Implementing the Strategic Habitat Conservation (SHC) Framework within the St. Joseph Watershed in Michigan, Ohio, and Indiana

A Case Study from the FWS/USGS Structured Decision Making Workshop: Strategic Habitat Conservation – Region 3
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Decision Problem

The primary factor limiting the Copperbelly Water Snake (CWS) population has been identified as habitat loss and fragmentation. Several Priority 1 recovery actions in the CWS draft recovery plan involve the conservation of habitat complexes sufficient for CWS recovery, such as identifying focal management areas, developing guidelines for habitat restoration and enhancement, working with landowners and agency land managers, and developing and implementing habitat conservation programs. Our challenge is to determine how to create the landscape to meet the population objectives for the CWS within existing constraints and to reverse the population decline in the next five years.

Background

Legal, regulatory, and political context

The Northern Distinct Population Segment (NDPS) of the CWS is federally listed as threatened under the Endangered Species Act of 1973, as amended. The CWS is found primarily on private lands with the exception of the Lake La Su An State Wildlife Area in Ohio. The Ohio Department of Natural Resources (ODNR) manages the area for fishing and grassland birds. A Draft Recovery Plan for CWS was issued in September of 2007. Critical habitat has not been designated for this species.

Ecological context

The CWS NDPS occurs in the St. Joseph River watershed (Lake Erie drainage) in the tri-state area of Michigan, Indiana, and Ohio. The CWS is associated with shallow wetlands, such as scrub-shrub, emergent, and margins of open water, within an upland forest matrix. The snakes

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use scrub-shrub wetlands for basking and forage for amphibians in shallow wetlands. The CWS is a vagile species, inhabiting a large home range (15 hectares) for a water snake. The CWS requires a diversity of wetlands—different types of palustrine wetlands as well as ephemeral wetlands of varying depths. The snake utilizes uplands as travel corridors and also as foraging habitat in summer if their ephemeral wetlands are dry. The CWS hibernates in crayfish burrows in forested wetlands. The primary threat to CWS is habitat loss and fragmentation.

Decision Structure

Because of its precipitous population decline, the CWS was already established as a Region 3 priority species. For several reasons, including existing cross-programmatic cooperation, the St. Joseph watershed was selected as a focal area for SHC in the region. Thus, our decision structure began from this point, with a focal species pre-selected and an emphasis on the Service's Partners for Fish and Wildlife (PFW) program.

Our decision structure evolved over the course of the workshop, based on choices made to get prototypes started and to focus our work further. For example, the PFW program lacks a standard method for differentiating amongst habitat restoration projects for the CWS, as well as targeting the areas which would most likely enhance CWS populations. Hence, part of our decision structure focused on the PFW program actions and specific alternatives. In addition, we agreed to use the population objectives from the draft Recovery Plan, but also to set a concrete goal of reversing the population decline within the next five years. Ultimately, our decision structure involved the development of three tools/models to assist the PFW program and to meet the population objectives for the CWS.

Alternative actions

Potential restoration activities could occur 1) on private lands around known locations of CWS populations, 2) on private lands without recent records of CWS, and 3) on public land with known locations of CWS.

Objectives

1) At least one population of CWS exceeds 1,000 adults. In addition, five geographically distinct populations of CWS are more than 500 individuals, or three metapopulations have a total population size of 3,000 with none less than 500.

2) The NDPS of CWS is stable or increasing in the next five years.

Predictive model

We developed three models/tools:

1) a GIS-based, spatially explicit habitat model to predict CWS occurrence and prioritize restoration activities based on biology of CWS and geography of the St. Joseph watershed;
2) a decision matrix for the PFW program, directly tied to the GIS model, but also incorporating the most important economical and practical parameters to PFW biologists; and
3) a stochastic demographic population model for CWS to test our population objectives, i.e., will 1,000 individuals provide a probability of extinction <10% for 100 years?

Decision Analysis

We developed the following three tools at the workshop as prototypes to test our concepts. Although preliminary, these early prototypes were useful in showing how these approaches could be used and why they are worth pursuing.

Restoration Model

The first goal of the habitat restoration model was to identify areas that satisfy all needs of the CWS within the existing landscape. We located patches where habitat needs are met and identified habitat complexes comprised of patches of suitable habitat and safe connecting corridors. Then we added constraints of barriers**,** such as roads, to display the habitat complex extent, now and in future. An example of this map is shown in Figure 1.

The second goal was to identify potential restoration areas and their restoration requirements. We used soils maps to identify areas suitable for wetland restoration and National Wetland Inventory maps, in conjunction with aerial photographs, to locate existing wetlands that are lacking the surrounding forest matrix necessary for the CWS.

The third goal was to rank the potential restoration sites in terms of their value to recovery of the CWS. This will require running simulations of the model, adding restored habitat to identify which sites provide the greatest improvement to the existing habitat complexes. This will generate a landscape map, depicting recovery values. With this in place, we can overlay property boundaries onto the recovery value landscape to indicate the relative value of each parcel for CWS recovery.

PFW Decision Matrix

To assist the PFW program biologists, we developed a ranking system to differentiate amongst PFW projects for the CWS across the tri-state area. In selecting restoration sites, PFW biologists need to consider not only biological aspects, but also economical and practical (real-world) parameters. We utilized the SMART (Simple Multi Attribute Ranking Technique) tool for development of the decision matrix. The matrix includes seven attributes, which were weighted based on factors that are most important in differentiating amongst potential CWS habitat restoration projects. We then used hypothetical projects that could be encountered in private lands work, with various combinations of restorable habitats (e.g., large wetland, small wetland complex, wetland and tree planting, tree planting only, etc.), to conduct a sensitivity analysis on the various attributes and their weightings to insure that the output of the decision tool made sense from a biological, as well as a programmatic, standpoint.

The decision matrix, with hypothetical projects, is presented in Table 1. The seven attributes are described below:

CWS Score – The CWS attribute was considered the most heavily weighted attribute but was not an absolute driver of the ranking process.

Lag Time – We included this attribute to differentiate amongst those projects that provide an immediate functional benefit (e.g., wetland restoration or tree planting in an agricultural field) versus those projects where the functional benefit is delayed (e.g., tree planting in sod).

Total Cost/Acre – Using total cost per acre allowed us to weight projects within and amongst different habitats equally.

Difficulty – This attribute could be viewed as the most subjective attribute; therefore, we classified the most common obstacles we face as PFW biologists, recognizing the types of obstacles may vary across states.

Priority Species – Examples include other federally listed endangered and/or threatened species, migratory birds, and non-trust resource species (e.g., state listed species).

Cost Share – This is a measure of the proportion of the cost of a project that the landowner bears.

Agreement Duration – Restorations conducted under the PFW program require the landowner to agree to maintain the restored habitat for a certain length of time, usually 10-15 years. Longer agreements were weighted more heavily.

<u>Stochastic Demographic Population Model</u>
One of our population objectives from the draft Recovery Plan is 1,000 adult CWS. The purpose of developing the population model was to test whether a population of 1,000 individuals would provide a probability of extinction less than 10% for 100 years. The analytical approach we utilized depended on CWS expert opinion to populate the model. We used a stable age-structure to set the initial population and then evaluated the model behavior. We later added catastrophic events, such as drought, to the model. A graph of our model output is shown in Figure 2.

The model variables are as follows:

- P = Proportion of adults breeding - sample from an equal distribution
- R = Proportion of reproductively mature females giving birth - sample from an equal distribution
- F = Number of young per female - sample from an equal distribution
- A = Adult survival rate - sample from an equal distribution
- Sn = Neonate survival rate age 0 - sample from an equal distribution
- Sji = Juvenile survival rate age 1 to 3 - sample from an equal distribution
- First age of breeding age = 3yrs
- Maximum age of breeding = 7yrs.

Uncertainty

Our uncertainty lies primarily with our knowledge of the biology and habitat requirements of the CWS. Information about its habitat preferences for hibernacula is lacking, and thus, a critical component may be missing from our habitat model. The basics of its reproductive biology, such as clutch size, are inferred from knowledge of the southern CWS population and other water snake species. In all the simulations of our population model, we were unable to drive the population to extinction, indicating a potential problem in our model.

The uncertainty associated with our PFW decision tool is related to the way the PFW program currently operates. In general, potential restoration sites are not actively sought in a specific area; rather, projects are dependent upon the voluntary initiative of private landowners to contact the FWS if they are interested in a restoration project. Thus, the sites that the decision tool evaluates may vary greatly from one year to the next. Additionally, the highest priority parcels for CWS may not have willing landowners; therefore, lower quality sites might be the only ones that are available.

Discussion

Value of decision structuring

Our decision structuring will lead to greatly improved conservation and management for the CWS. The habitat model will allow us to analyze visually the CWS locations and types of habitat occupied, as well as call attention to habitat-related questions for research. In addition, the model will help us to prioritize potential restoration sites, track completed restorations graphically, and evaluate the impact of restorations on the overall habitat value of the landscape.

The population model, with some refinements, will test our population objectives for CWS. The model can also be revised and updated as we obtain new information about the CWS's biology and population demographics. The model will also help us to understand research needs and guide future investigations.

Development of the PFW decision tool represents a potential paradigm shift in how the PFW program will operate in the St. Joseph watershed. The decision matrix has called attention to the need to target individual parcels for habitat restoration, based on the parcel's value to CWS recovery. In addition, PFW biologists are discussing new ways to allocate funding and biologists' time within the watershed to focus restoration work, regardless of artificial boundaries, where our efforts will provide the greatest benefit to CWS.

Further development required

The habitat model needs refinement to make it more accurate and useful. We still must complete a prototype with a scoring process for suitability for CWS, including roads, wetland types, residential areas, etc. We also intend to add decision support layers, such as parcels and restoration potential by treatment options.

The PFW decision tool is ready to use once the CWS habitat score is developed in the habitat model. With a tool in place to prioritize restoration work for CWS, the PFW biologists could explore funding distribution alternatives to support restoration work in CWS areas. We also need to design an evaluation process for the PFW decision tool. Ideally, we would be able to share the tool with other agencies, such as the U.S. Department of Agriculture's Natural Resources Conservation Service and Farm Service Agency, Michigan Department of Natural Resources, and The Nature Conservancy, all of which also work with private landowners within the St. Joseph watershed.

As with our habitat model, we still must refine and improve the stochastic demographic model. Based on the outputs from this model, we will examine the CWS population objective to insure that the extinction risk is acceptable and then revise the population objective as needed. In addition, we intend to perform a sensitivity analysis of the model to identify management priorities and research needs.

Prototyping process

Our team came to the workshop with an array of expectations as well as familiarity with models and GIS. This diversity in our team quickly became apparent when we attempted a rapid prototype of the CWS's limiting factors and initial construction of a habitat model. We decided to divide into two groups—the spatial modelers and the non-modelers. Starting from different places as we did definitely delayed performance of the group; however, once we split into smaller groups, our productivity and enthusiasm escalated. As we became more comfortable with the concept of rapid prototyping and could see progress in our work, we eventually divided into three groups, which ultimately developed the three models/decision tools discussed above. Although we struggled initially with the lack of detail in our early prototypes, we finally were able to try a prototype, react and assess, and then refine it. In the end, we agreed to the value of rapid prototyping for structuring our decision problems.

Recommendations

The following bullets represent recommendations for implementing SHC within Region 3 and utilizing structured decision making as a training vehicle for SHC.

- Need to increase capacity for modeling within Region 3
- Share modeling capacity across FWS program boundaries
- Consider assistance from USGS on modeling issues
- Accountability measures—should be outcome-driven rather than output-based
- Determine how to support outside expertise (e.g., University researchers)
- Functional directory of expertise of people to pull in to solve problems
- Bite off manageable sized pieces
- Follow up to workshop to bring team back together
- Break up workshop into smaller functional groups

Literature Cited

Hammond JS, Keeney RL, Raiffa H. 1999. Smart Choices: A Practical Guide to Making Better Life Decisions. Broadway Books, New York.

U.S. Fish and Wildlife Service. 2007. Copperbelly Water Snake (*Nerodia erythrogaster neglecta*) Draft Recovery Plan. Fort Snelling, Minnesota. ix + 68 pp.

Tables

				Potential CWS Habitat Restoration Projects							
Attribute	**Units**	**Goal**	**Weight**	**Multiple Wetlands**	**Upland Forest**	**Large Wetland**	**Forest and Wetland**	**Upland Forest**	**Small Wetland**	**Forest and Wetland**	**Wetland Complex**
CWS score	**1-10**	**max**	**65**	**65**	**0**	**32.5**	**16.25**	**32.5**	**8.125**	**48.75**	**24.375**
Lag Time	**0-1**	**min**	**10**	**10**	**0**	**10**	**10**	**0**	**10**	**10**	**10**
Total cost/acre	**$**	**min**	**5**	**0**	**4.565217**	**5**	**2.173913**	**3.913043**	**4.347826**	**3.26087**	**2.173913**
Difficulty	**1-5**	**min**	**5**	**0**	**5**	**2.5**	**2.5**	**3.75**	**5**	**2.5**	**2.5**
Priority Species	**#**	**max**	**10**	**5**	**5**	**5**	**10**	**10**	**0**	**10**	**10**
Cost Share	**%**	**max**	**5**	**0**	**5**	**5**	**0**	**2**	**0**	**0**	**0**
Agreement Duration	**#**	**max**	**5**	**0**	**1.25**	**1.25**	**1.25**	**1.25**	**0**	**5**	**1.25**
		sum	**105**	**0.761905**	**0.19824**	**0.583333**	**0.401656**	**0.508696**	**0.261646**	**0.757246**	**0.479037**

Table 1. Private Lands Decision Matrix

Figures

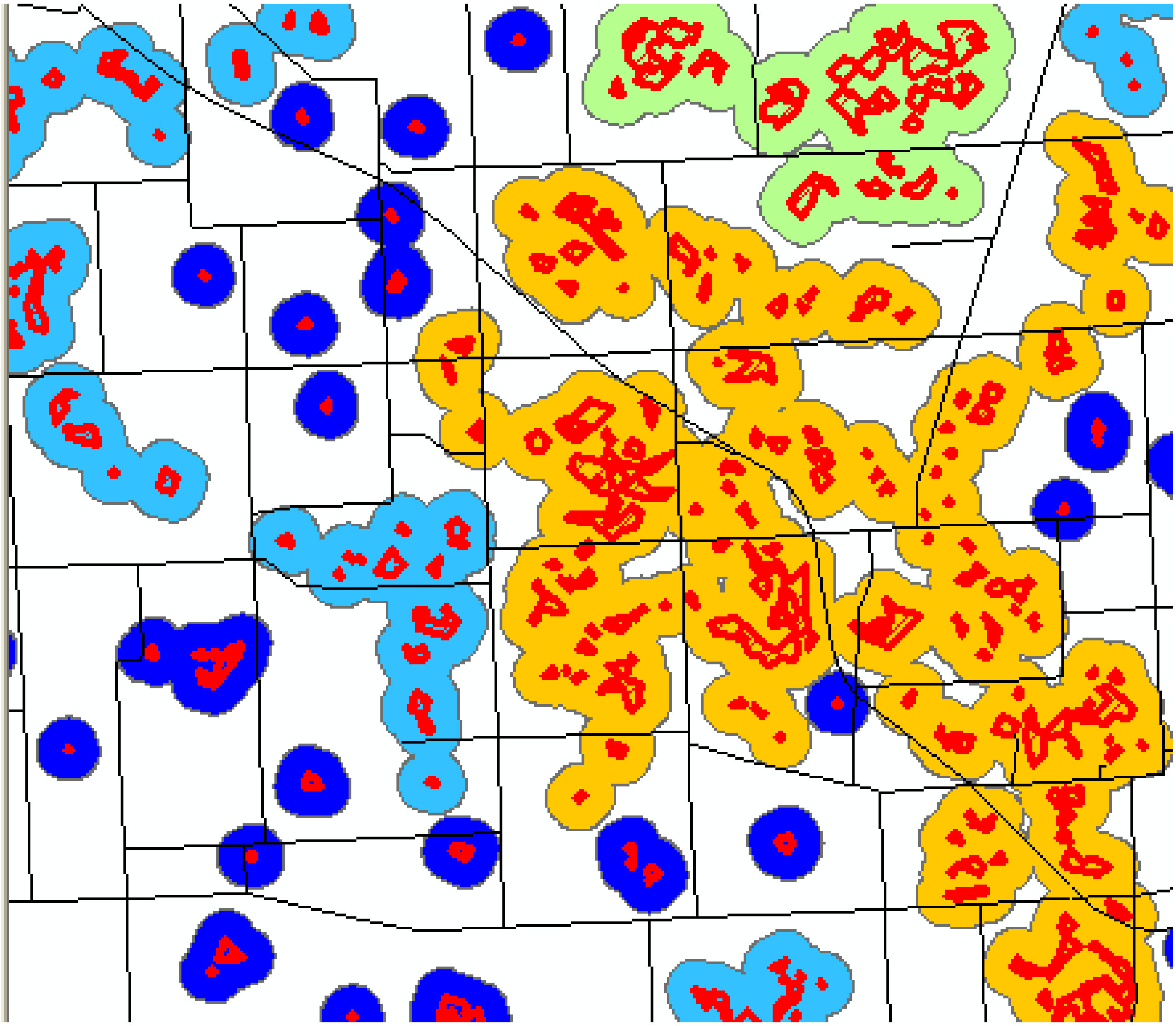

Figure 1. Forest and wetland component within 500m of each other, with roads

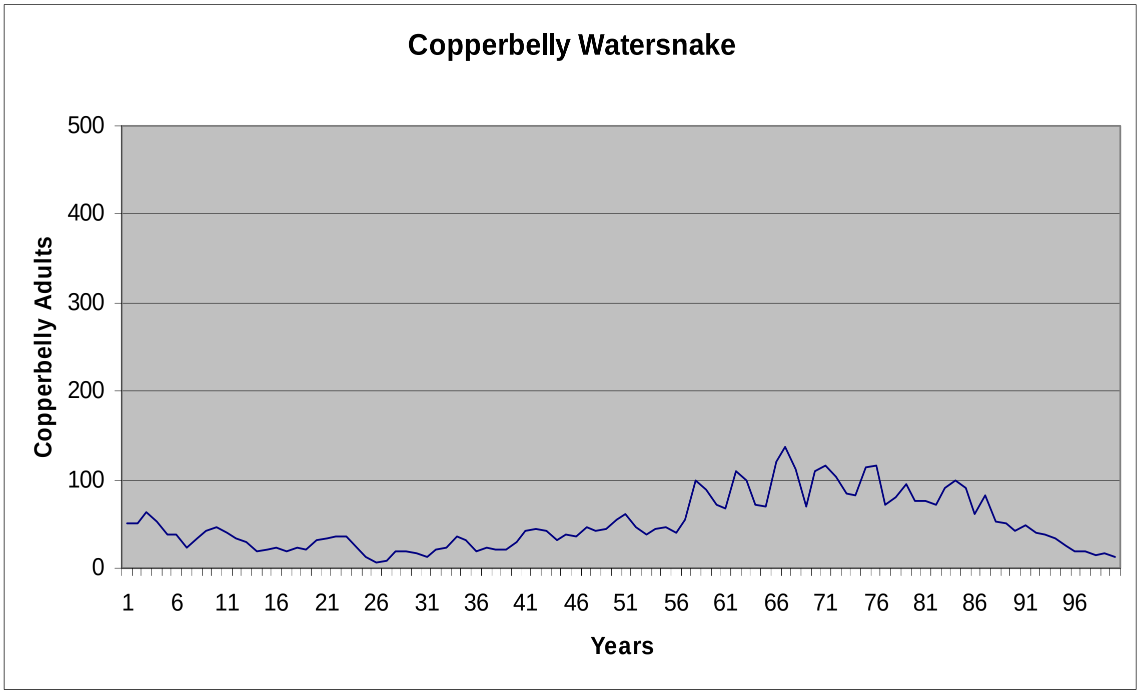

Figure 2. Stochastic Demographic Population Model