United States Department of Agriculture
Natural Resources Conservation Service

CEAP Science Note

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Using NatureServe Information to Assess Conservation Practice Effects on At-Risk Species

Summary Findings

NatureServe conducted a pilot project to determine if existing datasets could be used to assess effects of conservation practices on at-risk species.

- Natural Heritage species-occurrence data and geospatial models for predicting species distribution hold promise for assessing the effects of conservation practices on at-risk species.
- Lack of comprehensive geospatial digital data on conservation practice application hinders quantification of practice effects on wildlife.
- If Missouri pilot project data can be shown to apply to practice-to-species relationships nationwide, 89 percent of conservation practices nationwide have positive, neutral, or mixed effects on most terrestrial wildlife and 79 percent have expected positive or neutral effects on most aquatic biota.

Background

Conservation practices and programs are increasing focus on addressing the needs of declining and at-risk fish and wildlife species. Many of these species, especially those listed as “threatened” or “endangered,” have severely restricted ranges. The habitat requirements and rarity of occurrence of these species present special challenges in quantifying how and where conservation practices affect them. To explore the opportunities to address these challenges, NRCS engaged NatureServe to conduct a pilot project in Missouri.

NatureServe conducted this pilot project to develop and evaluate methods for assessing benefits of conservation practices to at-risk fish and wildlife species and habitats. The primary objective was to use NatureServe data and other data sources to demonstrate processes for documenting the effect of implemented conservation practices on at-risk species. A secondary objective was to look for ways to inform future conservation program enrollment decisions. The work was carried out in cooperation with Missouri NRCS, the Missouri Resource Assessment Partnership at the University of Missouri, and the Missouri Department of Conservation. This Science Note is drawn from NatureServe’s final project report, available at www.nrcs.usda.gov/technical/nri/ceap/.

Geospatial Analysis

The Spring River Watershed in southwest Missouri (Hydrologic Unit Code 11070207) was chosen to explore spatial correlations of known conservation practice applications with the locations of at-risk wildlife species and habitats. Four datasets were used to examine different representations of terrestrial species occurrence:

- Missouri Natural Heritage Program occurrence records (most precise).
- NRCS modified heritage occurrence buffers, which were Missouri Natural Heritage Program records expanded to include the area within set distances from record locations. Distance from heritage program records varied by species in accordance with life history and mobility characteristics.
- USDI Gap Analysis Program (GAP) species distribution models (least precise).
- Missouri NRCS modified heritage occurrence data intersected with GAP species distribution models.

Spatial data on conservation practice locations consisted of digitized common land units (CLUs) containing conservation practices applied from 2002 to 2005. Though many more practices have been applied in Missouri agricultural landscapes, data from these four years were all that were available for spatial analysis.

The Conservation Effects Assessment Project: Building the Science Base

The Conservation Effects Assessment Project (CEAP) is a multi-agency effort to scientifically quantify the environmental benefits of conservation practices used by private landowners. 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 conservation 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 NatureServe pilot, funded by the CEAP wildlife component, is an important contribution to building the science base for understanding and quantifying how conservation practices affect fish and wildlife on agricultural landscapes.

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

For this study, 8 terrestrial and 10 aquatic species of conservation concern in Missouri were selected for analysis (table 1).

Investigators focused the geospatial analysis on the dominant conservation practice digitized in the Spring River watershed—pasture and hay planting (practice code 512). Digitized practice data for 2002–2005 reveal that this practice was applied in CLUs consisting of 24,203 acres in the Spring River watershed. Other digitized practices comprised a relatively small total area of the watershed, rendering them irrelevant for assessment purposes. Pasture and hay planting in Missouri is applied in two ways, one using introduced grasses (512a) and one using native grasses and forbs (512b). Terrestrial species are likely to respond differently to these two practice applications (table 2). However, the digital data layer does not consistently distinguish between these two "sub-practices."

For very rare species, Natural Heritage Program occurrence records likely provide the highest confidence in reflecting where these species are likely to be found, largely due to extensive survey work conducted in suitable environments. For more common at-risk species, heritage records are less likely to reflect the full extent of occurrence due to the large extent of unsurveyed area (i.e., the absence of occurrence records does not mean absence of the species). Therefore, for some species, overlaying practices with heritage records alone would result in significant underestimation of the effects of conservation practices. At the other extreme, use of the more generalized GAP predicted distributions would likely result in overestimating conservation effects on many types of wildlife. Large portions of these generalized mapped distributions would be somewhat unlikely to support those individual at-risk species.

Terrestrial species. A matrix of expected effects of common conservation

About NatureServe—NatureServe partners with a nationwide network of state natural heritage programs as a leading source for reliable conservation-relevant biodiversity information. It informs land use planning by collaborating with a diverse user community including public agencies, tribes, landowners, universities, natural history museums, private industry, other non-profit organizations, and the general public. NatureServe has implemented a vulnerability ranking system for identifying at-risk species and ecological communities. Standard conservation status ranks (below) have been applied to most plant and animal species in the United States.

NatureServe conservation status ranks.

Spatial context	Vulnerability context
G = Global N = National S = Subnational (State/Provincial)	1 = Critically imperiled 2 = Imperiled 3 = Vulnerable to extirpation or extinction 4 = Apparently secure 5 = Demonstrably widespread, abundant, and secure.
For example, G1 would indicate a species that is critically imperiled across its entire range (i.e., globally). In this sense the species as a whole is regarded as being at very high risk of extinction. A rank of S3 would indicate the species is vulnerable and at moderate risk within a particular state or province, even though it may be more secure elsewhere.	

Table 1. Species selected for geospatial analysis in the Spring River Watershed, Missouri.

Bat	**Mammal other than bat**	**Bird**
Gray bat	Black-tailed jackrabbit	Northern bobwhite Northern harrier
Amphibian	**Insect**	**Plant**
Northern crawfish frog	Prairie mole cricket	Mead's milkweed Barbara's buttons
Fish	**Mussel**	**Crayfish**
Bigeye shiner Blackstripe topminnow Brindled madtom Ozark cavefish	Fatmucket Paper pondshell Slippershell Neosha mucket	Prairie crayfish Virile crayfish

Table 2. Terrestrial species/practice matrix developed for the Spring River Watershed.

Species	**NRCS Practice (Code)**							
	Prescribed Grazing		**Pasture/Hay Planting**		**Upl. Wildl. Habitat Mgmt. (645)**	**Nutrient Mgmt. (590)**	**Pond (378)**	**Mulch Till (345)**
	(528a)	**(528b)**	**(512a)**	**(512b)**				
Gray bat	Neut	Neut	Neut	Neut	Neut	Pos	Pos	Neut
Black-tailed jackrabbit	Pos	Pos	Neg	Pos	Pos	Neut	Neut	Neut
Barbara's buttons	NA	Pos	Neg	Neut	Pos	Neut	NA	NA
Mead's milkweed	NA	Pos	Neg	Neut	Pos	Neut	NA	NA
Northern bobwhite	Pos	Pos	Neg	Pos	pos	Neut	Neut	NA
Northern harrier	Neut	Neut	Neg	Pos	Pos	Neut	Neut	Neut
Northern crawfish frog	Neut	Neut	Neg	Pos	Pos	Pos	Neg	NA
Prairie mole cricket	NA	Pos	Neg	Pos	Pos	Neut	NA	NA

528a - applied to a continuous grazed fescue/clover pasture; **528b** - applied to a continuous grazed remnant prairie; **512a** - dominated by Bermuda grass or fescue; **512b** - mixture of native grasses and forbs; **645** - woody cover control on a grassland; **590** - waste spreading on grassland; **378** - suitable for fish stocking and will not destroy a natural plant community.

practices on the selected terrestrial species was developed by subject area experts in Missouri (table 2). This matrix was used as the basis for predicting where overlap of spatial practice data with species occurrence data is associated with positive, neutral, or negative effects on at-risk species.

Table 3 presents the total acreage of CLUs containing the pasture and hay planting practice for four select terrestrial species in the Spring River watershed by species occurrence dataset. This table demonstrates the varying precision and results across these datasets. The Natural Heritage Program records—based on recorded field observations—did not overlap with any CLUs containing digitized pasture and hay planting practices. On the other extreme, GAP predicted distributions—the most generalized data source—associated occurrence of gray bat, northern harrier, and crawfish frog with nearly all of the 24,203 acres of pasture and hay planting CLUs in the watershed. The effects of pasture and hay planting on these specific terrestrial species, however, regardless of the data set used, is difficult to predict since the digital data layer does not consistently distinguish between 512a (introduced grasses) and 512b (native grasses and forbs).

Aquatic species. For freshwater aquatic species, investigators determined that the only practical way to spatially represent species occurrence is through predicted distribution maps that depict stream segments and lake features where select species are likely to occur. Digitized practice locations were considered to have an effect on these species if they occurred within the "segmentshed" associated with stream reaches expected to contain the species. Segmentsheds encompass adjacent upland areas immediately draining into specific stream reaches or segments.

Practice effects matrices developed for aquatic species were less sensitive to whether pasture and hay planting is applied through use of 512a or 512b (table 4). Conversion of row crop fields to pasture and hay land, regardless of plant materials used, is generally expected to benefit surface water quality, and thus aquatic biota. Spatial analysis of pasture and hay planting CLU polygons intersected with segmentsheds in the Spring River watershed predicted to contain the identified aquatic species provided useful insight. Figure 1 demonstrates how the spatial analysis was conducted using the brindled madtom as an example. While the effects on this species are

The USGS **GAP Analysis Program** provides information on species and plant communities that are not adequately represented on existing conservation lands. Predicted species potential distribution maps are developed by application of habitat affinity models created for each species. These maps identify habitats, based on land use and other information, that are likely to support the occurrence of individual species tracked in the GAP system. See http://gapanalysis.nbii.gov for additional information.

Table 3. Total acreage of CLUs containing the pasture and hay planting practice in the Spring River watershed that intersect select terrestrial species distributions using several different species occurrence datasets.

	Species occurrence data source			
Species	**Natural Heritage occurrence records**	**Expanded heritage records that include species-specific buffers**	**GAP predicted distribution overlap with expanded heritage records**	**GAP predicted distribution**
Gray bat	0	13,004	13,004	23,385
Black-tailed jackrabbit	0	1,264	599	12,962
Northern harrier	0	809	809	23,285
Northern crawfish frog	0	42	42	22,433

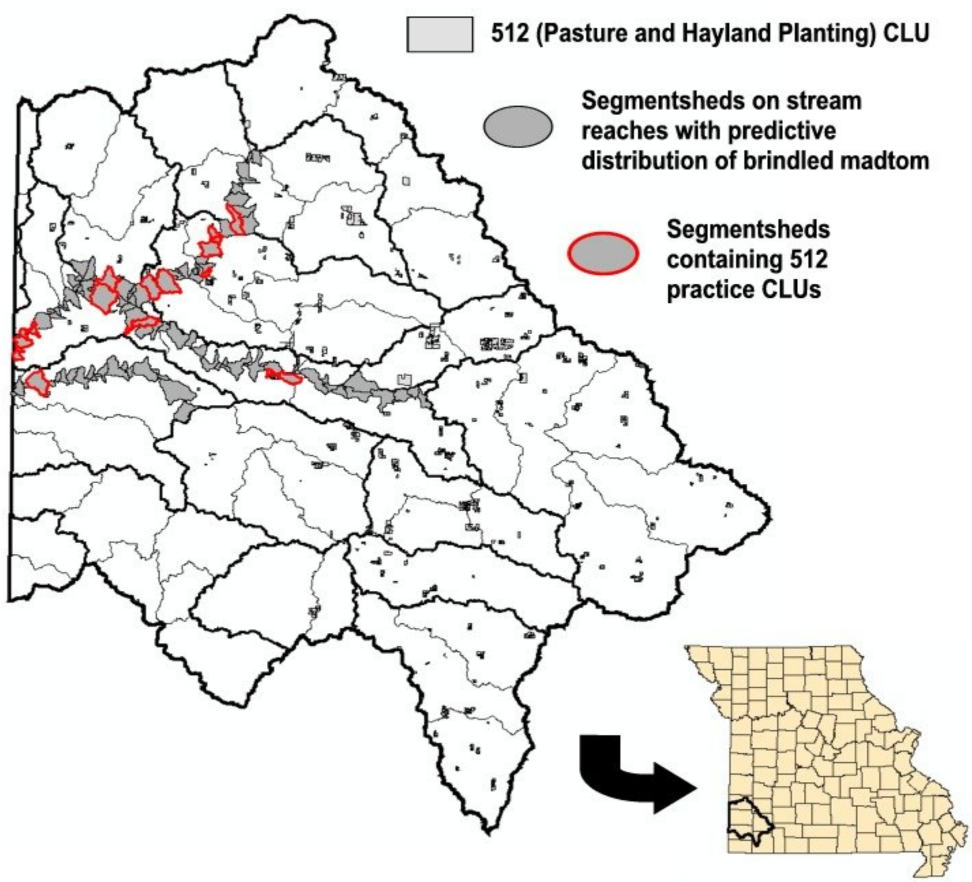

Figure 1. Spatial overlays of segmentsheds containing the Aquatic GAP predicted distribution of the brindled madtom and Practice 512 digitized common land units. The brindled madtom is expected to be benefited by Practice 512 in segmentsheds delineated in red.

somewhat limited because of its restricted range in the watershed (only 8 percent of its distribution was affected by practice 512—table 4), it provides a useful illustration of how the analysis was conducted.

Other aquatic species are expected to be benefited by pasture and hay planting in the Spring River watershed to a greater degree (Table 4). For example, 31 percent of the fatmucket mussel's distribution was affected positively by pasture and hay planting, and 98 percent of all 512 practices applied in the watershed from 2002 to 2005 had a predicted positive effect on this species.

Given the variability in species occurrence data, investigators suggest using knowledge of relative abundance of at-risk species to guide selection of the appropriate spatial dataset to represent their distribution. These suggested guidelines are provided in table 5.

Table 4. Summary of results from overlays of the pasture and hay planting (code 512) practice applied in the Spring River Watershed on freshwater aquatic species, 2002-2005.

Species	Stream length (km) w/in species distribution affected by applied 512 practices[1]	% of species distribution in Spring River watershed affected by Practice 512	% of Practice 512 in the Spring River watershed that affects subject species	Practice specifications	
				512a - Bermuda grass or fescue	512b - native grasses and forbs
Bigeye shiner	22.7	31	17	Pos	Pos
Blackstripe topminnow	36.5	31	28	Pos	Pos
Brindled madtom	4.9	8	4	Pos	Pos
Fatmucket	123.7	31	98	Pos	Pos
Paper pondshell	55.3	35	43	Pos	Pos
Slippershell	24.3	30	15	Pos	Pos
Virile Crayfish	110.5	31	90	Pos	Pos

[1] Sum of the lengths of streams within segmentsheds containing digitized 512 practices that are also within the predicted distribution of the subject species

Table 5. Recommended scale for analysis of practice effects on various rare or at-risk fish and wildlife species.

Species characteristics	Occurrence data for use in analysis
Very rare (< 20 occurrences/ state; G1G2 rank) terrestrial species with small home range size	Natural Heritage Program occurrence records
At-risk (G3G5;S1S3) plants and terrestrial species with small home range	Species-specific set distances from Natural Heritage Program occurrence records
At-risk (G3;S1S3) species with larger home range size	Species-specific set distances from Natural Heritage Program occurrence records intersected with predicted distribution models (e.g.,
Common (G4G5) terrestrial species with large home range size	Predicted distribution models
At-risk freshwater aquatic species	Predicted distribution models that indicate where a given species is likely to occur (e.g.,

Species-Practice Matrix Analysis

Investigators developed approaches to assign impacts (positive, negative or neutral) of the full suite of conservation practices on at-risk wildlife species and habitats in Missouri. One-to-one evaluation of the expected response of each species to each conservation practice was not practical. Species were grouped based on similarity in expected response to practices (table 6). Practices expected to have similar impacts on aquatic species were also grouped. Expert knowledge was used to develop a matrix that identified whether each practice or practice group would likely have a positive, negative or neutral impact on each species group.

Many ambiguities are associated with assigning expected effects of individual practices (positive, negative, or neutral) on fish and wildlife species groups. Practice type, as well as specifics of how each practice is installed and maintained, greatly influences how different species respond. However, generalities can be made based on the typical practice characteristics and most likely effects.

Most practices have either a neutral or positive expected effect on most fish and wildlife, whereas some are predicted to negatively impact some groups (Table 7). Some practices may benefit some terrestrial species within a group and be detrimental to other species in that same group. If the species groupings developed (table 6) are determined to be applicable beyond Missouri, as well as the practice-to-species relationships developed, the implication is that 89 percent of conservation practices applied regionally or nationally are predicted to have positive, neutral or mixed effects on most terrestrial wildlife and 79 percent have expected positive or neutral effects on most aquatic biota (Table 7). Documentation of frequently-applied practices, analysis, and peer review outside Missouri is needed to explore regional and/or nationwide applicability of these findings.

Many of the conservation practices evaluated are designed to improve surface water quality, thus more practices are predicted to positively affect aquatic species than terrestrial species. Conversely, many water quality practices have little influence on many terrestrial groups; over half of the practices were assigned neutral effects on terrestrial species groups.

Lessons Learned

Results from this pilot indicate that conservation effects assessments could be conducted at several consistent spatial scales, including watershed, state, regional, and national scales. Standard methods can be developed (albeit within certain data limitations) to evaluate impacts of past and current applications of conservation practices.

This Missouri pilot project revealed methods for predicting whether/how certain practices affect at-risk species. However, greater effort is needed to develop procedures for quantifying the extent of practice effects beyond simple designations of positive, neutral, and negative effect.

A primary constraint in predicting the effects of applied practices on at-risk species is the lack of digital data on where practices have been applied on the landscape. Even with extra effort made in Missouri to digitize applied practices (45 staff years were expended to digitize practices applied in 2002–2005), coverage is still limited to practices applied in recent years. Other states are likely to have less digital coverage of practice application history.

The size of typical CLUs in Missouri is approximately 10 acres. Digital practices are assumed to apply to this entire area, yet some practices may apply to only a part of this area. In states with considerably larger CLU size, this may decrease the ability to tie specific practices to spatially restrictive at-risk species effects.

Type of vegetation established within individual practices greatly influences the expected effect on a particular species. For example, the pasture and hay planting practice that uses Bermuda grass and fescue monocultures (512a) is expected to negatively affect more terrestrial species examined than the use of native grasses and forbs (512b) (table 2). However, spatial practice data offers little insight on how practices were applied beyond basic practice standards.

At-risk aquatic species occurrence predictors are less variable than terrestrial distribution maps by virtue of their focus on streams and other aquatic habitats. Assessment of practices applied in segmentsheds associated with aquatic species distribution models may be more reliable than a terrestrial species focus.

Table 6. Species groups used for analysis of practice effects on at-risk species.

Terrestrial Groups (n=13)	Aquatic Groups (n=22)
Terrestrial plethodontid salamanders	Mussel/gravel
Terrestrial amphibians with aquatic larvae	Mussel/mud
Completely aquatic riverine or spring-dwelling amphibians	Crayfish/burrower
Wetland birds (marsh, swamp, riparian)	Crayfish/semiburrower/lotic
Water birds (ponds, lakes, rivers)	Crayfish/semiburrower/lentic
Upland forest/shrubland birds	Crayfish/nonburrowing/lotic
Upland grassland birds	Crayfish/nonburrowing/lentic
Upland reptiles	Crayfish/Troglogbitic
Aquatic/wetland reptiles	Crayfish/headwater
Bats	Crayfish/midsize
Aquatic/wetland mammals (e.g., otter, raccoon, muskrat)	Crayfish/large
Upland forest/shrubland mammals	Fish/grazer
Upland grassland mammals (e.g., voles, ground squirrels)	Fish/benthic insectivore
	Fish/piscivore
	Fish/omnivore/pelagic
	Fish/omnivore/surface
	Fish/lithophil/no care
	Fish/lithophil/care
	Fish/pelagophil
	Fish/phytophil
	Fish/speleophil
	Fish/floodplain

Table 7. Percent of practices with expected effect on species groups.

Species group	Pos	Neut	Neg	Mix
Terrestrial[1] (n=13)	21	54	11	14
Aquatic[2] (n=22)	39	40	21	-

[1] 163 practices evaluated [2] 49 practice groups evaluated

Recommendations

The following recommendations are suggested for future analyses using the approach developed through this Missouri pilot effort.

- Species-practice matrices should be refined and regionalized to accurately fit the scale of future analyses.
- It is absolutely essential to have more comprehensive geospatial data on where conservation practices have been applied on the landscape—both in terms of practice type and how practices are applied (e.g., plant materials used, specifications, management regimes, etc.). Efforts to populate the geographic practice implementation data layer through use of the current version of the NRCS Customer Service Toolkit may help fill this need in the future. Where feasible, other land use data may be useful as a surrogate for/or in addition to a geospatial conservation practice data layer.
- Whereas efforts are being made to improve predicted species distribution models, much work is needed to more precisely characterize and map habitat components for wildlife species within their predicted range so that we may assess practice effects with higher confidence.