



United States Department of Agriculture
Natural Resources Conservation Service

CEAP Conservation Insight

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Ecological Monitoring Insights from the Wetlands Reserve Program in Missouri

Summary Findings

- Ecological monitoring data from wetlands enrolled in WRP in Missouri clearly show land-cover changes associated with wetland restoration, with major shifts from open crop fields to forested wetlands through time.
- Habitat quality (represented by Habitat Suitability Index values) for select wetland wildlife species has improved due to restoration.
- For non-forest species (e.g., least bittern) habitat quality is better in the early (herbaceous) years following restoration than in older easements, where forest succeeds open habitat. For forest species, habitat quality is expected to continue to improve as trees mature.
- Due to the variety of wetland types enrolled in WRP in Missouri, ecological monitoring data there illustrate regional ecological and wildlife benefits of WRP.

Recommendation

- Continued ecological monitoring of WRP easements is needed to track the value of habitat and other wetland functions through time to maximize benefits derived from the program.

This assessment was conducted in cooperation with Missouri NRCS, the Missouri Department of Conservation, and the U.S. Geological Survey Cooperative Fish and Wildlife Research Unit at the University of Missouri.

Background

At the beginning of major European settlement (ca. 1780s), the territory of present-day Missouri is estimated to have held slightly more than 4.8 million acres of wetlands, an area equivalent to nearly 11 percent of the state today. The vast majority of these wetlands were associated with the state's great rivers, the Mississippi and Missouri, and their tributaries.

Large-scale wetland losses began in Missouri after the Federal Swamp Act (1850) was enacted. This legislation, while targeting flood control and reclamation for agriculture, resulted in the transfer of Federal lands to the state and ultimately into private hands, and led to massive drainage. Channelization and damming of rivers also contributed to the loss and degradation of the state's wetlands.

By the early 1980s, losses due to agricultural conversions, urban development, and flood-control measures had resulted in a decrease of approximately 87 percent of Missouri's original wetlands to about 643,000 acres, or approximately 1.4 percent of the state's area (Demas and Demcheck 1996).

Wetlands, typically components in a larger hydrologic system, provide significant and influential ecological and socio-economic benefits and services. Wetlands contribute to the amelioration of flooding, groundwater replenishment, sediment and nutrient retention and export, and water purification. Wetlands also afford opportunities for recreation and tourism as well as education and research, and support such economic activities as food, fisheries, and timber production. Many wetlands are reservoirs of biodiversity, providing habitats for birds, fish, and other animals and plants, including threatened and endangered species. Centrally located along the Mississippi Flyway, Missouri's wet-

lands are integral to this important migration corridor for waterfowl and other migratory birds.

Wetlands Reserve Program

The Wetlands Reserve Program (WRP) is a voluntary nationwide program of the U.S. Department of Agriculture (USDA). It offers landowners the opportunity to protect, restore, and enhance wetlands on their property at minimal cost to themselves. WRP restoration and protection of wetlands in agricultural settings allows for environmentally sensitive and, in many cases, marginal cropland to be taken out of cultivation while contributing to the national goal of no net loss of wetlands.

Three conservation options are available to landowners through WRP: Permanent easements (88 percent of Missouri study easements are permanent), 30-year easements, and restoration cost-share agreements. The USDA Natural Resources Conservation Service (NRCS) provides technical and financial support to help landowners restore and maximize wetland and wildlife habitat functions on lands enrolled in the program.

WRP commenced as a pilot program in Missouri in 1992 (along with eight other states). At the end of Fiscal Year 2006, Missouri was among the leading states in number of easements (787 sites) and total area enrolled (115,583 acres). Many Missouri WRP sites are located along tributaries of the Missouri and Mississippi Rivers and in the Bootheel region of the state, the northernmost extent of the Mississippi Alluvial Valley (map 1).

Nationwide, WRP monitoring typically has focused solely on compliance. Easement compliance monitoring is concerned with questions such as these: Are WRP easement boundaries marked? Are the land uses being implemented authorized? Are other easement terms and conditions being met?

Under a pre-existing agreement between NRCS and the Missouri Department of Conservation (MDC), on-site ecological monitoring data were collected on 594 separate WRP easements throughout Missouri during Fiscal Years 2004 through 2006 (map 2). These monitoring data enable assessment of restoration progress, namely allowing evaluation of whether site-specific species targets are being met.

Monitoring provides the feedback necessary to adjust WRP restoration so that it continues to deliver positive responses from wetland fauna and flora. Each monitored site was visited once after restoration was initiated. Field data were collected to determine wetland class and dominant vegetation species and to measure habitat variables associated with wildlife habitat suitability index models described below.

Through an agreement between NRCS and the University of Missouri, funding support from the Conservation Effects Assessment Project (CEAP) facilitated a detailed analysis of WRP ecological monitoring data previously collected. An initial assessment of the effectiveness of wetland restoration, with a view to enhancing future monitoring protocols, was undertaken by the university in cooperation with the NRCS state office in Columbia, Missouri, MDC, and independent experts. Findings of this analysis are presented here.

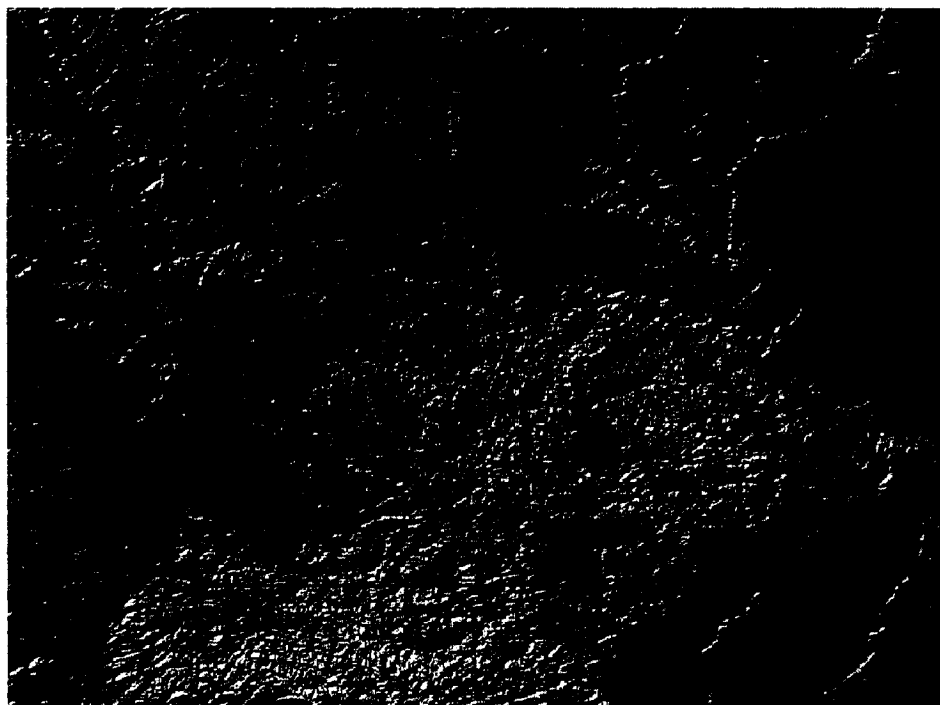
Analysis Dataset

Ecological data were collected in the field using geographic information system (GIS) software on handheld computers, a global positioning system (GPS), and custom electronic data forms to populate GIS attribute tables. Previously digitized easement boundaries, planned wetland habitat type boundaries (polygons), and information on installed practices were used with the mobile GIS and GPS in the field to locate and verify features. Wetland habitat type at the time of monitoring was recorded using a modified Cowardin habitat classification system (Cowardin et al. 1979). Analysis of monitoring data was accomplished using GIS and conventional database methods.

Data analysis focused on easements for which pre-restoration Cowardin wetland classes had been mapped and digitized



Map 1. General locations of WRP easements in Missouri (January 2007).



Map 2. General locations of 594 WRP easements monitored in Missouri during Fiscal Years 2004-06 (in green).

for an earlier project. A spatial intersection was established between the dataset of monitored sites (covering approximately 66,700 acres in 594 conservation easements) and a data layer characterizing pre-restoration land cover. The overlap between these two datasets yielded

the parent database for the study covering approximately 52,200 acres (488 easements). The majority of these sites (88 percent) were permanent easements. Analyses used relevant subsets of the parent database. Records lacking any key data were excluded.

Restoration age for each site was considered to be the time between the “start of restoration” documented in project files and the date of the site visit for monitoring data collection. The oldest restoration age of easements included in the analysis was 12.2 years; the youngest was 2.7 years.

Habitat Succession

Although succession of plant communities on individual sites was not closely tracked through time, observation of land cover conditions among sites of varying post-restoration age can be used as an indicator of how wetland vegetation changes in the years following restoration. Change in land cover or “habitat succession” was examined by contrasting before- with after-restoration conditions. Figure 1 presents an overall breakdown of five land cover classes for the period just before restoration commenced, and at the time the site was monitored. A successional shift from former cropland to natural and semi-natural land covers is evident.

Figure 2 refines the successional analysis by charting restoration progress within two discrete 4-year periods (4.1–8 years and 8.1–12.2 years since restoration began; records falling into a 0.1- to 4-year age interval were not included because the acreage for this age-class was nearly negligible). By the fifth year of restoration, only scant remnants of cropland remained in easement areas. Note that the total acreage in each discrete age-interval varied. Thus the *percentage* of the total acreage that each land-cover class constituted in each age-interval was used to reflect habitat changes. A general shift in vegetation toward forested cover is evident in the older easement age class.

Figure 3 represents the successional fate of the WRP lands that were exclusively cropland at the start of restoration. At the time of easement monitoring, almost all of the lands had succeeded to emergent-herbaceous and forested/wooded land-cover types. The forest/woodland category is a mixture of natural regeneration and tree planting.

Habitat Suitability Indices

Enhancement of wildlife habitat through wetland restoration is a central tenet of the WRP. Successful wetland restoration

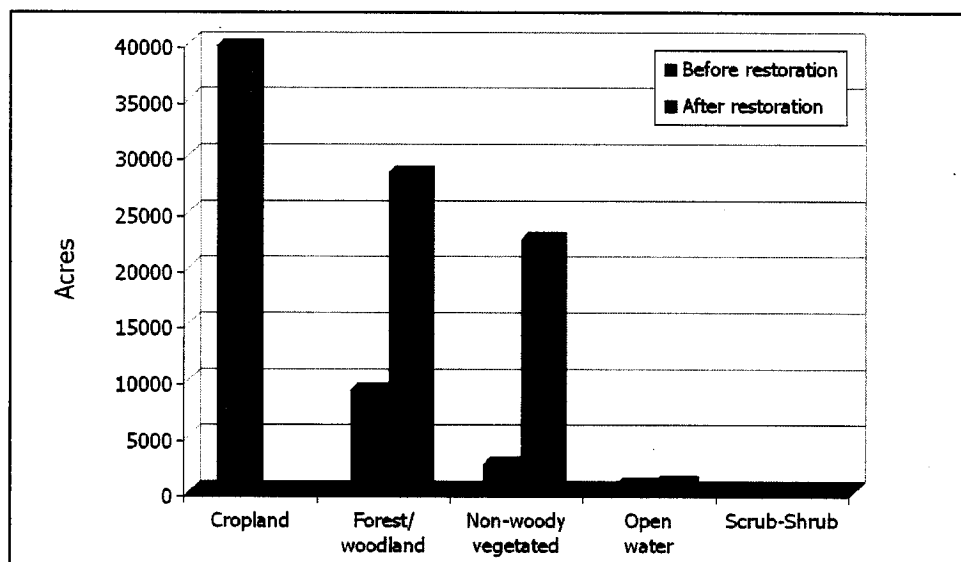


Figure 1. Land-cover status before (light green) and after (dark green) restoration of 52,200 acres of WRP easements in Missouri.

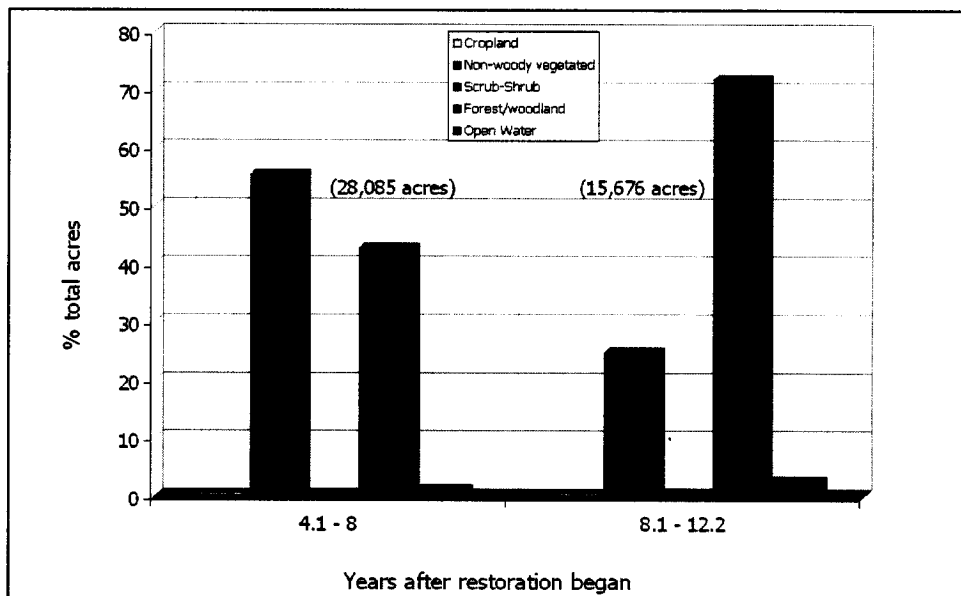


Figure 2. Relative land-cover composition observed in two post-restoration age classes covering nearly 43,800 acres of Missouri WRP easements.

is expected to increase wetland wildlife habitat quality. Collectively, wetlands are one of the most biodiverse ecosystems; thus, restoration from cropland to wetlands results in a more diverse biota when compared to the former, usually monotypic, cropland condition.

In Missouri, wildlife habitat quality on restored WRP sites was assessed through the application of habitat suitability index models for indicator wetland wildlife species. These models are driven by habitat variables measured in the field that are associated with species'

life-history requirements documented in the scientific literature. Habitat variable values measured in the field are combined through the use of algorithms that represent species-specific habitat associations to generate Habitat Suitability Index (HSI) scores for each site. HSI scores range from 0 (unsuitable for the species) to 1.0 (optimum for the species). Whereas some HSI models have been validated by species response data, most rely on published life-history requirements and species experts for their reliability. As a planning tool, HSI scores provide a useful measure of the

potential of the habitat to support particular fish and wildlife species in a study area.

For Missouri WRP sites, three HSI models for species associated with non-forest habitats and three HSI models for species associated with forested habitats were selected to quantify wildlife habitat values. Many wetlands restored in Missouri are expected to succeed to forested cover types; others are planned to remain in open marsh condition. However, initial stages of forested wetland restoration typically provide habitat for species associated with herbaceous vegetation. Models representing both forested and non-forested cover types should generate useful information on habitat quality in both land-cover settings. Species models representing non-forested habitats include mallard, least bittern, and lesser yellowlegs. Species models representing forested habitats were mallard (model developed specifically for bottomland hardwood forested wetlands), wood duck, and prothonotary warbler.

For each model, HSI scores were clustered into value-ranges (0.100, 0.101–0.399, 0.400–0.699 and 0.700–0.999) for analysis. Since on-site HSI data do not exist for sites prior to restoration, pre-restoration HSI values for all species were assigned a value of 0.1. Although most pre-restoration easements provide some habitat value for some species, an HSI value of 0.1 was assumed to reflect the limited wetland wildlife value associated with “unrestored” sites.

Some easement sites contained significant areas of natural vegetation at enrollment. In these instances, the assumed unrestored HSI value of 0.1 for some indicator species could underestimate pre-restoration wildlife habitat value. Thus, analysis of HSI data was limited to those easements where the pre-restoration condition consisted of cropland only. The assigned pre-restoration HSI value of 0.1 for all species models is more defensible for sites consisting entirely of cropland at enrollment than it is on more diverse sites.

Whereas species response varies, post-restoration HSI scores were markedly higher than the pre-restoration score (0.1) for all non-forest models (figure 4) and two of the three forest models (figure 5). The magnitude of the increase in habitat quality was greatest for spe-

cies associated with emergent-herbaceous (non-forest) habitats, which develop faster than forest, and are often an early precursor of forested wetlands. However, 45 percent of acres restored showed no improvement of habitat quality for the lesser yellowlegs, an early successional wetland species that prefers the sparse vegetation characteristic of the earlier stages of restoration. Least bittern, on the other hand, showed the greatest improvement in habitat quality due to its dependence on dense herbaceous vegetation, a condition that increased on most easements as succession proceeded following wetland restoration (figure 4). The mallard, a species associated with both forested and non-forest categories of restored land, depending on the season, showed the least HSI improvement of the species associated with forest (figure 5). However, the forest model for mallard relies on mature bottomland hardwood forest—a habitat that has not had time to develop fully in the majority of study sites. HSIs on restored forested sites exceeded the pre-restoration value to a greater extent in the wood duck and prothonotary warbler models. These data illustrate the diversity of initial habitat quality response among species.

An analysis of HSI data by age categories showed no patterns among age classes examined. Therefore, overall HSI values presented above provide the most useful information at this time. As

wetlands succeed in the future, temporal changes in habitat quality for indicator species are expected to emerge.

Future Direction

This analysis of Missouri WRP ecological data has yielded unique practical experience and insights that, coupled with experiences from the field, provide an opportunity to improve WRP monitoring in Missouri and other states. The data illustrate clear ecological and wildlife benefits of WRP restoration and reveal important contributions to state and national conservation goals.

The analysis has relevance and implications beyond state boundaries, especially for wetlands having similar characteristics in the Lower Mississippi Alluvial Valley and floodplains of the Upper Mississippi River Basin. Continued ecological monitoring of WRP easements is needed to track value of habitat and other wetland functions through time to provide feedback that will maximize benefits derived from the program, and to guide future easement selection and restoration strategies.

Ecological data also have been collected outside of this project on a variety of non-WRP wetland restoration projects in Missouri. Comparison with other relevant datasets has the potential to help document the effects of WRP and other wetland restoration practices on a variety of wildlife species and habitats.

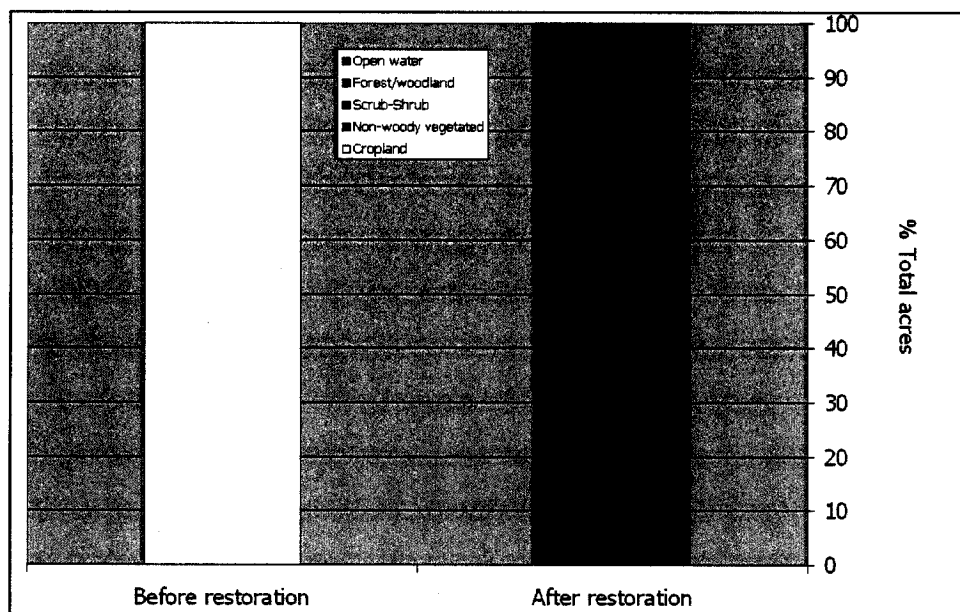


Figure 3. Land-cover before and after wetland restoration on 33,700 acres of former cropland enrolled in WRP in Missouri.

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HSI species selected for the Missouri WRP easement analysis

The adaptable mallard (*Anas platyrhynchos*), the world's most abundant duck, is the most important waterfowl game species in North America.

The wood duck (*Aix sponsa*) is the most numerous North American cavity-nesting duck and is the region's second-most-important waterfowl game species.

The prothonotary warbler (*Protonotaria citrea*), a striking bright-yellow migratory songbird, is also a cavity-nester that favors wooded areas near water, especially flooded bottomland hardwood forests, cypress swamps, and wooded margins along large bodies of water.

Lesser yellowlegs (*Tringa flavipes*), once an important migratory game species that is now fully protected, is a shorebird that utilizes non-forested wetlands with mudflats interspersed with shallow water and where vegetation is absent or sparse.

Least bittern (*Ixobrychus exilis*) is the smallest heron, an inconspicuous state-listed "vulnerable" species found in wetlands with dense emergent vegetation interspersed with open water (Sources: Poole 2005; Missouri Department of Conservation 2007).

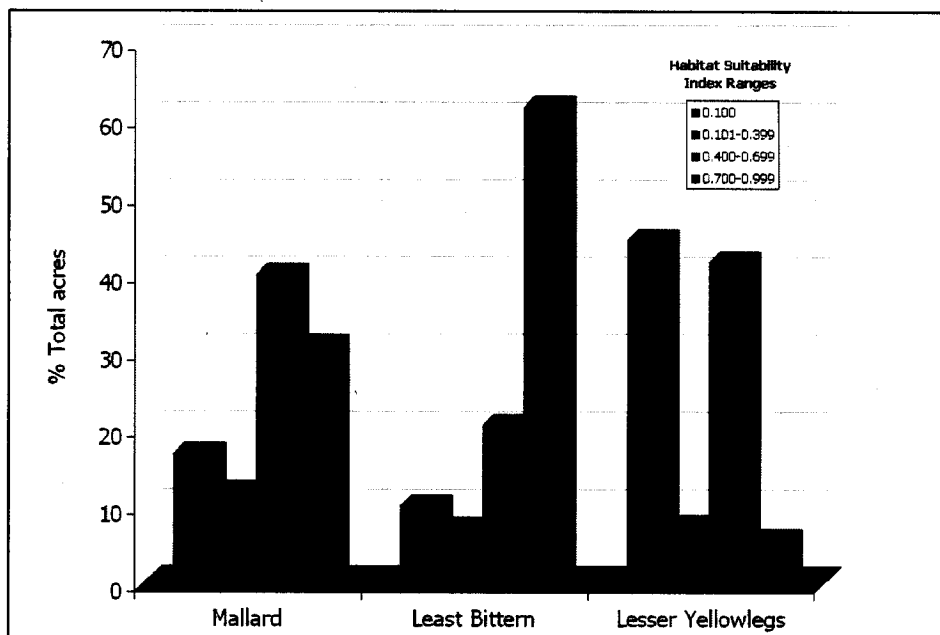


Figure 4. Habitat Suitability Index (HSI) value ranges recorded for species associated with non-forest habitats following wetland restoration on 17,200 acres of former cropland enrolled in the Wetlands Reserve Program in Missouri.

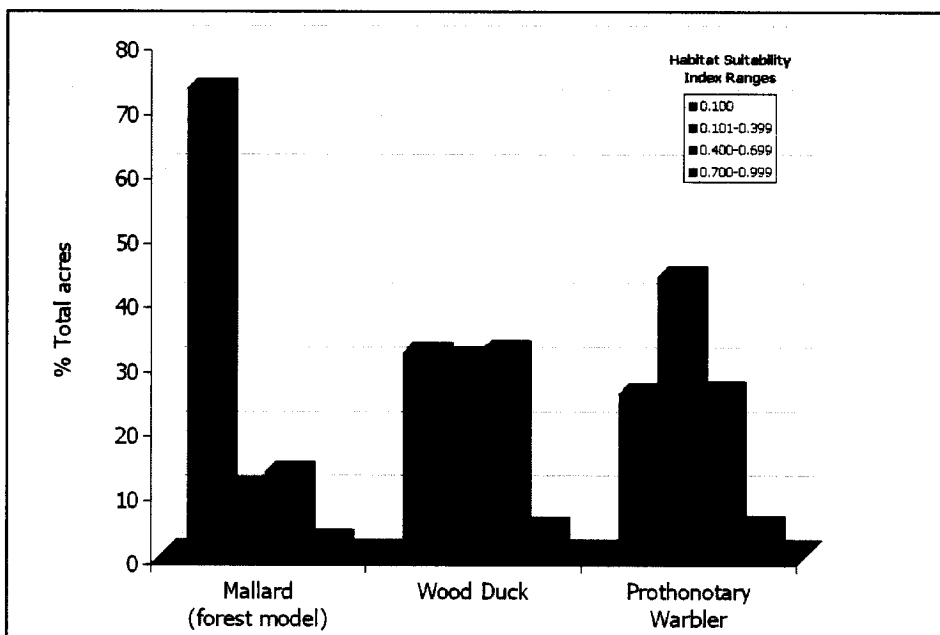


Figure 5. Habitat Suitability Index (HSI) value ranges recorded for species associated with forest habitats following wetland restoration on 15,900 acres of former cropland enrolled in the Wetlands Reserve Program in Missouri.

The Conservation Effects Assessment Project: Building the Science Base

The Conservation Effects Assessment Project (CEAP) is a multi-agency effort to build the science base for conservation. Project findings will help to guide USDA conservation policy and program development and help farmers and ranchers make informed conservation choices.

One of CEAP's objectives is to quantify the environmental benefits of conserva-

tion practices for reporting at the national and regional levels. Because fish and wildlife are affected by conservation actions taken on a variety of landscapes, the wildlife national assessment draws on and complements the national assessments for cropland, wetlands, and grazing lands. The wildlife national assessment works through numerous partnerships to capitalize on relevant studies already underway, and it focuses on regional scientific priorities.

This effort to analyze WRP ecological monitoring data from Missouri, funded

by the CEAP wildlife component, is an important contribution to building the science base for understanding and quantifying how conservation practices, particularly wetland restoration, affect wildlife habitats on agricultural landscapes.

Primary investigators on this project were Scott Frazier and David Galat of the University of Missouri.

For more information:
www.nrcs.usda.gov/technical/NRI/ceap/