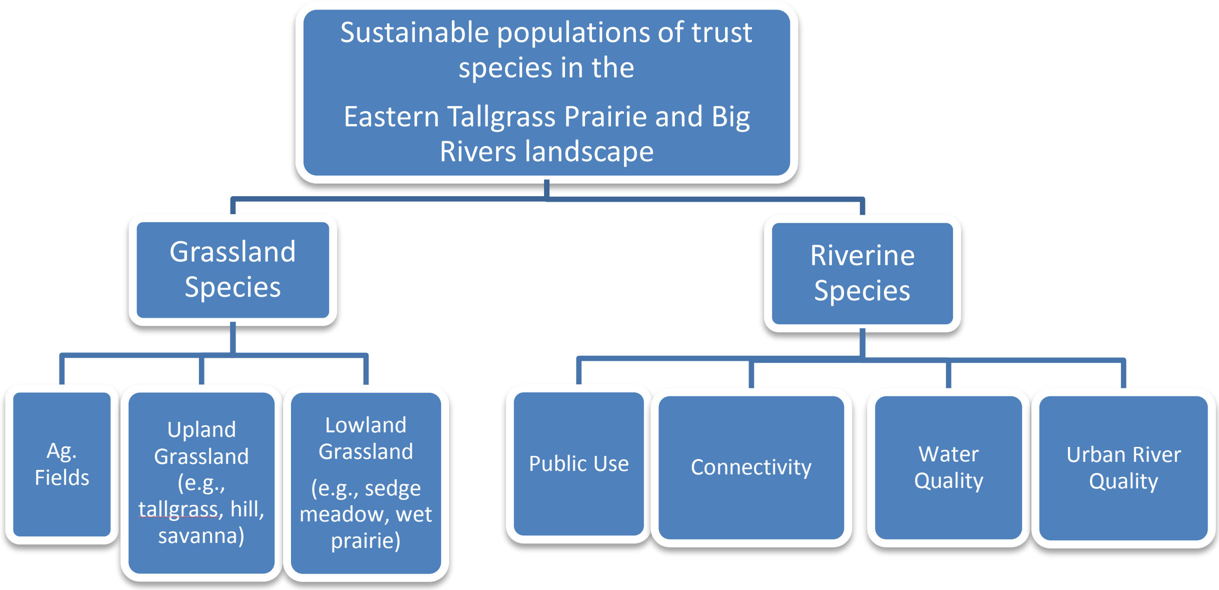

Figure C4. This diagram represents our definition of a functional landscape for the ETP-BR geography; fundamental objectives form the top two rows and means objectives form the bottom row

Species Objectives

For our first prototype we initially used generic limiting factors as placeholders for our species-habitat needs. In practice, we discussed the use of existing species lists and compiling and screening based on guidance in the NWRS's Handbook for Selecting Resources of Concern (USFWS 2009). Alternatively the Service could use focus groups for different habitat types to identify species and species-habitat relations. Later, comprehensive literatures searches or species-habitat relation databases would help guide the habitat and landscape features desired or help set threshold criteria.

There was repeated debate during the workshop about whether to 1) select species *a priori* and then look for habitat relationships or 2) to look at the landscape along with the resources of concern to help identify the resource needs. The guidance directs us to select species first, but there was some concern about doing this without considering features of the landscape. We realized that setting our objectives to define our functional landscape forced us to look forward in the SHC wheel (figure C1). At a generic level, we were forced to think about the limiting factors, the population-habitat relationships, and the ways to set habitat objectives for the species in the ETB landscape. Thus, we used a combination of the two approaches in an iterative fashion.

Habitat Objectives

Influence diagrams are useful for visualizing important features of a landscape and how different species might respond to those features. The flowcharts (Objectives hierarchies) here also served as influence diagrams to help our group think through what we valued about landscapes, how we might think about landscapes from a species perspective, and how we determine which conservation actions to take that will result in the greatest potential benefit. Influence diagrams allow us to distinguish between species-habitat relations that can and cannot be affected by land management or policy changes.

Figure C5 provides an alternative example of an influence diagram for species that may or may not be affected by patch connectivity. Diagrams should be kept simple like this sketch of how team members might expect different species of concern might respond to the landscape. Influence diagrams include assumptions and uncertainty and allow all team members to consider additional questions. Alternative models or scenarios can be quickly created and allow for comparisons among alternatives. Team members can also use an influence diagram to think through how they would measure a particular landscape feature. Figure C5 was derived from discussions during objective setting and during the project evaluation exercise (see figure C10) to show the conceptual relationships that team members used when thinking about how to measure a landscape feature or evaluate an example landscape project.

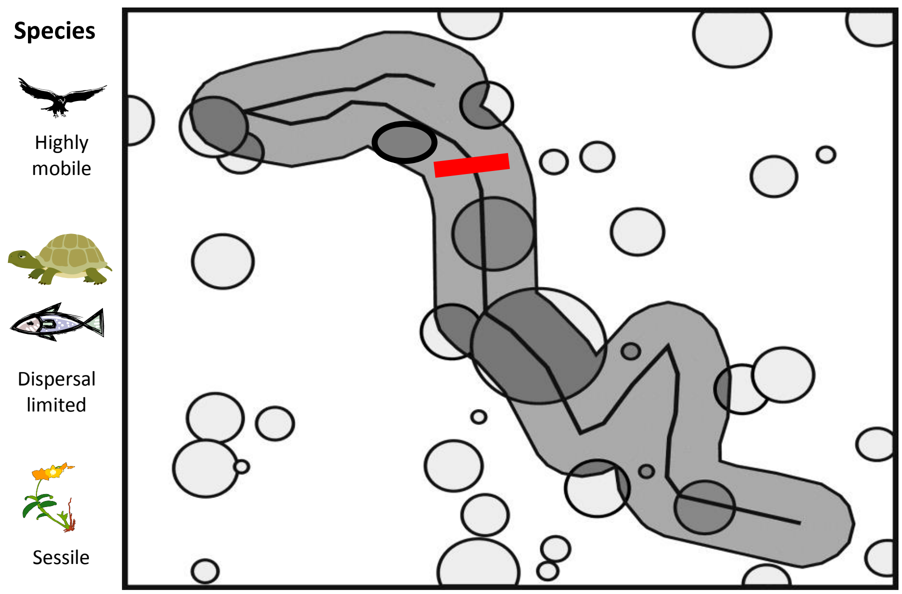

Figure C5. Example of an influence diagram of how different species might respond to landscape connectivity for the ETB geography

Our team initially identified landscape characteristics that support species and define landscape quality. We then identified characteristics, those properties and elements we felt most influence landscape quality (our means objectives). We selected measures for each objective that reflected the effects of conservation actions on those objectives, and we identified a pool of species that were related to our means objectives. Lastly, we would select surrogate species, or a suite of them, that best reflected the effects of our conservation actions on the species pool.

We considered features of the landscape that might be important to species of concern (recognizing that we did not select any one species *a priori*) and how we might measure those features. Figures C6–C9 show our objectives hierarchies for each habitat type in the ETB geography. For our first prototype, we used generic taxa to identify the landscape characteristics that the team felt were important (e.g., habitats large enough to support life history needs, intact natural habitat conditions, connectivity among patches to allow for dispersal and evolutionary processes, etc.). We anticipated using species-specific evaluations of the landscape to guide patch size, protection, and connectivity in later prototypes. For our first prototype, we considered river navigation and cost of conservation actions as constraints recognizing that they could also be viewed as competing objectives in future iterations. As we constructed our objectives hierarchy, we were able to think about how we might measure each component and ultimately create a functional landscape "score" to compare among alternate portfolios of possible actions.

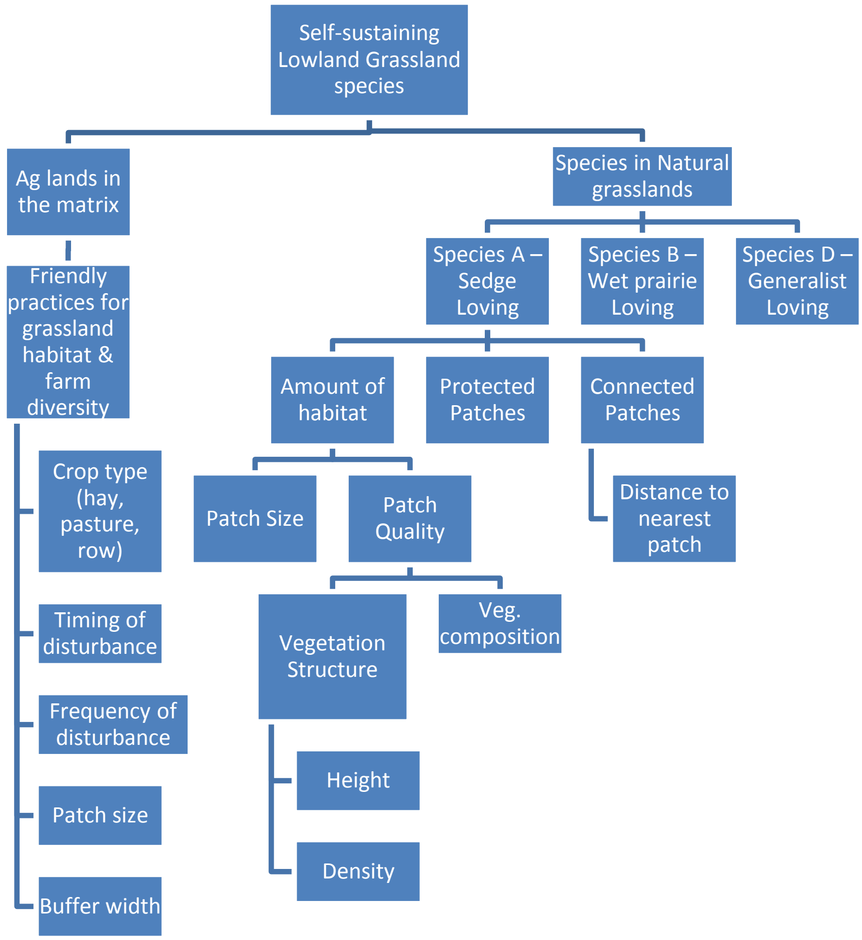

Figure C6. Objectives hierarchy for the ETB geography for our two lowland grassland habitats (agricultural and natural grasslands)

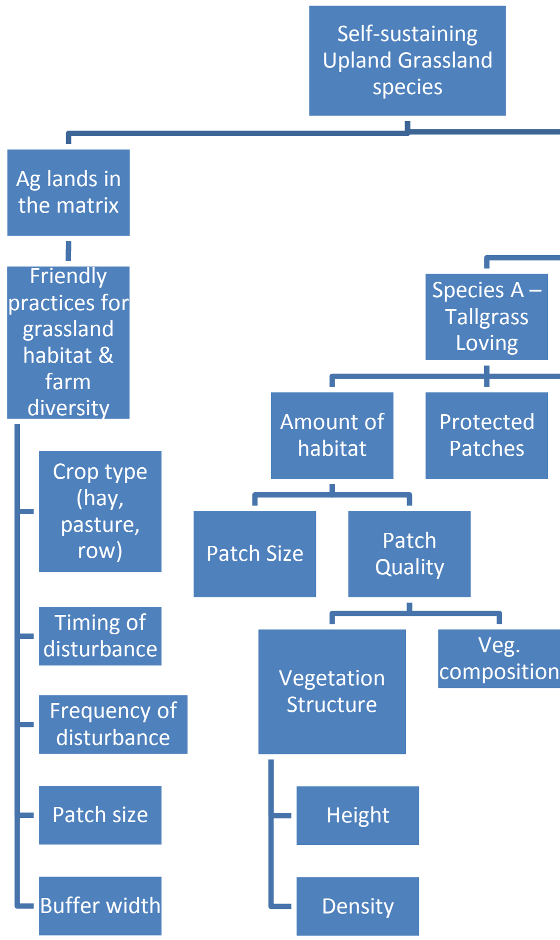

Figure C7. Objectives hierarchy for the ETB geography for our two upland grassland habitats (agricultural and natural grasslands)

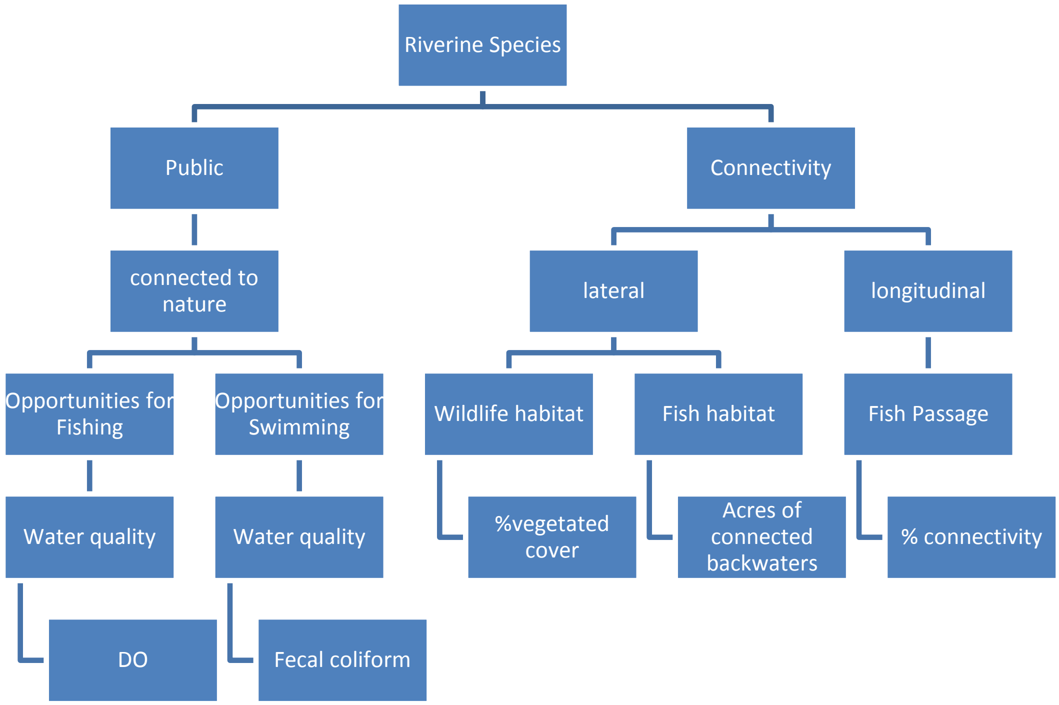

Figure C8. Objectives hierarchy for 2 of our 4 objectives for riverine habitat in the ETB geography

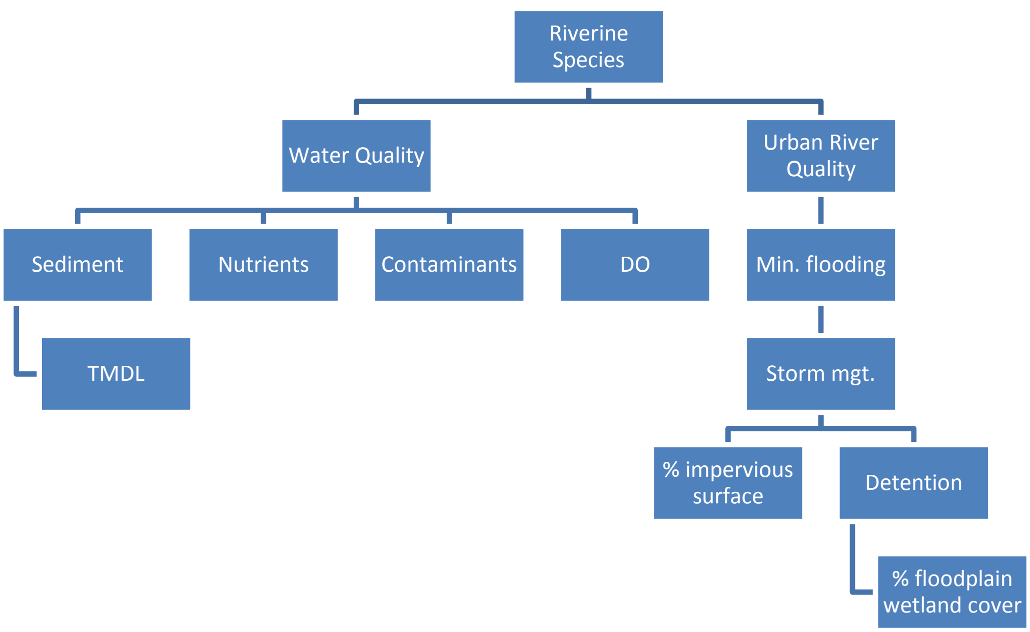

Figure C9. Objectives hierarchy for 2 of our 4 objectives for riverine habitat in the ETB geography

STAKEHOLDER AND PARTNER VALUES

Another area of much discussion focused on when and how to elicit and reflect stakeholder and partner values. Currently, the draft guidance states that the process is for the Service to articulate our values as an agency. In this case, the agency would develop its own list and then share the list with partners. However, there is a conflicting statement in the draft document directing the Service to engage with state partners in the process. It is unclear when and how engagement with the states should be done. The members of our team recognized that other, Non-Service, objectives for any ecosystem are important and may represent conflicting objectives that require reconciliation.

We focused on Service values for our workshop as there were no partner or stakeholder representatives on our team. Regardless, we determined that we could select species that reflect both Service objectives and many socioeconomic or other values (e.g., Species X is correlated with fecal coliform counts). Our decision analyst referred to this as the “Trojan Horse” model. In this way our process could easily be adapted to include partners and stakeholders and their values.

APPLICATION OF THE SURROGATE SPECIES CONCEPT TO THE FRAMEWORK

Now that we defined what our group meant by a functional landscape, we turned our attention to selecting surrogate species (Steps 3–6 and 8 of the draft guidance). The general idea of surrogate species is to use one or a suite of species to represent the values of a larger set of species. Thus, surrogate species allow us to use one or more species to represent a variety of values of other species including:

- Biodiversity
- Environmental health
- Vegetation quality
- Rare or threatened species
- Public values (e.g., storm water management)

SURROGATE SPECIES SELECTION THEORETICAL APPROACH: ANALOGY TO POPULATION MANAGEMENT

To transparently select surrogate species, we can use a similar theoretical approach used to target management actions in population management. In population management, a classic life-history approach is often used to target management actions in the following way. First, create a life history table that shows age-specific mortality and age-specific reproduction. Second, calculate the expected growth rate of the population (λ) by finding the eigenvalue of the life history table using matrix algebra. Based on the life history table, find the trait (z_i; i.e., age-specific mortality and age-specific reproduction) that most influences λ using sensitivity analysis ($\partial\lambda/\partial z_i$). Finally, choose management actions (a_j) that target that most sensitive trait ($\partial z_i/\partial a_j$) Solve for the action that most influences λ as follows:

$$\partial\lambda/\partial z * \partial z/\partial a = \partial\lambda/\partial a$$

A simple example is shown graphically in figure C10. In this example, management actions would be targeted toward increasing adult reproduction.

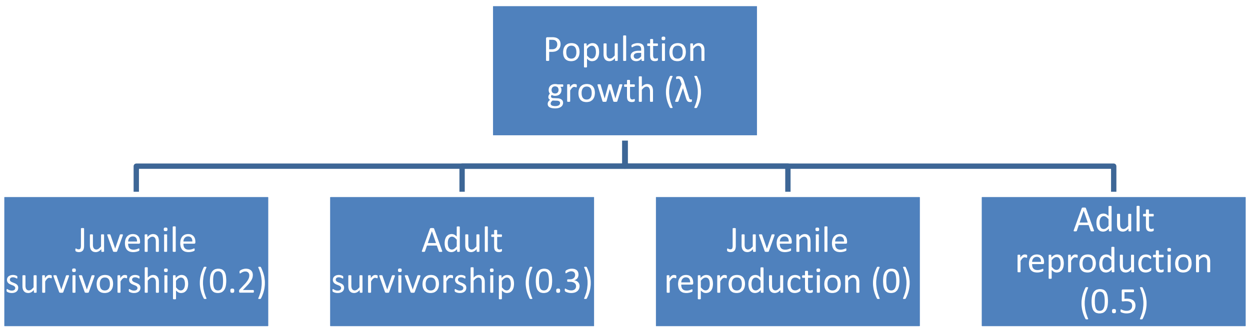

Figure C10. Example life history objectives hierarchy where the fundamental objective is population growth (λ) and the sensitivity of each life-history trait is shown in parentheses

Extending this population management analogy to surrogate species selection, we apply this same logic to the selection of surrogate species—conceptually swapping "functional landscape" for λ as follows. Our functional landscape's life history table can be constructed based on the objectives hierarchy and the "properties & elements" of that landscape. As mentioned before, the identification of fundamental and means objectives will be an iterative process between selecting groups of species (e.g., functional guilds), limiting factors for those species or groups, and habitat characteristics on the landscape. The "properties & elements" give us a way to construct our landscape matrix (i.e., life history table) and measure the current value of our landscape. We called this value our functional landscape score, and it is analogous to λ in population management. Using a similar approach to sensitivity analysis in population management, we can identify the "properties & elements" of our landscape that have the greatest influence on our functional landscape score. Then, we can use this sensitivity to select surrogate species that target "properties & elements" that will increase our functional landscape score, similar to selecting management actions to target traits in a life history table.

Building Our Surrogate Species Selection Approach

We set our criteria for selection of surrogate species based on the objectives within our definition of a functional landscape, the functions (i.e., approaches) that we want from our suite of surrogate species (e.g., umbrella, flagship), and pragmatic considerations about the surrogate species. The characteristics within the definition of a function landscape (i.e., measures of functional landscape objectives) are those that groups of species are sensitive to, and that we can group our priority species pool based on sensitivity to these landscape objectives. For example on our species selection spreadsheet, Henslow's Sparrow is one species within a functional guild that is sensitive to changes in all the measures for native upland grasslands (table C1). Surrogates should also have other pragmatic properties including, existing population data, are easy to monitor, be economically important, or be relevant to national objectives. Using these criteria (i.e., landscape, surrogate approach, and practical considerations), we set up a spreadsheet exercise to select an efficient, yet comprehensive suite of surrogate species from our pool of potential surrogate species. At the heart of our species selection approach is a correlation matrix detailing the correlation between each species in our potential surrogate species pool and our landscape, surrogate approach, and pragmatic selection criteria. We also required that every criterion be covered by a minimum number of surrogate species (e.g., two surrogates per objective). Given that all of the above criteria have been met, we would select the smallest number of surrogate species we can to minimize costs.

In table C1, we placed our fundamental objectives in the first column on the left. The second (middle) column contains our means objectives, those landscape features we considered necessary to meet our definition of a functional landscape. The team then identified species that were ostensively correlated with the mean objective measures and were placed in the third column. A species could be related to and used for more than one measure. For the purposes of developing a prototype, these species were intended to represent a functional guild of species that are correlated to the landscape measures of interest.

Table C1. Initial species-habitat relations table for our fundamental and means objectives and measures

Fundamental Objective	Means Objectives - Metrics	Species
Ag – grassland	Crop type (hay, pasture, row)	Bobolink
	Timing of disturbance	Mallard
	Frequency of disturbance	Bobwhite Quail
	Patch size	Grasshopper Sparrow
	Buffer width	Grasshopper Sparrow
Native upland grassland	Amount of habitat	Henslow's Sparrow
	Patch size	Henslow's Sparrow
	Vegetation structure – height	Henslow's Sparrow
	Vegetation structure – density	Henslow's Sparrow
	Vegetation composition	Henslow's Sparrow
	Protected patches	Henslow's Sparrow
	Connected Patches – dist to nearest patch	Henslow's Sparrow
Native lowland grassland	Amount of habitat	crawfish frog
	Patch size	crawfish frog
	Vegetation structure – height	crawfish frog
	Vegetation structure – density	crawfish frog
	Vegetation composition	crawfish frog
	Protected patches	crawfish frog
	Connected patches - dist to nearest patch	crawfish frog
River public fishing	DO	sauger
River public swim	Fecal coliform	Canada Goose
River connectivity lateral - fish	% vegetated cover	northern pike
River connectivity	acres backwater connected	Blanding's turtle

lateral – wildlife		
River connectivity longitudinal – passage	% connectivity	pallid sturgeon
River - water quality	TMDL – sediment	mussels
	Nutrients	aquatic inverts
	Contaminants	aquatic inverts
River – urban – flood	% impervious surface	black-nosed shiner
	% floodplain wetland cover	cricket frog
Other Selection Criteria	**public awareness**	
	ease of monitoring	
	habitat/population data available	
	adaptive to climate change	
	economic importance	
	indicator of biodiversity	
	large spatial needs	
	relevant to national objectives	
	population objectives available	

Continuing to build out the table, we added our species pool to the column headings immediately to the right of our functional guild representatives column (table C2). Species listed here were considered reasonable placeholders with which to test our process. Team members were asked to score the species by species matrix on a scale of -10 to 10 in regard to how well the surrogate species in the potential pool of species did in representing the species listed in the functional guild column (e.g., Did it do better, worse or the same as the species listed in the functional guild column?). A species could be given up to a -10 if there was a perfect negative relation between the potential surrogate and the functional group representative; a 0 if there was no relation; and a 10 if there was a perfect positive relation. The resulting correlation matrix allowed us quickly see which species were strongly related to a given functional group and to our desired landscape measures.

Table C2. Surrogate species selection criteria for the ETB geography; the green blocks indicate the species can be monitored, have adequate species-habitat information, and are correlated with our landscape measures

			Potential Species Pool			
Fundamental Objective	**Means Obj. - Measures**	**Species Functional Group**	bobwhite	sauger	aquatic inverts	prairie chicken
Agricultural fields	Practice type	Bobolink	1	0	0	0
	Timing of disturbance	mallard	0	0	1	1
	Frequency of disturbance	bobwhite quail	1	0	0	1
	Patch size	grasshopper sparrow	1	0	0	1
Native upland grassland	Composite of all measures	henslow sparrow	0	0	0	1
Native lowland grassland	Composite of all measures	crawfish frog	0	0	1	0
River - public	DO	sauger	0	1	1	0
	Fecal coliform	Canada goose	0	0	0	0
River - connectivity lateral	%vegetated cover	northern pike	0	0	1	0
	acres backwater connected	Blanding's turtle	0	0	1	0
River - connectivity longitudinal	% connectivity	palid sturgeon	0	1	1	0
River - water quality	TMDL - sediment	mussels	0	1	1	0
	Nutrients	aquatic inverts	0	1	1	0
River - urban - flooding	% impervious surface	black-nosed shiner	0	1	1	0
	% floodplain wetland cover	cricket frog	0	0	1	0
Other Selection Criteria		**public awareness**	1	1	0	1
		adaptive to climate change	1	1	1	0
		economic importance	1	1	0	0
		indicator of biodiversity	1	0	0	0
		large spatial needs	1	1	0	1
		relevant to national objectives	1	0	0	1
		population objectives available	1	1	0	1

Linear programming and similar techniques, such as integer and goal programming, are common decision analysis tools that are useful when one objective is of primary concern in the analysis and others can be treated as constraints. These common techniques have been used for decades in resource management for setting timber harvest by the U.S. Forest Service (Kent 1989) and have seen application in conservation planning for selection optimal packages of actions given constraints (e.g., Haight et al. 2002).

To select species from our pool of potential surrogates from the correlation matrix (table C2), we used a threshold approach that allowed the use of linear programming to solve for an optimal suite of surrogate species. First, we applied a minimum correlation among the species in the potential surrogate pool and the availability of data and ease of monitoring. We called this our prediction & observation threshold. This prediction & observation threshold states that to be a surrogate, a species in the pool must be easy to monitor OR have ample population data available, as these were deemed to be the most important criteria for being a useful surrogate by the team members. Second, we applied a minimum correlation among the species in the potential surrogate pool and the species functional group or other selection criteria. This was our surrogacy threshold. This threshold states that the surrogate species must have a relatively strong positive correlation with the species functional group or other selection criteria. Third, we ensured that all objectives for selecting species were represented by at least a minimum number of surrogate species (e.g., for two surrogates per objective, count across columns of potential surrogates and make sure each has two green cells). This was our comprehensiveness threshold. Finally, we selected a suite a surrogate species that had the fewest species given that all of the above criteria were met. This optimal selection was conducted using the Solver add-on's GRG Nonlinear engine in Excel.

Using this method, we could identify an optimal selection of surrogate species, (i.e., fewest # of species that accomplish all objectives). Even though it was a first prototype, working through the process of selecting species and creating an optimization tool gave us confidence that we could select a reasonable number of species for future monitoring. Additionally, our method would be clear to anyone interested in the process and link explicitly to what we care about as an agency.

Our approach addresses Step 8 of the guidance. Step 8 of the guidance directs us to test for the logic and consistency of the selection of surrogate species, not the effectiveness of the management actions for meeting our biological outcomes. We use the iterative process of defining what we want to see in a functional landscape and then combining the use of surrogate species as fundamental and means objectives. We also selected species based on the functions (i.e., approaches) that we want from our suite of surrogate species (e.g., umbrella, flagship) and pragmatic considerations about the surrogate species. We built a transparent process for selecting and testing the appropriateness of the surrogate species based on a correlation matrix and linear programming.

Alternatives

The next step in the decision process was to develop suites of actions (alternatives) that could be taken to achieve the objectives for our landscape. For this initial prototype, we considered how the process of using surrogate species to improve our landscape might fit into on-going decision making with the agency. We asked ourselves:

- What annual decisions are being made that change landscapes?
- What characteristics do we need to achieve to create a functional landscape?
- Where do we restore or reconstruct habitats?
- Where do we purchase new protected areas?
- How do we restore, recreate existing or new protected areas or provide certain functions outside of protected areas?

To develop our suite of alternatives, we again considered the common factors limiting species (populations) and the public use activities (economic and recreational) that could be affected by Service actions. As stated in our problem definition, we would evaluate the cumulative effect of actions taken over a 10-year period of time.

Examples of 10 alternative actions that programs could perform include (figure C11):

- Migratory Birds (NAWCA Grant proposal)
  - Restore tallgrass prairie on private land in upland area (1,000 acres)
  - Restore floodplain wetland along the river (1,000 acres)
- Partners for F&W
  - Restore upland on private lands (100 acres)
  - Restore riparian zone (100 acres)
- Fisheries
  - Remove a dam (20 miles of free-flowing river)
  - Breach a levee (200 acres)

- Refuges
  - Convert food plots to wetlands in refuge (160 acres)
  - Clear willows for grassland (160 acres)
- Ecological Services
  - Restore habitat for piping plover with beach restoration on an island (7 acres)
  - In-channel designation of critical habitat for mussels with structures to increase flow to increase pea gravel (0.31 miles)

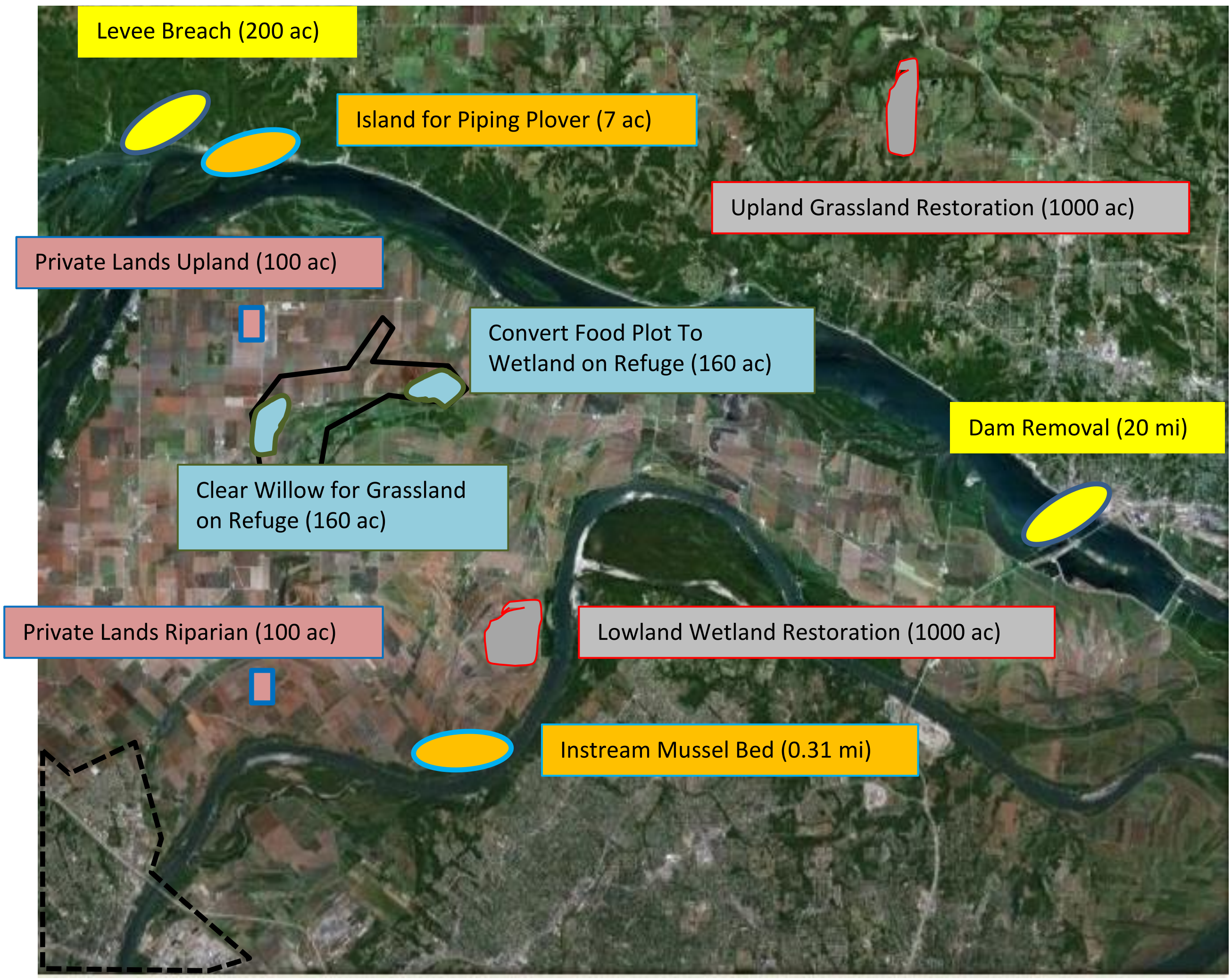

Figure C11. Ten example programmatic opportunities for habitat conservation in the ETB landscape

Using Surrogate Species: A Framework for Evaluating Progress towards a Functional Landscape

As mentioned for our surrogate species selection approach, we can use our objectives hierarchy and measures to calculate a functional landscape score. This score can be used to evaluate different action alternatives (or portfolios of actions) based on our fundamental objectives. Based on our problem statement and the intent of the technical guidance, we were interested if cross-programmatic collaboration would results in a higher landscape score for this analysis.

For our initial prototype, we referred back to the example actions each program could take in our geography. We began to build a table starting with our landscape objectives and measures down the left side (table C3) and added our simple set of possible programmatic actions across the top (table C4). To keep our world simple, we constrained each program to only afford the implementation of one action. We compared our projected “efficiency” by choosing only one of the two programmatic actions and compared the “winning” programmatic action to the effectiveness of different combinations of actions across programs (figure C12).

To help us evaluate how species specific programmatic and cross-programmatic goals could be reached, we used two decision analysis techniques. First, we used a Simple Multi-attribute Ranking Technique (SMART) to calculate a baseline functional landscape score and a functional landscape score for each project. Second, we, again, used linear programming to choose an optimal set of actions given that each program could only implement one of their two projects.

Calculating a Functional Landscape Score: SMART Analysis

SMART is a multi-objective decision analysis technique that calculates a single score for all alternatives (Goodwin & Wright 2011). The approach is conceptually similar to cost-benefit analysis in economics and is a powerful and commonly used technique. This single score incorporates both the values individuals or groups of stakeholders place on the multiple objectives and the scientific information used to predict the outcome of each alternative. First, each alternative is evaluated based on the measures of each objective. These predictions of the outcomes of each alternative are normalized to a 0-1 scale and weighted by the weight the stakeholders or participants place on each objective. The final score for each alternative is the sum of these weighted and normalized scores.

We first assigned weights to our objectives (table C3). The weights are a measure of importance that the team placed on the objectives, and represent the values of the group. As a starting place for the prototype, we assigned weighs equally between our fundamental objectives as we had no prior preference for action in either river habitats or grassland habitats. However, we did value natural grasslands more than land used for agriculture, so we gave greater weight to projects that affected natural grasslands. We gave equal weighting to each measure within a given means objective.

Scientific information would ideally be used to evaluate the outcome of each alternative action, and this evaluation can be done with various levels of rigor from reviewing the published scientific literature to convening a panel of technical experts. For the purposes of prototyping, we had the team members serve as technical experts. The team was broken into pairs, and each pair was assigned several objectives. For their assigned objectives, each pair evaluated the current condition of the landscape, which served as the baseline condition, and then predicted the outcomes of each of the 10 alternatives.

This process ensured a consistent evaluation for each objective and gave us a rapid assessment of consequences for our prototype (table C4).

The values in table C4 were normalized to a 0–1, weighted by the weight assigned to that objective in table C3, and, for each alternative action, the normalized, weighted scores summed across all objectives. The result was a functional landscape score for the baseline condition of the landscape and the landscape after implementation of each alternative, individually (figure C12).

If each program implemented their preferred action, Ecological Services would create mussel beds, Fisheries would remove a dam, Refuges would convert food plots to sedge wetlands, Migratory Birds would restore floodplain wetlands, and Partners would restore riparian zone habitat (figure C12). The single project that resulted in the greatest increase in functional landscape score was the Migratory Birds floodplain restoration project.

Table C3. This table shows the initial weights we assigned to each of our means objectives

Obj. #	Fundamental	Metric	Goal	Units	Weights	means	fundamental
1	Ag - grassland	Crop type (hay, pasture, row)	MIN	acres	0.020	0.20	0.50
2		Timing of disturbance	MAX	Days	0.020		
3		Frequency of disturbance	MIN	#/year	0.020		
4		Patch size	MIN	acres	0.020		
5		Buffer width	MAX	feet	0.020		
6	native upland grassland	Amount of habitat	MAX	acres	0.029	0.40	
7		Patch Size	MAX	acres	0.029		
8		Vegetation Structure - height	MAX	inches	0.029		
9		Vegetation Structure - density	MAX	# stems/sq ft	0.029		
10		Vegetation composition	MAX	# spp.	0.029		
11		Protected Patches	MAX	1 = N, 2 = Y	0.029		
12		Connected Patches - dist to nearest patch	MIN	miles	0.029		
13	native lowland grassland	Amount of habitat	MAX	acres	0.029	0.40	
14		Patch Size	MAX	acres	0.029		
15		Vegetation Structure - height	MAX	inches	0.029		
16		Vegetation Structure - density	MAX	# stems/sq ft	0.029		
17		Vegetation composition	MAX	# spp.	0.029		
18		Protected Patches	MAX	1 = N, 2 = Y	0.029		
19		Connected Patches - dist to nearest patch	MIN	miles	0.029		
20	river public fishing	DO	MAX	ppm	0.063	0.25	0.50
21	river public swim	Fecal coliform	MIN	Count	0.063		
22	river connectivity lateral - fish	%vegetated cover	MAX	%	0.042	0.25	
23	river connectivity lateral - wildlife	acres backwater connected	MAX	acres	0.042		
24	river connectivity longitudinal - pas:	% connectivity	MAX	miles	0.042		
25	river - water quality	TMDL - sediment	MIN	mg/L	0.042	0.25	
26		Nutrients	MIN	mg/L	0.042		
27		Contaminants	MIN	mg/L	0.042		
28	river - urban - flood	% impervious surface	MIN	%	0.063	0.25	
29		% floodplain wetland cover	MAX	%	0.063		

Table C4. Consequence table showing our mean objectives, the "properties & elements" or species groups linked to those properties & elements that we value about a functional landscape, and the different programmatic actions that could be carried out

			ES		fisheries		refuges	
Objectives	Goal	Units	piping plover	mussels	dam removal	levee breach	food to sedge	willows to gras
Crop type (hay, pasture, row)	MIN	acres	0	0	0	0	0	0
Timing of disturbance	MAX	Days	0	0	0	0	0	0
Frequency of disturbance	MIN	#/year	0	0	0	0	0	0
Patch size	MIN	acres	0	0	0	0	0	0
Buffer width	MAX	feet	0	0	0	0	0	0
Amount of habitat	MAX	acres	13,000	13,000	13,000	13,000	13,000	13,000
Patch Size	MAX	acres	100-1500	100-1500	100-1500	100-1500	100-1500	100-1500
Upland Grassland Species A	MAX	inches	50	50	50	50	50	110
Upland Grassland Species B	MAX	# stems/sq f	100	100	100	100	100	125
Vegetation composition	MAX	# spp.	5	5	5	5	5	5
Protected Patches	MAX	1 = N, 2 = Y	2	2	2	2	2	2
Connected Patches - dist to nea	MIN	miles	0.001	0.001	0.001	0.001	0.001	0.001
Amount of habitat	MAX	acres	1,600	1,600	2,100	800	1,780	1,760
Patch Size	MAX	acres	50	50	200	100	230	210
Lowland Grassland Species A	MAX	inches	8	8	8	8	75	8
Lowland Grassland Species B	MAX	# stems/sq f	10	10	10	10	90	10
Vegetation composition	MAX	# spp.	25	25	28	28	28	28
Protected Patches	MAX	1 = N, 2 = Y	1	1	2	2	2	2
Connected Patches - dist to nea	MIN	miles	0.5	0.5	0.5	0.3	0.1	0.3
DO	MAX	ppm	25	25	30	25	25	25
Fecal coliform	MIN	Count	5	5	5	6	5	5
%vegetated cover	MAX	%	0	0	2	10	0	0
acres backwater connected	MAX	acres	0	0	50	200	0	0

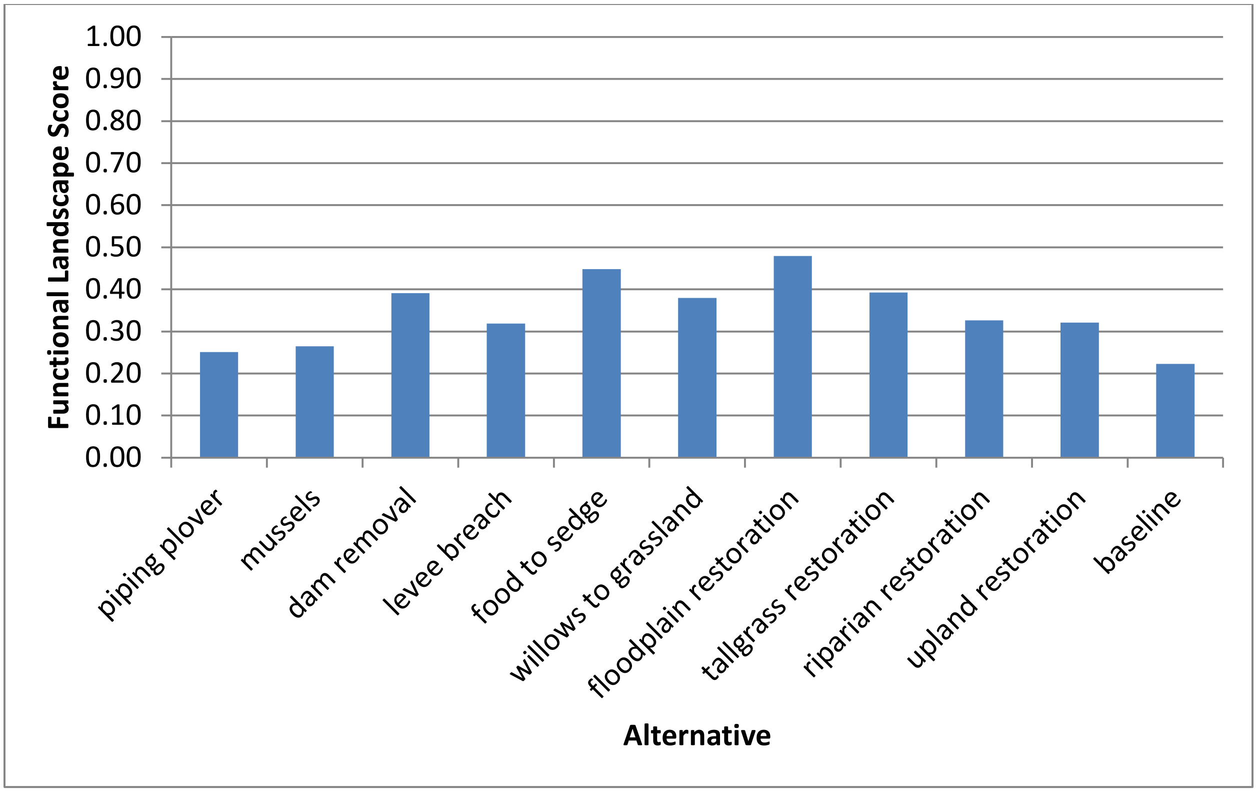

Figure C12. Functional landscape scores based on example programmatic opportunities for habitat conservation in the ETB landscape

Sensitivity Analysis

Promoting Cross-Programmatic Collaboration: Selecting an Optimal Portfolio of Actions

Putting alternatives together in different portfolios allows that Service to work together to maximize goals for the landscape. We wanted to select the best portfolio of actions that will synergistically change the landscape in our favor, but that would also allow our stakeholders to maximize benefits from their perspective (e.g., flood control, etc.).

To assess how much these individual actions contributed to a more functional landscape, we needed a score for the entire landscape. We calculated a functional landscape score by evaluating the contribution of each action relative to the increase it causes for each "property & element" (or species functional group). We did this by calculating the difference between the predicted outcome of the action and the baseline (i.e., current) condition of the landscape for each objective (i.e., the gain in functionality with regards to that objective from implementing that action) and adding the amount gained the baseline condition for the landscape. We then normalized, weighted, and summed the scores as before to calculate the functional landscape score if we were to implement the entire portfolio of actions (i.e., each program implements one action for a total of five actions implemented on the landscape).

Remember, if each program implemented their individually preferred action, Ecological Services would create mussel beds, Fisheries would remove a dam, Refuges would convert food plots to sedge wetlands, Migratory Birds would restore floodplain wetlands, and Partners would restore riparian zone habitat (figure C12). This allocation of resources independently by each program resulted in a functional landscape score of 0.63 for the entire landscape.

We then asked the question, "Could we increase the functional landscape score for the entire landscape if programs worked collectively?" We used linear programming to determine the optimal selection of actions by each program that would achieve the highest functional landscape score for the entire landscape. We first constrained each program to a single action. We then use Solver in Excel to select the action for each program that maximized the functional landscape score for the entire landscape. This analysis resulted in a 0.01 increase in functional landscape score. More interesting than the magnitude of increase in our hypothetical example was the switch in decisions by two programs. Fisheries would implement the levee breach and Partners would implement the upland restoration.

Conclusion

Insights and Needs for Additional Consideration

1. Can this report lead to more discussion about the structure and make-up of the Service? (Identify expertise needed within the Service or obtainable via contract, etc.)
2. Scale is still problematic and needs to be looked at further.
3. Partner engagement – is this an activity that first should be done by the Service to understand its needs, opportunities, etc. and then revisited with partners engaged and with full recognition that the Service may negotiate changes to SS species based on partner values and the ability of the swaps species to meet Service objectives, OR should the Service start the process right away with partner involvement?
4. Threats from mining, wind power, transportation infrastructure etc. can be incorporated into the process as competing objectives or as constraints.
5. One of our team members and one of our observers did not see how species fit into our process. In essence, do we set species as a fundamental objective (yes for threatened and endangered species) or do we set a functional landscape as our fundamental goal?

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