FINAL REPORT

INVASIVE SPECIES COVER AND WILDLIFE USE AT COMPENSATORY MITIGATION SITES

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Executive Summary

This Invasive Species Cover and Wildlife Use at Compensatory Mitigation Sites study (study) was sponsored by the Federal Highway Administration (FHWA) to evaluate compliance with invasive species performance standards at state Department of Transportation (DOT) wetland mitigation sites. Many state DOTs have had such standards recently applied to their projects by local U.S. Army Corps of Engineers (Corps) districts or state permitting agencies. Performance standards applied to state DOT mitigation projects range from specific areal cover thresholds (e.g., 10% or less) to general directives (e.g., "invasive species shall not dominate the site"). A survey of successful state DOT wetland mitigation initiatives (Federal Highway Administration 2005) revealed concerns about the difficulty of complying with these invasive species performance standards and prompted further research.

This study compares invasive species cover and wildlife use at eight DOT mitigation sites and eight corresponding reference sites. The costs and impacts of compliance with these performance standards on state DOT programs as a whole were evaluated. Study methods included identifying suitable mitigation and reference sites, performing fieldwork to assess invasive species cover and wildlife use at the sites, and surveying state DOT personnel. Mitigation sites and undisturbed, natural wetland reference sites were selected and paired for study. Invasive species cover and wildlife use were documented at the paired sites. Field data were compared to performance standards developed specifically for the mitigation site and to a typical 10% areal cover threshold, which is the most common areal cover threshold identified by these state DOTs. Wildlife surveys were performed as a cursory assessment of whether DOT mitigation projects provided comparable habitat to the reference sites.

Field results indicated that a comparable number of mitigation sites (five) and reference sites (four) exceeded the 10% areal cover threshold. Wildlife observations at the paired sites were also comparable. Field data were collected to assess each site's overall condition and to determine whether a performance standard was likely to have been met. Sample size and sampling precision were not assessed. Survey results showed that all eight state DOTs implemented strategies to meet invasive species performance standards throughout project implementation, from site selection through construction and maintenance. Site selection was identified as the most important factor in minimizing invasive species cover, and the potential to achieve invasive species cover thresholds that would comply with performance standards. Low areal cover of invasive species was determined to be unachievable on some sites, particularly in watersheds where invasive species are widespread. Invasive species are most common in watersheds that have been altered for agriculture or residential development, where capacity-increasing DOT projects tend to occur.

The studies performed at the eight paired sites resulted in 66% of the mitigation sites and 50% of the reference sites not meeting the areal cover performance standard. The DOT personnel survey results also disclosed that invasive species performance standards affect state DOT mitigation site selection, likely extending project timelines and potentially adding cost. One state DOT respondent expressed concern that good restoration opportunities are lost when invasive species-dominated sites are avoided as mitigation projects, noting that highly degraded sites provide the greatest opportunity to increase wetland function. Survey respondents indicated that compliance with invasive species performance standards requires the expenditure of significant resources, both time and direct costs. Wildlife survey results were similar between mitigation sites and their

corresponding reference site, indicating the mitigation projects were generally successful in providing habitat to wildlife species.

Future study could develop more achievable and meaningful performance standards based on scientific information. Suggested topics include evaluating accepted functions assessment methods to estimate invasive species effects on wetland function as a foundation for appropriate invasive species standards, estimating areal cover of invasive species in the impact areas for proposed state DOT improvement projects to match mitigation performance standards to conditions of impact sites, considering factors such as landscape position and natural reference wetlands in determining appropriate standards, and evaluating alternative permitting mechanisms (e.g., programmatic agreements) for controlling invasive species.

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Acronyms and Abbreviations

BSWR	Board of Soil and Water Resources
Corps	U.S. Army Corps of Engineers
DOT	Department of Transportation
DSL	Department of State Lands
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
HGM	hydrogeomorphic
HUC	hydrologic unit code
I-5	Interstate 5
I-90	Interstate 90
LGU	local government unit
M-45	Michigan Highway 45
MDEQ	Michigan Department of Environmental Quality
MDOT	Michigan Department of Transportation
MDT	Montana Department of Transportation
Mn/DOT	Minnesota Department of Transportation
NHDOT	New Hampshire Department of Transportation
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
ODOT	Oregon Department of Transportation
study	Invasive Species Cover and Wildlife Use at Compensatory Mitigation Sites study
USFWS	U.S. Fish and Wildlife Service
VDEQ	Virginia Department of Environmental Quality
VDOT	Virginia Department of Transportation
WMA	wildlife management area
WPA	Waterfowl Production Area
WSDOT	Washington State Department of Transportation

Introduction

The Federal Highway Administration (FHWA) funds research evaluating policy and technical issues related to wetland mitigation for FHWA-funded transportation projects. One such issue is the expanding practice of applying invasive species performance standards to mitigation projects. Many state Departments of Transportation (DOTs) have such standards applied to their projects by local U.S. Army Corps of Engineers (Corps) districts or state permitting agencies. These performance standards range from specific areal cover thresholds (e.g., 10% or less) to general directives (e.g., "invasive species shall not dominate the site"). A survey of successful state DOT wetland mitigation programs (Federal Highway Administration 2005) revealed concerns about the difficulty of complying with these invasive species performance standards. In response, the FHWA funded this Invasive Species Cover and Wildlife Use at Compensatory Mitigation Sites study (study) to evaluate the viability of invasive species performance standards at state DOT wetland mitigation sites.

The Corps and state wetland permitting agencies require performance standards or permit conditions for DOT-sponsored mitigation projects. Invasive species performance standards are often applied to all mitigation projects in some states, regardless of location or site condition, and areal cover thresholds for invasive species that are often low. For the purpose of this study, eight DOT mitigation projects are compared to naturally occurring, high quality reference sites from the northeast, southeast, Rocky Mountain region, and western United States. In addition, the affects of complying with invasive species performance standards on the overall mitigation program are qualitatively assessed in a survey of state DOT personnel.

This study includes multiple steps, each of which provides insight into the scope and impact of complying with invasive species performance standards. The primary steps are listed below.

- Identify states where invasive species performance standards are routinely applied to state DOT mitigation projects.
- Locate mitigation sites that met the criteria for study as described in the Methods section.
- Collect field data comparing wildlife use and invasive species cover at the mitigation and reference sites.
- Survey state DOT personnel to understand site history and program-wide practices to comply with invasive species performance standards.
- Summarize the results of each step in a final report.

Methods

The methods for this study were developed by the project consultants and a project technical committee composed of FHWA Headquarters and Division Staff. Methods included identifying paired sites, developing and applying field sampling methods, gathering information on the paired sites and overall programs of the state DOTs, and interpreting the results. At each step, the consultants and FHWA technical staff considered the data or information to be collected, and collectively decided how best to proceed with the subsequent tasks.

This report presents information gathered from state DOT and Corps transportation liaison staff via telephone and email, field data collected at the paired sites, and survey results from a standardized questionnaire collected from state DOT personnel. Field data were collected by experienced biologists with extensive experience in monitoring methods and sampling design, and are presented using simple descriptive statistics.

Site Selection

The goal of site selection was to identify eight paired sites distributed across differing physiographic regions of the United States, including the northeast, southeast, Rocky Mountain region, and western United States.

The paired sites were selected to meet the following criteria:

- **Mitigation site ownership.** Mitigation sites are state DOT-owned, single-user mitigation banks, consolidated mitigation sites (multiple DOT projects mitigated at a single site), or concurrent mitigation sites (a single DOT project mitigated at one mitigation site).
- **Mitigation and reference site representation.** Mitigation and reference sites are representative of the physiographic region and do not represent a rare wetland type or uncommon mitigation practice.
- **Mitigation and reference site correlation.** Mitigation and reference sites are within the same 8-digit hydrologic unit code (HUC) with preference for similar elevations and watershed position, share the same hydrologic regimes and Cowardin classes (Cowardin et al. 1979), have similar surrounding land use, with mature vegetation communities (scrub-shrub and emergent mitigation sites are at least 5 years old; forested mitigation sites are at least 10 years old). All reference sites are identified as high quality and relatively undisturbed in the context of their watershed by state DOT personnel, Corps liaison staff, or local permitting agency staff.
- **Application of performance standards.** Mitigation sites in these states are subject to local Corps district or state agency application of invasive species performance standards.

State DOT or Corps transportation liaison staff members of 45 states were contacted via telephone and/or email to identify potential study sites. For each contacted state, appropriate personnel were identified from agency websites and verified by telephone and email. These individuals were interviewed to identify potential study sites. For states where the Corps or state DOT personnel did not respond, two attempts each via telephone and email were made before the state was determined unresponsive. In many instances, it was necessary to contact several individuals to identify the appropriate staff who could provide mitigation information. Data provided by state DOT and Corps

personnel were recorded in a spreadsheet to ensure that consistent data were collected from each state and to allow data to be queried by site attribute.

Background data collected for potential mitigation sites included size, location, year constructed, Corps permit number, hydrogeomorphic (HGM) classes, Cowardin classes, target invasive species, invasive species performance standards, invasive species control efforts, and any reference sites that may have been identified as part of the construction planning and permitting process.

The study team also performed an internet and electronic library search for similar studies that could provide additional information. The search focused on wetland mitigation projects or evaluations of invasive species control plans.

Fieldwork and Data Collection

Fieldwork occurred during between June 1 and July 31, 2009, beginning with sites with the earliest growing season to provide good conditions for bird breeding observations and vegetation identification. Fieldwork was performed by two or more biologists with backgrounds in botany and wildlife surveys as well as mitigation monitoring. Field staff and project managers coordinated closely to ensure that data collection was consistent. Standardized data sheets were used for quantitative monitoring (wildlife counts and invasive species). A site characterization form was developed to coordinate consistent data collection for vegetation communities, hydrologic conditions, and surrounding land uses at mitigation and reference sites. Mitigation plans, permits, and monitoring reports provided by state DOTs were reviewed prior to performing fieldwork so that field biologists were familiar with site conditions and site-specific invasive species management practices.

Some reference sites were much larger than the paired mitigation site, and a few parcels were over 1,000 acres. In these circumstances, aerial photographs were used to select an appropriate portion of the parcel that best matched the mitigation sites in hydrologic regime, vegetation communities, and surrounding land use.

Land uses surrounding the mitigation and reference sites were evaluated using aerial photography. Uses were categorized based on development of high intensity (highways, industrial), moderate intensity (residential, agricultural, maintained parks), and low intensity (pasture, open space) uses. Land uses surrounding the mitigation site were categorized to consider how these conditions might affect wildlife use or the presence of invasive species. Potential exposure to invasive species seed sources, noise disturbance, or hydrologic alterations were noted for each paired site.

Successful breeding by wildlife indicates that a site provides functional wildlife habitat that can contribute to the local, regional, and national biodiversity goals. Birds and amphibians are more readily observed than other taxonomic groups and were the focus of wildlife sampling efforts. The presence or sign of other wildlife species were also noted.

Bird Surveys

Bird surveys focused on observing signs of breeding, including the presence of displaying males, mated pairs, nests, eggs, and juveniles. Temporary monitoring transects were established at all paired sites for both bird surveys and invasive species sampling. Bird monitoring points were distributed along, or near, the transects in a similar manner at each site, and a similar number of

points were sampled at all sites. Point sampling occurred between 05:00 and 09:00 a.m. for 2 days at each site. Following the conclusion of each point sampling period, the observer retraced the sampling route, making observations of bird activity and behavior. The site sample sequencing used during the first survey was reversed during the second survey day. The species present, relative abundance of each species, and likelihood of breeding were assessed using a standard, semi-quantitative point count methodology (Ralph et al. 1995). Incidental observations of bird activity were also recorded. Birds having documented associations with wetland habitats are listed in the results section for each studied state; complete lists of birds observed at paired sites are available in Appendix A.

Wildlife Surveys

The survey for other wildlife was strictly qualitative. All species seen or heard during the morning bird point counts and bird observation period were recorded. During the vegetation surveys, all incidental observations of amphibians, reptiles, and mammals were noted; species were identified, and behavior was observed. Amphibian activity is sensitive to weather conditions, the air temperature, sky conditions, and wind speeds. These conditions were noted on data sheets at set intervals throughout the bird and vegetation surveys to provide context for the abundance of amphibians observed at each site.

Invasive Species Sampling

The areal cover of invasive species cover was estimated along the temporary transects established at paired sites using the line intercept sampling method, as described in Measuring and Monitoring Plant Populations (Elzinga et al. 1998). Targeted species were those identified as invasive in the mitigation plan, permit, or monitoring reports, and varied from site to site. When a targeted species was identified along a transect, its intercept length was recorded for each occurrence. The total intercept length was divided by the total transect length to generate cover estimates for each site.

Transects were configured to sample a proportionate area of the vegetation types (Cowardin class) and hydrologic regimes present at both paired sites. The baselines were typically established on a fence or other landmark along the site boundary so that transects would run perpendicular to ecological gradients; transects were oriented to run up or down slopes, or across streams. This transect and baseline configuration minimize the likelihood of sampling bias by exposing each sample (transect line) to the widest potential variability (slope and hydrologic conditions).

The transect spacing, quantity, and length were determined by site size. Sampling was not done in portions of the reference site that appeared anomalous to the rest of the site, such as upland areas or open water ponds, to avoid skewing information. A target of 1,500 feet of transect at each sampled site was established, but some smaller sites accommodated only about 1,200 feet. The application of these methods is described in the results for each site, providing specific number of transects, transect length, and modifications that were made to sampling methods because of logistical considerations such as avoiding anomalous areas.

Data Analysis

Bird point count data were used to generate species lists for each site. Qualitative observations of bird behavior were reviewed and interpreted based on breeding bird atlas data standards

(Smith 1990) to determine the likelihood that the species observed were breeding at the site. Observations of adults carrying food or with dependent fledglings, and active or recently abandoned nests were considered breeding signs. Each species was classified as a wetland obligate, wetland associate, or non-wetland species based on its habitat requirements (Poole 2009) and known habitat at the site. The total number of wetland obligate or associated species, the total number of non-wetland species, and the total number of confirmed breeders was counted for each site. The number of wetland-dependent species and breeders was qualitatively correlated to habitat differences at each site based on each species' known habitat requirements.

Published field guides (Burt and Grossenheider 1976; Conant and Collins 1998) describing known habitat requirements of likely breeders were reviewed to determine which wetland attributes (water regime, flora, vegetation structure, and nutrients) created breeding habitat value at each site and to classify the species as wetland obligates or associates, or non-wetland species.

Vegetation data were analyzed using a spreadsheet program to develop an estimated areal percent cover of invasive species for each site and a percent cover of each invasive species identified by Cowardin vegetation class. The data are intended to compare invasive species cover between paired sites and to compare invasive species cover to performance standard thresholds at mitigation sites. The field sampling design incorporated random and stratified samples, but the standard deviation was not used to determine sample size. However, data were collected by experienced biologists along multiple transects using scientifically approved methods. Estimated areal cover percentages are based on these data. Because statistical tests of data confidence or precision have not been performed, the data should be considered a detailed, calibrated characterization of the invasive species cover rather than a result that meets standardized statistical criteria.

Similar or Related Studies

The study team searched for scientific papers that addressed similar issues such as invasive species performance standards for mitigation sites or comparisons of reference wetlands to compensatory wetland mitigation projects. Abstracts of related studies are provided in Appendix B.

State DOT Survey

A two-page questionnaire was distributed to state DOT personnel to gather information on the paired sites and the state's overall mitigation program. The questionnaire asked for descriptions, opinions, or estimates of invasive species control methods, costs, and effectiveness and the permit compliance ramifications for exceeding invasive species performance standards. The questionnaire form used to survey DOT personnel is provided as Appendix C.

The data include qualitative information collected via conversations and a questionnaire, and quantitative and qualitative field data collected during site visits. These data are not intended to provide empirical evidence to support a hypothesis; rather, they support a comparison of paired sites and a description of the effect invasive species performance standards have on the successful implementation of state DOT mitigation programs. As previously described, the field data were collected using standardized, scientifically approved methods but have not been analyzed for statistical data confidence or precision.

Agency Contact Summary and Document Review

The study team contacted state DOT or Corps transportation liaison staff in 45 states. There was a wide range in the breadth of the mitigation programs as well as interest in this study. Most state DOTs have mitigation monitoring programs that provide compliance monitoring, and most respondents report productive working relationships with permitting agencies. Several state DOTs have robust programs with information available on agency websites, while others described their programs as lagging behind current mitigation policy requirements. Performance standards applied to state DOT projects included quantitative standards for all mitigation projects and qualitative standards (e.g., meeting the criterion that "invasives will not dominate"). Other state DOTs did not respond to emails or phone calls. Project documents, such as mitigation plans, monitoring reports, and permits, were collected for sites that met the site selection criteria.

Two notable trends were identified during site selection:

- **The use of reference sites is rare.** Of all the state DOTs contacted, only the Oregon DOT routinely uses formal reference sites for mitigation site planning or design. The Montana DOT uses reference reaches for stream mitigation and many other state DOTs informally consider natural wetlands near the mitigation projects in their mitigation design. Many state DOTs use preservation as a mitigation practice. Preservation areas were considered acceptable as reference sites for this study as they are typically high-quality wetland areas.
- **The application of invasive species performance standards is expanding.** Sixteen state DOTs reported that either quantitative or qualitative invasive species performance standards were required on mitigation projects as a routine practice. Of these 16 states, three states reported that the Corps had only begun requiring invasive species performance standards within the last 2 to 3 years. Few states reported using performance standards for longer than 10 years. No states reported that invasive species performance standards had been applied to their projects in the past, but were no longer being applied.

The application of invasive species performance standards by the 45 state DOTs consulted is summarized in Table 1.

Table 1. Application of Invasive Species Performance Standards for DOT Mitigation Projects

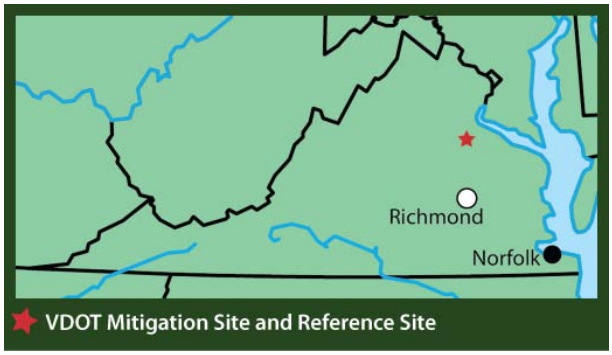
Performance Standard Application	Number of States
Quantitative invasive species performance standards apply to all DOT mitigation projects	13
Qualitative invasive species performance standards apply to all DOT mitigation projects	3
Invasive species performance standards are applied on a project-by-project basis	2
No invasive species performance standards	11
No information available	16
Total	**45**

Paired Sites

Field studies were performed at eight sets of paired mitigation and reference sites in Virginia, New York, New Hampshire, Michigan, Minnesota, Montana, Oregon, and Washington. Most of the sampled state DOTs routinely implement performance standards that specify a low areal cover of invasive species (typically 10%). Other state DOTs qualitatively describe a general invasive species condition. Although the purpose of this study is to evaluate the application of low-cover threshold performance standards, state DOTs with qualitative standards were included because they have paired sites of the appropriate age for the study, and they represent a wider geographic distribution.

Virginia Department of Transportation – Mattaponi Mitigation Bank

The Virginia Department of Transportation (VDOT) builds, maintains, and operates the state's transportation infrastructure, including roads, bridges, and tunnels. VDOT funds airports, seaports, rail, and public transportation and oversees the third-largest state-maintained highway system in the country. VDOT has an active wetland mitigation program, and constructs its own concurrent mitigation and bank sites to mitigate for wetland impacts resulting from highway improvement projects in the same watershed.



The Mattaponi Mitigation Bank was developed to mitigate unavoidable impacts on non-tidal wetlands from the construction of VDOT projects located in the Mattaponi and York River watersheds. The site is located east of the town of Milford in Caroline County, VA. Despite its proximity to the nation's capital, this area is predominantly rural and largely forested, with limited agriculture. Development consists primarily of roadways, scattered residences, and small towns. Invasive herbaceous species do not appear to be common in this vicinity. The mitigation site is bounded by the Mattaponi River to the west and an unnamed perennial stream to the south. The 79-acre site consists of approximately 21.1 acres of newly created wetlands, 37.5 acres of preservation wetlands, 3.4 acres of riparian buffer and 17 acres of

uplands. The constructed wetlands are on converted agricultural lands and were excavated in 2001 and planted in 2002 and 2003 with a native seed mix and native trees and shrubs.

The Mattaponi Mitigation Bank includes a preservation area; however, because this portion of the bank is mature forested wetland, it was not an adequate reference site for the constructed emergent wetlands. The limited amount of public land and the high proportion of forested lands in the vicinity of the mitigation area limited the availability of potential reference sites. VDOT personnel recommended contacting Fort A.P. Hill, a U.S. Army training facility with large acreages of undeveloped land located in the Mattaponi watershed. Fort A.P. Hill generously granted access to their property, and an emergent wetland area somewhat similar to the mitigation site was identified along the property's western boundary. Located about 8.5 miles north of the Mattaponi Mitigation Bank, the reference site is part of a well-developed emergent and scrub-shrub wetland associated with Meadowview Creek, and appears to have experienced little to no disturbance since Fort A.P. Hill was established in 1941. Beavers were active in the reference area, but did not appear to be causing changes to water levels or vegetation at the time of the survey.

Field Studies

The paired sites were surveyed for birds, wildlife, and invasive species cover on June 18 and 19, 2009. Bird surveys were conducted between 5:00 and 9:00 am on both days for both sites, and all surveys were conducted by the same staff. Five 330-foot transects oriented north to south were established in the mitigation site, evenly spaced across the site from a random starting location. Three transects, ranging between 400 and 577 feet, were used in the reference site. The transects radiated out from a section of uplands, and were oriented to sample emergent and scrub-shrub wetland types similar to the mitigation area. Wildlife stations for the bird surveys were positioned around the edge of the wetlands at both the mitigation and the reference sites, and distributed to minimize overlap. Site maps with approximate invasive species transects and wildlife locations are shown in Figures 1 and 2. Both the mitigation and reference sites include emergent dominated areas, scrub-shrub cover, and open water areas.

Wildlife Use

A comparable number of wetland bird species were observed at the mitigation site (26) and reference site (25), and a slightly greater proportion was categorized as wetland obligates or associates at the mitigation site (35% vs. 32%). All of the species observed in both sites are common summer residents in northern Virginia (Northern Prairie Wildlife Research Center 2009) except the great egret observed at the mitigation site, which is classified as a species of special concern in Virginia (Virginia Department of Game and Inland Fisheries 2009). Evidence of breeding was observed at both sites, including a recently abandoned red-winged blackbird nest at the mitigation site, and juvenile common yellowthroats begging from their parents and a tree swallow entering a nest box carrying food, at the reference site. Birds were assigned a wetland classification indicating categories of wetland use based on habitat use (Poole 2009).

Table 2 summarizes the bird observations at the mitigation and reference sites. Only the wetland species have been listed in detail; all non-wetland species are summarized into the total number observed by site.

Table 2. Birds Species Observed at the Mattaponi Mitigation Bank and Reference Site

Species	Scientific Name	Mitigation	Reference	Wetland Use
Barn swallow	*Hirundo rustica*	X	X	Associated
Canada goose	*Branta canadensis*	X		Obligate; PEM, open water
Common moorhen	*Gallinula chloropus*		X	Obligate; PEM
Common grackle	*Quiscalus quiscula*	X	X	Associated
Common yellowthroat	*Geothlypsus trichas*	X	X	Obligate; PSS, PEM
Eastern kingbird	*Tyrranus tyrranus*		X	Associated
Great blue heron	*Ardea herodias*		X	Obligate; open water
Great egret	*Ardea alba*	X		Obligate; open water
Mallard	*Anas platyrhynchos*	X		Obligate; PEM, open water
Purple martin	*Progne subis*	X		Associated
Red-winged blackbird	*Agelaius phoeniceus*	X	X	Obligate; PEM, PSS
Tree swallow	*Tachycineta bicolor*		X	Associated
Yellow warbler	*Dendroica petechia*	X		Obligate; PFO, riparian zones
Wetland obligate or associated		9	8	
Non-wetland species		17	17	
Total Species Observed at Site		**26**	**25**	
Confirmed breeders		1	2	
Unique to site		17	13	

Confirmed breeders: species observed carrying food or with young, or a nest identifiable to that species was observed in the wetland.
Unique to site: species observed at the either the mitigation or the reference site, but not both.
Note: PEM = palustrine emergent, PFO = palustrine forested, PSS = palustrine scrub-shrub

Both sites provided suitable habitat for amphibians. Green, bull, cricket, and chorus frogs were heard at both sites, with all but the bullfrogs chorusing, indicating breeding activity. Habitat for reptiles was less abundant. There were only a limited number of basking sites due to the lack of large woody debris in both sites. Recently deceased painted turtles were observed at both sites. At the mitigation site, three recently deceased but otherwise intact turtles were found during the vegetation surveys, and the cause of death could not be determined. The carapace of a musk turtle and a recently shed black racer skin were observed at the mitigation site. At the reference site, red-bellied turtles were observed, and multiple road-killed turtles were in evidence on the roadway at the western end of the site. No mammals or sign were observed at the mitigation site, but deer feeding in the wetlands and an active beaver lodge were observed in the reference site, as well as two nearly intact beaver and deer skeletons in the adjacent woods.

Table 3 summarizes all observations of non-avian species at both the mitigation and reference sites. Observed wildlife species were assigned a wetland classification based on habitat use (Conant and Collins 1998; Burt and Grossenheider 1976).

Table 3. Non-Avian Species Observed at the Mattaponi Mitigation Bank and Reference Sites

Species	Scientific Name	Mitigation	Reference	Wetland Use
AMPHIBIANS				
Bullfrog	*Rana catesbeiana*	X	X	obligate; PEM, PAB
Chorus frog	*Pseudacris triseriata*	X	X	obligate; PEM, PAB
Cricket frog	*Acris crepitans*	X	X	obligate; PEM, PAB
Green frog	*Rana clamitans*	X	X	obligate; PEM, PAB
REPTILES				
Musk turtle	*Sternotherus oderatus*	X		obligate; PEM, PAB
Painted turtle	*Chrysemys picta*	X	X	obligate; PEM, PAB
Red-bellied turtle	*Pseudemys rubriventris*		X	obligate; PEM, PAB
MAMMALS				
Beaver	*Castor canadensis*		X	obligate; PFO, PSS, open water
White-tailed deer	*Odocoileus virginianus*	X	X	
	Total Species Observed at Site	**7**	**8**	
	Wetland obligate or associated	6	7	
	Unique to site	0	2	

Note: PEM = palustrine emergent, PFO = palustrine forested, PSS = palustrine scrub-shrub, PAB = palustrine aquatic

Invasive Species Cover

Conditions of the permit to construct the Mattaponi Mitigation Bank specified that if any invasive species accounted for more than 5% of the areal cover in the wetland, an invasive species control plan would be developed and implemented. Vegetation monitoring conducted after the first growing season indicated that broadleaf cattail (*Typha latifolia*) was the dominant species. Although this species is native to Virginia, both the Corps and the Virginia Department of Environmental Quality (VDEQ) indicted that full credits for the bank would not be granted if cattail was the dominant species in the wetland. In 2006, when cattail cover in the emergent and scrub-shrub planted areas was observed to reach 95%, a cattail control plan was initiated. The control plan included installing pipes and constructing ditches to reduce water levels in the wetland, mowing, and applying herbicides.

Cattail control appears to have been effective; live cattail was observed along 4 of 1,650 feet of transects measured at the mitigation site, or less than 1% of the total area (Table 4). No cattail was observed in the reference site.

Table 4. Invasive Species Cover Comparison

Invasive Species	Mitigation (areal cover)	Reference (areal cover)	Project Performance Standard (areal cover)
Cattail	<1%	None observed	< 5%


Mattaponi mitigation bank, looking north.

The mitigation and reference sites are both dominated by emergent and aquatic bed wetland types. The vegetation at the mitigation site occurred as distinct patches dominated by one to three species, interspersed by shallow open water with poorly developed aquatic bed vegetation. In addition to the small amount of cattail at the mitigation site, aneilema (*Murdannia keisak*), a nonnative floating species, was observed along 8% of the total transects at the mitigation site. This species is not addressed by project performance standards but is listed as highly invasive by the Virginia Department of Conservation and Recreation (Virginia Department of Conservation and Recreation 2006). This species formed floating mats in the wide ditch that follows the southern edge of the impoundment. This small infestation of aneilema appears recent, potentially introduced by floodwaters from the Mattaponi River, waterfowl, or equipment used during the cattail control and site management.

The wetland vegetation at the reference site was mature and consisted of a mix of three to seven dominant species in the emergent and aquatic bed areas, and a diverse mix of over 20 species of shrubs and emergent species in the shrubby cover areas. Invasive species did not account for more than 5% of the areal cover.

Discussion

Both the mitigation and the reference site appear to provide good quality wildlife habitat. Birds and frogs were abundant both in number of individuals and number of species present. However, the differences in the development and structure of the vegetation at the site two sites were reflected in the avian species present, as only about 40% of the avian species observed occurred at both sites. More of the species observed at the mitigation site (e.g., American goldfinch, field sparrow, indigo bunting, killdeer, and Canada goose) prefer the open or brushy habitats common to the mitigation site, which is located on abandoned agricultural land. More of the species observed at the reference site (e.g., the non-wetland species blue-grey gnatcatcher, eastern towhee, eastern wood peewee, yellow-throated vireo) prefer the forest and dense understory cover that surround that site. Conditions for amphibians at both sites appear to be favorable, while conditions appear to be less favorable for reptiles.

The mitigation and reference sites are both dominated by emergent and aquatic bed wetland types, but showed some variation in setting and attributes. Although the same Cowardin classes were observed at both sites, the distribution and density of plant species within each wetland class varied. The wetland vegetation at the new mitigation site was comparatively less developed, as a result of

its recent establishment, weed management activities, and periodic flooding from the adjacent Mattaponi River. The pattern of vegetation and open water follows the intentionally constructed, relatively flat contours of the wetland. Relatively stable water depths at the reference site appear to dictate the vegetation types present. These plant communities follow the natural, relatively steep contours of the wetland.

Table 5 summarizes the conditions and land uses surrounding the paired sites.

Table 5. Land Uses and Site Characteristics

Attribute	Mitigation Site			Reference Site		
Watershed characteristics	Primarily forestland, but also agricultural uses and urban development. The terrain varies from nearly level to rolling hills.			Same as mitigation site.		
HGM class	Depressional			Riverine		
Cowardin class	PSS, PEM, PAB			PSS, PEM, PAB		
Plant diversity	High (>20)			High (~ 30)		
Woody debris/habitat structures	No snags, stumps, or logs. Some LWD available along forested edges.			No snags, stumps and logs. Some LWD available along forested edges.		
Hydrologic conditions	Seasonally flooded by high water from the Mattaponi, seasonally saturated by groundwater.			Natural wetland, impounded by a road bed with a 20-foot wide bridge structure providing an outlet; permanently flooded, permanently saturated.		
Surrounding land use (distance from site)	**330 feet**	**825 feet**	**3,300 feet**	**330 feet**	**825 feet**	**3,300 feet**
High Intensity (highways, industrial)	5%	5%	5%	5%	5%	5%
Moderate Intensity (residential, agriculture, parks)	20%	5%	5%	5%	50%	50%
Low Intensity (pasture, residential with > 5 acre lots)	-	-	-	-	-	-
Undeveloped (open space)	75%	95%	95%	95%	50%	50%

Note: PAB = palustrine aquatic bed, PEM = palustrine emergent, PSS = palustrine scrub-shrub, LWD = large woody debris

Both the mitigation and reference site contain less than 5% areal cover of invasive species identified in the Mattaponi Mitigation Bank's invasive performance standards, which target only cattail. Cattail, a native of North America, is prone to forming large monotypic stands. The mitigation site has undergone extensive management to eliminate cattail, which now represents less than 1% areal cover. Management strategies have focused on herbicide applications and changes to the water regime, to which cattail is sensitive. The long-term success of the cattail management program will depend on the effects of the new water regime. As discussed above, the highly invasive aneilema appears to have been recently introduced, and now accounts for 8% of the areal cover along measured transects.

No invasive species were observed in the reference site, nor were signs of significant natural disturbance or management interventions. This reflects its undisturbed nature and setting in the surrounding landscape where invasive species appeared to be uncommon.

Implications of Invasive Species Performance Standards

The information presented in the following section was obtained via questionnaire from VDOT personnel experienced with the VDOT mitigation program, unless otherwise cited. This information is not intended to state policy or guidance and only represents responses from VDOT personnel interviewed for this study.

Invasive species cover requirements have been included as part of VDOT's wetland permits for over 10 years, and they are required on all wetland mitigation projects (Haus pers. comm.). VDEQ and the Corps issue the permits, but other agencies can be signatories. For the Mattaponi Mitigation Bank, FHWA and the U.S. Fish and Wildlife Service (USFWS) were also permit signatories. VDOT wetland permits typically contain a 5% threshold for action, i.e., if invasive species account for 5% or more of the cover at a mitigation site, an invasive species control plan is required. A plan could call for continued monitoring and/or remediation. The need to implement remediation depends on the species, its aggressiveness, and its level of dominance. VDOT consults with the permit signatories to determine the course of action required. In the case of the Mattaponi Mitigation Bank, both the Corps and VDEQ Quality indicted that full credits for the bank would not be granted if cattail was the dominant species in the wetland. General knowledge about the problems associated with certain well-known invasive species (e.g., cattail, purple loosestrife [*Lythrum salicaria*], common reed [*Phragmites australis*]) appears to serve as the agencies' basis for including the 5% invasive criteria in permit performance standards.

There is a broad list of species that may be included for control as part of a permit. VDEQ references the Virginia Department of Conservation and Recreation List of Alien Plant Species (VA DCR 2006), which includes many species that may or may not be a problem at a given VDOT site. Either the Corps or VDEQ may determine that a mitigation site is noncompliant based on invasive species performance standards, even when all other permit criteria have been meet. This situation is not common, but it has happened on at least one occasion.

Emergent communities at the reference site.

VDOT has proposed alternatives to active species control or eradication to meet invasive species performance standards. One proposal is a three-tiered approach, based on The Nature Conservancy's invasive species management philosophy:

1. identify threats to the system;
2. identify vectors of exposure; and
3. identify management opportunities.

If threats to system success are low (e.g., invasive herbaceous species are present in a wetland designed and planted to become a forested cover type) VDOT has proposed, with success, to simply monitor invasive species

without implementing control measures. So far, VDEQ and the Corps have cautiously accepted VDOT's proposals.

Compliance Strategy

VDOT generally considers the need to meet invasive species performance standards in all aspects of mitigation implementation, including site selection, design, construction, and maintenance (Table 6). VDOT considers the presence of invasive species when selecting mitigation sites; however, many watersheds have existing populations of invasive species. During site preparation, temporary seeding and over-seeding may be used to control established invasive species or to prevent new populations form taking hold on exposed soils. Compliance monitoring identifies new or growing problems with invasive species. Site-tailored controls are implemented as needed and may include hand pulling, mowing or cutting, and spraying with a suitable herbicide. Hydrological regimes may be adjusted. Control programs may be conducted by independent contractors, on-call contractors, or VDOT staff. An on-call contractor provided invasive species control at the Mattaponi Mitigation Site.

Table 6. Invasive Species Controls by Project Phase

Project Phase	Invasive Species Controls
Site selection	• Select sites without established invasive populations
Site preparation/construction	• Seed or over-seed sites • Remove invasive plants manually or mechanically • Treat with herbicides
Site maintenance	• Remove invasive plants manually or mechanically • Mow or cutting standing plants • Treat with herbicides • Adjust hydrological regime

Site Management Costs

VDOT personnel were able to provide only a limited estimate of the costs associated with establishing and maintaining wetland mitigation sites, but indicated that the cost of site construction, weed control, and monitoring are associated with the costs of meeting performance standards. An estimated 20% of the annual monitoring budget is spent addressing invasive species performance standards. All VDOT wetland permits require weekly hydrologic monitoring and annual vegetation and soils monitoring. Any changes in the areal coverage of invasive species as a result of control activities must be assessed and reported; this report objectively documents the effectiveness of any invasive controls applied.

Summary and Conclusions

Both the mitigation and reference site have less than 5% areal cover of cattail, the targeted invasive species. An aggressive cattail eradication program at the mitigation site helped to achieve this threshold. Although the overall vegetative communities differed between sites, wildlife was abundant at both sites. The total number of observed species and number of wetland-dependent species were similar but species composition differed between the sites, reflecting the variation in the vegetative community.

VDOT considers the need to meet invasive species performance standards in all aspects of mitigation implementation. Invasive species cover requirements have been included as part of VDOT's wetland permits for over 10 years, and they are required on all wetland mitigation projects. Generally, cover of 5% or greater triggers the need to develop a control plan, which could call for continued monitoring and/or remediation. VDOT personnel have proposed alternative performance standards for invasive species, which the Corps and VDEQ are cautiously accepting.

New York State Department of Transportation – Mitigation Area 4

The New York State Department of Transportation (NYSDOT) implements the transportation policy and infrastructure for the state, overseeing state highways, railroads, mass transit, ports, waterways, and aviation facilities. NYSDOT is responsible for developing mitigation for unavoidable transportation-related impacts on the natural environment. Impacts on wetlands are mitigated in projects concurrent with the permitted projects. Although no mitigation banks are currently approved in New York, this mitigation strategy is under consideration.

The selected NYSDOT mitigation site, Mitigation Area 4, is located in Region 2, the Mohawk Valley Region, near the City of Utica in Oneida County. The City of Utica was historically and today remains a transportation hub. The city is divided by the Erie Canal, three railroad lines, and the New York State Thruway, Interstate 90 (I-90), as well as numerous local roadways. The confluence of highways, railroads, and waterways in the Mohawk Valley provides easy access for invasive species, and exotic vegetation is well- distributed throughout the I-90 corridor. Mitigation Area 4 was developed in 1999 to mitigate impacts incurred by construction of the Utica-Rome Expressway Project, which links the City of Rome to I-90, just to the west of Utica. This 9.1-acre site is situated between and adjacent to both the Erie Canal and State Route 49, a four-lane limited- access highway.

The reference site is approximately 3.5 miles south-southeast of the mitigation site and located partially within the city limits of Utica. This site is also adjacent to the Erie Canal, in Utica Marsh, a wildlife management area (WMA) administered by the New York State Department of Environmental Conservation (NYSDEC). The WMA includes both uplands and wetlands, offering substantially more wetland habitat than the 9.1-acre mitigation area. This reference site was recommended by the NYSDOT staff as typical for the area, with proximity to the mitigation site and a similar ecological setting along the Erie Canal. It is difficult to locate totally undisturbed sites in this developed area.

Field Studies

The paired sites were surveyed for birds, wildlife, and invasive species cover on July 7 and 8, 2009. Bird surveys were conducted between 5:00 and 9:00 am on July 8 and 9, at both sites on both days by the same staff. All transects were oriented north-south except for one that ran east-west in the

reference area. The transects in the mitigation site ranged in length from 192 to 680 feet due to the shape and small size of the wetland, and were located to sample all vegetation classes present. Transects in the reference site ranged in length from 200 to 660 feet and were located to sample vegetation classes similar to those sampled at the mitigation site. The transects started along upland embankments, but ended well before reaching the opposite wetland edge because of the size of the Utica Marsh WMA. Wildlife sampling stations were positioned around the edge of the mitigation wetland, and along the northern edge of the two major impoundments at Utica Marsh. Site maps with approximate invasive species transects and wildlife station locations are shown in Figures 3 and 4.

Wildlife Use

Fewer bird species were observed at the mitigation site (14) than the reference site (19), but about the same proportion were categorized as wetland obligates or associates (50% vs. 53%), and roughly the same number of confirmed breeders were observed (4 vs. 3). All of the species observed in both sites are common summer residents in this part of the Mohawk Valley (Friends of Utica Marsh 2000). Birds were assigned a wetland classification based on habitat use (Poole 2009).

Table 7 summarizes the bird observations at the mitigation and reference sites. Only the wetland species have been listed in detail; all non-wetland species are summarized into the total number observed by site.

Table 7. Birds Species Observed at Mitigation Area 4 and Reference Site

Species	Scientific name	Mitigation	Reference	Wetland Use
Common grackle	*Quiscalus quiscula*		X	Associated
Common yellowthroat	*Geothlypsus trichas*	X	X	Obligate; PSS, PEM
Eastern kingbird	*Tyrannus tyrannus*	X		Associated
Mallard	*Anas platyrhynchos*		X	Obligate, PEM
Marsh wren	*Cistothorus palustris*		X	Obligate, PEM, open water
Red-winged blackbird	*Agelaius phoeniceus*	X	X	Obligate; PEM, PSS
Song sparrow	*Melospiza melodia*	X	X	Obligate; PSS, riparian zones
Swamp sparrow	*Melospiza georgiana*	X	X	Obligate; PSS, PEM
Tree swallow	*Tachycineta bicolor*	X	X	Associated
Willow flycatcher	*Empidonax traillii*		X	Obligate; PSS
Yellow warbler	*Dendroica petechia*	X	X	Obligate; PFO, riparian zones
Wetland obligate or associated		7	10	
Non-wetland species		7	9	
Total Species Observed at Site		**14**	**190**	
Confirmed breeders		4	3	
Unique to site		1	6	

Confirmed breeders: species observed carrying food or with young, or a nest identifiable to that species was observed in the wetland.
Unique to site: species observed at either the mitigation or the reference site, but not both.
Note: PEM = palustrine emergent, PFO = palustrine forested, PSS = palustrine scrub-shrub

The non-avian wildlife observed was typical of reasonably undisturbed habitat located within a matrix of suburban and urban development. The northern leopard frog was observed at both sites, but bull and green frogs were observed only at the reference area. A painted turtle was observed at the mitigation site, Eastern cottontail rabbits were observed at the reference site, and white-tailed deer were observed at both sites.

Table 8 summarizes all observations of non-avian wildlife species at the mitigation and reference sites. Observed wildlife species were assigned a wetland based on habitat use (Conant and Collins 1998, Burt and Grossenheider 1976).

Table 8. Non-Avian Species Observed at Mitigation Area 4 and Reference Sites

Species	Scientific Name	Mitigation	Reference	Wetland Use
AMPHIBIANS				
Bullfrog	*Rana catesbeiana*		X	Obligate; PEM, PAB
Green frog	*Rana clamitans*		X	Obligate; PEM, PAB
Leopard frog	*Rana pipiens*	X	X	Obligate; PEM, PAB
REPTILES				
Painted turtle	*Chrysemys picta*	X		Obligate; PEM, PAB
MAMMALS				
Eastern cottontail	*Sylvilagus floridanus*		X	
White-tailed deer	*Odocoileus virginianus*	X	X	
	Total Species Observed at Site	**3**	**5**	
	Wetland obligate or associated	2	3	
	Unique to site	1	3	

Note: PEM = palustrine emergent, PFO = palustrine forested, PSS = palustrine scrub-shrub, PAB = palustrine aquatic

Invasive Species Cover

The Corps permit issued for highway project construction includes a special condition that requires less than 5% total areal cover of invasive and/or exotic species on the mitigation site. The permit specifically names purple loosestrife and common reed as invasive species. The invasive species survey focused on the distribution of these two species, which were detected at both sites (Table 9). At the mitigation

Mitigation site emergent area with mixed grasses and forbes; common reed bed in the background.

site, purple loosestrife and common reed each accounted for an estimated areal cover of 9%. Common reed was primarily sampled in brief intercept lengths, indicating a scattered distribution. NYSDOT controls common reed at the mitigation site with herbicide applications. Purple loosestrife was also scattered across the mitigation site. NYSDOT has an active biological program to control purple loosestrife (beetle releases). Most loosestrife plants were less than 3 feet in height and displayed moderate to severe damage from the beetles used for biological control.

Carex patch at the reference site.

At the reference site, purple loosestrife accounted for 29% of the areal coverage along surveyed transects. This species was co-dominant or essentially monotypic across hundreds of feet of transect. Most plants were over 5 feet tall, very robust, and with little to no beetle damage. Common reed accounted for 6% areal coverage along the surveyed transects, occurring mostly in a single large stand that stretched for 80 feet of transect intercept.

Table 9. Invasive Species Cover Comparison

Invasive Species	Mitigation (areal cover)	Reference (areal cover)	Project Performance Standard (areal cover)
Purple loosestrife	9%	29%	<5%
Common reed	9%	6%	<5%
Total Invasive Cover	**18%**	**35%**	**<5%**

There was no consistent pattern in the distribution of in invasive species by Cowardin type, except that no invasive species were recorded in the small area of forested wetland sampled at both sites (Table 10).

Table 10. Invasive Species Cover by Cowardin Classification

Invasive Species	Mitigation Site (areal cover)			Reference Site (areal cover)		
	Emergent Area	Scrub-Shrub Area	Forested Area	Emergent Area	Scrub-Shrub Area	Forested Area
Purple loosestrife	12%	11%	0%	26%	3%	0%
Common reed	8%	20%	0%	7%	0%	0%

Note: Values presented for each Cowardin class do not correspond to the total invasive species cover presented in the previous table because the mitigation and reference sites contain multiple Cowardin classes of varying sizes.

Despite the lower invasive cover achieved at the mitigation site, more nonnative species (15) were observed along the transects at the mitigation site than at the reference site (7). This reflects the more disturbed nature of the recently constructed mitigation site, and possibly the colonization opportunity created by the common reed control program.

Discussion


Leopard frog - this species was observed at both sites.

The wildlife communities at the reference and mitigation sites were similar, likely due to similar site conditions and connectivity with the Erie Canal. Both sites lie directly adjacent to the canal, which is bordered by a well-developed riparian zone that creates an area of extensive natural habitat for wetland species and acts as a travel corridor between other wetland habitats. The observed differences in wildlife use can be attributed to the difference in wetland size and the presence of permanent open water areas at the reference site. Roughly half of the avian species observed at both sites are wetland obligates or associates. Marsh wren and mallard duck were observed at the reference site but not at the mitigation site, likely because the mitigation site is smaller and has limited amount of open water. Bull and green frogs, observed at the reference site but not the mitigation site, require permanent standing water for reproduction. It is likely that the small open water areas at the mitigation site dry up periodically, making the mitigation area a suboptimal habitat for these two amphibian species.

Table 11 summarizes the conditions and land uses surrounding the paired sites.

Table 11. Land Uses and Site Characteristics

Attribute	Mitigation Site			Reference Site		
Watershed characteristics	Forest cover dominates the headwaters located on the southern Adirondacks, while agriculture dominates the rolling hills and flood plains adjacent to the main stem. Development occurs mostly within urban centers along the main stem.			Same as mitigation site.		
HGM class	Depressional			Riverine		
Cowardin class	PFO, PSS, PEM			PFO, PSS, PEM		
Plant diversity	High			Moderate		
Woody debris/habitat structures	No snags, stumps, or logs. Some LWD available in the adjacent PFO wetland.			No snags, stumps, or logs. Some LWD available along forested edges.		
Hydrologic conditions	Seasonally flooded, seasonally saturated			Seasonally flooded, seasonally saturated		
Surrounding land use (distance from site)	**330 feet**	**825 feet**	**3,300 feet**	**330 feet**	**825 feet**	**3,300 feet**
High Intensity (highways, industrial)	25%	20%	15%	5%	5%	30%
Moderate Intensity (residential, agriculture, parks)	-	-	25%	-	-	35%
Low Intensity (pasture, residential with > 5 acre lots)	-	-	10%	-	-	-
Undeveloped (open space)	75%	80%	50%	95%	95%	35%

Note: PEM = palustrine emergent, PFO = palustrine forested PSS = palustrine scrub-shrub, LWD = large woody debris

The distribution of invasive species, and plants in general, vary between the mitigation and reference site. Less invasive cover was observed at the mitigation site. The reference site supports a mosaic of large, single-species stands, while the mitigation site is more heterogeneous. The patterns of invasive species and overall vegetation distribution in the mitigation site appear to be due to local microtopography as well as management practices. By design, the mitigation site contains many small changes in elevation, providing varied growing conditions throughout the site. The reference site is essentially flat with gradual changes in elevation that create large areas with a similar water regime, facilitating the establishment of monotypic stands of cattail, purple loosestrife, common reed, and lake sedge (*Carex lacustris)*, in order of stand prevalence.

The mitigation area has also been subjected to regular disturbance by mowing and spraying to control common reed, as well as some remedial earthwork in 2001 to prevent the adjacent Crane Creek from establishing a permanent overflow channel across a portion of the wetland. Although the areal cover of purple loosestrife and common reed exceeded the performance standards, the impact of the invasive species control program is reflected in the distribution of these species, which were present at only low levels in both the PEM and PSS wetland classes. Common reed occurs mostly in

small patches and loosestrife was never dominant. The Utica Marsh Council sponsored a student program to raise and release beetle in adjacent Utica Marsh as recently as 2008 (Utica Marsh Council 2009) but any effects of this program were not apparent in the portion of the marsh sampled for this study. Both common reed and purple loose strife occur in expansive, monotypic stands in Utica Marsh, a pattern that is typical of wetlands throughout the I-90/Erie Canal corridor in central NY (Barnum pers. comm.).

Implications of Invasive Species Performance Standards

The information presented in the following section was obtained via questionnaire from NYSDOT personnel experienced with the NYSDOT mitigation program, unless otherwise cited. This information is not intended to state policy or guidance and only represents responses from NYSDOT personnel interviewed for this study.

Performance standards for areal cover of invasive species have been required by the Corps on NYSDOT projects since the 1990s (Tobiasz pers. comm.). Although the Corps has discretion when setting performance standards for NYSDOT mitigation permits, the performance standard for Mitigation Area 4 is typical of most NYSDOT mitigation projects: 5% or less areal cover of all invasive species. The 5% invasive cover performance standard is reported to be based on the professional judgment of Corps personnel, supported by the interpretation of scientific literature, and/or personal observations of the effects of these species in the field.

In the past, the 5% standard was applied relative to adjacent natural, relatively undisturbed reference wetlands. If adjacent reference wetlands had 10% invasive cover, then the standard for the mitigation site was 10 plus 5 or 15%. This "relative" standard no longer appears to be applied. NYSDOT personnel speculate that the Corps did away with this "relativism", or that the permitting agencies informally trended away from using relative performance standards. NYSDOT personnel expressed concern that achieving less than 5% cover for all invasive species was not possible on some mitigation projects because of site conditions. Invasive species populations in or surrounding the sites can make these low cover thresholds unachievable.

Mitigation Area 4, along with many other NYSDOT mitigation sites, currently does not meet the 5% performance standard even though invasive species control was considered at all phases of project development, including site design, construction, and management. Other project goals appear to have been met, including achieving the desired amount of wetland area and establishing the desired plant communities. If the "relative" standard described above was applied to this project, Mitigation Area 4 would likely meet the performance standard as the Mohawk River Valley is heavily infested with invasive species (Barnum pers. comm.). Region 2 has not yet applied for credits from the mitigation site due in part to the ongoing invasive control program. NYSDOT personnel were unaware of any projects in Region 2 where a mitigation site was considered to be in violation of its permit as a result of exceeding invasive species cover performance standards.

Compliance Strategy

NYSDOT uses a variety of strategies throughout the development of mitigation sites to control invasive species (Table 12). NYSDOT avoids selecting sites with high invasive species cover, but the availability of otherwise suitable sites is often limited in Region 2. Exclusion of invasive species is emphasized during site construction by removing seed sources in topsoil where appropriate, considering competitive species in planting design, and washing construction and maintenance equipment. NYSDOT uses a variety of approaches to control invasive species once the maintenance

phase of a project is initiated, including mowing, applying appropriate herbicides, excavating, installing plastic sheeting, and releasing beetles for purple loosestrife control.

Table 12. Invasive Species Controls by Project Phase

Project Phase	Invasive Species Controls
Site selection	• Select sites without established invasive populations
Site construction	• Remove seed sources in topsoil • Consider competitive species in planting choices • Wash construction and maintenance equipment
Site maintenance	• Mow standing plants • Treat with herbicides • Excavate to remove invasive plants • Apply plastic sheeting • Release beetles to control purple loosestrife

Site Management Costs

NYSDOT personnel were able to provide only a limited estimate of the costs associated with establishing and maintaining wetland mitigation sites. In general, land acquisition costs and construction costs vary widely. Construction costs are driven by the amount of excavation required to establish hydrology. For some sites where excavation is less and acquisition costs are low, mitigation costs have been about $50,000 per acre. At other sites, costs have approached$500,000 to $600,000 or more per acre. Mitigation costs for one 0.17-acre project in design in 2009 are estimated at $470,000 to $650,000 per acre.

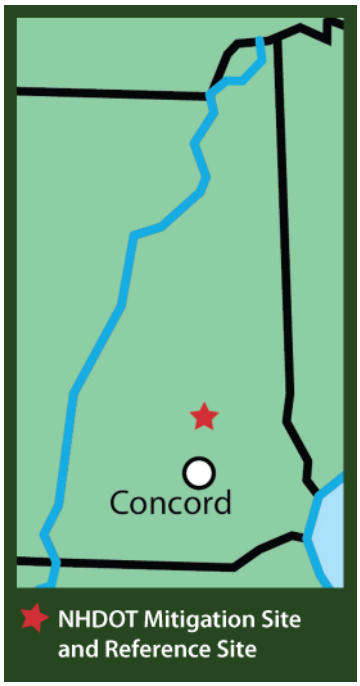
No cost estimates were available for monitoring or invasive control activities. Monitoring is a routine part of staff duties and is not tracked separately. For invasive control, NYSDOT estimated a cost of $325 per acre along a railroad corridor for maintenance with a boom sprayer, but indicated that backpack spot spraying, the approach used in wetland creation areas, is likely to be more expensive.

Summary and Conclusions

The areal cover of invasive species was lower at the mitigation site than at the reference site. This is attributed in part to NYSDOT's invasive species control program. Although the wildlife species observed at both sites had similar habitat requirements, some species requiring open water were only observed at the reference site. The mitigation site appears to provide the intended wetland water regime, vegetation present and wildlife habitat value. However, NYSDOT has not yet applied to the Corps for credits because invasive species performance standards have not been met. NYSDOT personnel were unaware of sites where the monitoring has been closed out, but invasive species performance standards had not been met.

New Hampshire Department of Transportation – Rocky Pond Mitigation Site

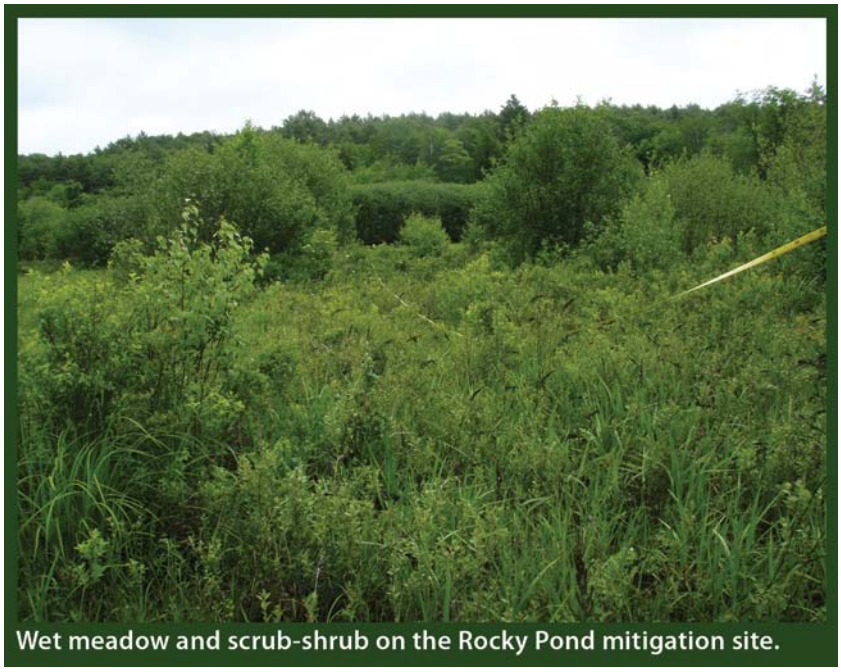
The New Hampshire Department of Transportation (NHDOT) oversees the transportation policy and infrastructure for the state, including air, rail, highway, bike/pedestrian, and public transportation. NHDOT is responsible for developing mitigation for unavoidable transportation-related impacts on the natural environment. NHDOT constructs its own wetland mitigation projects to compensate for impacts created by roadway projects, as the Corps has not accepted a wetland banking program for any type of wetland impacts in New Hampshire.



The NHDOT mitigation site, Rocky Pond Mitigation Site, is located in the town of Gilmanton in central New Hampshire, on the southern edge of Belknap County. This part of New Hampshire is predominantly rural and forested. The terrain is hilly and wetland areas are generally associated with ponds and streams. Because of the rural setting, roadways are a major form of disturbance and development in the landscape, and a primary vector for the spread of invasive species. However, the prevalence of invasive species is relatively low compared to more urban or agricultural settings.

The Rocky Pond Mitigation Site was developed to mitigate approximately 8.7 acres of wetland impacts incurred by improvements to Route 106 in the Towns of Loudon, Gilmanton, and Belmont. The mitigation site is a 65-acre parcel which includes 43 acres of preservation (including both wetlands and uplands), and a reclaimed gravel pit that encompasses 13.5 acres of uplands and 8.3 acres of wetlands. Wetland grading began in summer 1998 and was completed in fall 1998; planting was completed in spring 1999.

The reference site is located adjacent to the mitigation site at the northern end of Rocky Pond. The mitigation site is west of Kimball Brook, and the reference site is east of the brook. The reference site includes emergent and scrub-shrub portions of the preserved wetlands. The forested wetland preservation area was not used for this study because the mitigation site only includes emergent and scrub-shrub vegetative classes.


Wet meadow and scrub-shrub on the Rocky Pond mitigation site.

Field Studies

The paired sites were surveyed for birds and wildlife on June 5 and 16, 2009. Bird surveys were

conducted between 5:00 and 9:00 am. Surveys for invasive species cover were conducted on June 12 and July 13, 2009. The same personnel conducted all surveys. Both sites included multiple impoundments: the mitigation site incorporated constructed impoundments and the reference site had been dammed by beavers. Vegetation transects were oriented to sample a similar proportion of each wetland class at both sites, and to maximize their lengths. All transects extended from upland edge to upland edge, and therefore varied according to the size of the impoundments. Five transects varying in length from 203 to 459 feet were installed at the mitigation site and four transects varying in length from 192 feet to 398 feet were installed the reference site. Site maps with approximate transect and point count locations are shown in Figures 5 and 6. Both sites included emergent-dominated areas and open water areas.

Wildlife Use

The same number of bird species was observed at the mitigation site (19) as the reference site (19), and similar proportions were categorized as wetland obligates or associates (42% and 37% at both sites). All of the wetland species observed in both sites are common summer residents in southern New Hampshire (New Hampshire Audubon 2004). No signs of breeding (e.g., nests, adults carrying food, begging fledglings) were observed at either site. Birds were assigned a wetland classification based on habitat use (Poole 2009).

Table 13 summarizes the bird observations at the mitigation and reference sites. Only the wetland species have been listed in detail; all non-wetland species are summarized into the total number observed by site.

Table 13. Bird Species Observed at the Rocky Pond Mitigation Site and Reference Site

Species	Scientific name	Mitigation	Reference	Wetland Use
Alder flycatcher	*Empidonax alnorum*	X		Obligate; PSS
Common grackle	*Quiscalus quiscula*	X	X	Associated
Common yellowthroat	*Geothlypsus trichas*	X	X	Obligate; PSS, PEM
Eastern kingbird	*Tyrannus tyrannus*	X	X	Associated
Red-winged blackbird	*Agelaius phoeniceus*	X	X	Obligate; PEM, PSS
Song sparrow	*Melospiza melodia*	X	X	Obligate; PSS, riparian zones
Tree swallow	*Tachycineta bicolor*	X	X	Associated
Yellow warbler	*Dendroica petechia*	X	X	Obligate; PFO, riparian zones
Wetland obligate or associated		8	7	
Non-wetland species		4	12	
Total Species Observed at Site		**19**	**19**	
Confirmed breeders		0	0	
Unique to site		7	3	

Confirmed breeders: Species observed carrying food or with young, or a nest identifiable to that species observed in the wetland

Unique to site: Species observed at either the mitigation or the reference site, but not both.

Note: PEM = palustrine emergent, PFO = palustrine forested, PSS = palustrine scrub-shrub

All non-avian species observed at the sites (Table 14) are typical of southern New Hampshire habitats, which are minimally to moderately influenced by human activities. Adult bull and green

frogs were heard calling at both sites. American toads were observed at the mitigation site only, where they were heard calling and observed as tadpoles. Predated painted turtle nests were present in upland areas in the mitigation site, and an adult was observed in the reference site wetland. No mammals were observed directly and mammal sign was relatively scarce at both sites. Fresh scat was observed on muskrat feeding platforms and on an older beaver dam at the reference site, and mustelid scat on was observed on a rock in the mitigation site.

Table 14 summarizes all observations of non-avian species at both the mitigation and reference sites. Observed wildlife species were assigned a wetland classification based on habitat use (Conant and Collins 1998, Burt and Grossenheider 1976).

Table 14. Non-Avian Species Observed at the Rocky Pond Mitigation Site and Reference Site

Species	Scientific Name	Mitigation	Reference	Wetland Use
AMPHIBIANS				
Bull frog	*Rana catesbeiana*	X		Obligate; PEM, PAB
Green frog	*Rana clamitans*	X		Obligate; PEM, PAB
American toad	*Bufo bufo*	X		Obligate; PEM, PAB
REPTILES				
Painted turtle	*Chrysemys picta*	X	X	Obligate; PEM, PAB
MAMMALS				
Beaver	*Castor canadensis*		X	Obligate; PFO, PSS, PEM
Muskrat	*Ondatra zibethicus*		X	Obligate; PEM, PAB
	Total Species Observed at Site	**4**	**3**	
	Wetland obligate or associated	4	3	
	Unique to site	3	2	

Note: PAB = palustrine aquatic, PEM = palustrine emergent, PSS = palustrine scrub-shrub, PAB = palustrine aquatic

Invasive Species Cover

Conditions of the New Hampshire Department of Environmental Services permit issued for project construction specified that purple loosestrife and common reed not be introduced to the site during wetland creation and that a plan to remove invasive species be included as part of the monitoring protocol. The Corps permit issued for the mitigation site does not include vegetation standards, but references the Wetland Mitigation Report Rocky Pond – Site 9 mitigation plan as a special condition of the permit. This document proved to be unavailable, but presumably contained the vegetation specifications and monitoring standards that governed development of the site.

Both sites had exceptionally low levels of invasive species in all wetland classes (Table 15); no common reed was present, and only scattered individual purple loosestrife plants were present in both sites. Approximately 1% of the total transects in the mitigation site and less than 1% in the reference site had a measurable amount of purple loosestrife.

Table 15. Invasive Species Cover by Cowardin Classification

	Mitigation Site (areal cover)			Reference Site (areal cover)		
Invasive Species	**Emergent**	**Scrub-Shrub**	**Emergent/ Scrub-Shrub**	**Emergent**	**Scrub-Shrub**	**Emergent/ Scrub-Shrub**
Purple loosestrife	2%	0%	0%	0%	0%	0%
Common reed	0%	0%	0%	0%	0%	0%
Total Invasive Cover	**2%**	**0%**	**0%**	**0%**	**0%**	**0%**

Note: Values presented for each Cowardin class do not correspond to the total invasive species cover presented in the previous table because the mitigation and reference sites contain multiple Cowardin classes of varying sizes.

Both sites had a mix of emergent, scrub-shrub, and open water cover types, but the mitigation site had a greater proportion of emergent cover and shallow open water areas. The reference site vegetation types were more mixed, as opposed to consisting of discrete stands, and a greater diversity of shrub species was present. Both sites had a high diversity of plants, with over 20 species providing significant cover.

Diverse wet meadow with some scattered cattail at the Rocky Pond mitigation site.

Some nonnative species not targeted in the New Hampshire Department of Environmental Services permit were observed at both sites, but like the targeted species, these other species were not prevalent. Observed invasive species included a moderate amount of glossy buckthorn (*Frangula alnus*) at the wetland forest edges of the reference site and small amounts of reed canarygrass at both sites.

Discussion

Both sites appear to provide good wildlife habitat. The relatively small sizes of the sites, their similarity, and their close proximity make these two sites essentially one habitat unit. While some individual birds observed were clearly defending territories specific to the mitigation or the reference site, most individuals probably used the entire wetland complex to some degree. However, a slightly greater number of species were observed in the mitigation site. Because it is younger and was designed with impoundments, the mitigation site offers more shallow open water areas and a greater interspersion of upland and wetland habitats. This habitat diversity likely contributes to the

greater number of species observed. The shallow, open water area in the mitigation site also offers better amphibian breeding habitat, particularly for American toad, which was observed only in the mitigation area.

Very low levels of invasive species were recorded during sampling of the mitigation or observed outside the sampled areas, and neither site contains a significant amount of the targeted invasive species.

Table 16 summarizes the conditions and land uses surrounding the paired sites.

Table 16. Land Uses and Site Characteristics

Attribute	Mitigation Site			Reference Site		
Watershed characteristics	The topography of the Soucook River watershed is gently rolling. The majority of the area is forested with a small amount of farmland and developed land.			Same as mitigation site.		
HGM class	Depressional			Riverine		
Cowardin class	PSS, PEM			PSS, PEM, PFO		
Plant diversity	High			High		
Woody debris/habitat structures	No snags, stumps and logs.			Few snags, stumps or logs. Some LWD along the edges of the adjacent forested wetland.		
Hydrologic conditions	Restricted outlet (30-inch culvert), seasonally flooded, seasonally saturated			Channel and sheet flow currently present, as a result of historic beaver activity. Seasonally flooded, seasonally saturated.		
Surrounding land use (distance from site)	**330 feet**	**825 feet**	**3,300 feet**	**330 feet**	**825 feet**	**3,300 feet**
High Intensity (highways, industrial)	-	5%	5%	5%	5%	5%
Moderate Intensity (residential, agriculture, parks)	-	-	-	-	-	-
Low Intensity (pasture, residential with > 5 acre lots)	5%	10%	20%	5%	10%	25%
Undeveloped (open space)	95%	85%	75%	90%	85%	70%

Note: PEM = palustrine emergent, PFO = palustrine forested PSS = palustrine scrub-shrub, LWD = large woody debris

The mitigation and reference sites are located adjacent to one another and are therefore similar in setting. Both sites have a mix of emergent, scrub-shrub, and open water cover types, and the primary distinction between vegetation communities is age. Because of its age and intentional design, the mitigation site has a greater proportion of emergent cover and shallow open water areas. Both sites have a high diversity of plants, with over 20 species providing significant cover. Composition and distribution of vegetation in the mitigation site still strongly reflect the original plantings. Overall, the reference site vegetation types were more mixed, as opposed to consisting of discrete stands, and a greater diversity of shrub species was present.


Reference site shallow marsh with diverse plant communities.

Neither site contains a significant amount of the targeted invasive species. Project documentation regarding the site construction indicates that it was free of invasive when construction began and that efforts were made to avoid introduction of invasive species during construction. The limited populations of invasive species in the surrounding landscape also play a significant role in the small number of invasive species at the paired sites. Other nonnative species include a moderate amount of glossy buckthorn in the reference site and a small amount of reed canarygrass in both sites.

In general, the mitigation plan for the Rocky Pond Mitigation Site appears to be successful in establishing intended site conditions and vegetation communities. The mitigation site meets the site performance standards. NHDOT adjusted the outlets of some of the impoundments since initial construction, but has applied no other active management to the wetlands at the mitigation site. It is interesting to note that although NHDOT does not have an active loosestrife control program in this wetland, a moderate amount of beetle damage to the loosestrife plants was observed in one of the mitigation impoundments. Loosestrife plants in the other impoundments did not display any damage.

Implications of Invasive Species Performance Standards

The information presented in the following section was obtained via questionnaire from NHDOT personnel experienced with the NHDOT mitigation program, unless otherwise cited. This information is not intended to state policy or guidance and only represents responses from NHDOT personnel interviewed for this study.

The New England District of the Corps and the New Hampshire Department of Environmental Services require NHDOT to control invasive species on mitigation sites, but do not generally set specific standards for invasive cover (Goodmen pers. comm.). In practice, each site is addressed individually during the monitoring period and the Corps makes recommendations regarding invasive species control based on the site and its setting, rather than mandating a single areal cover target. Each mitigation site must include an invasive species control plan as part of the monitoring plan required by the permit. The Corps does not have a set process for "closing out" a NHDOT mitigation site once the monitoring requirements of a permit have been meet. However, if the goals of the invasive species control plan are met by the end of the monitoring period, the Corps generally accepts the mitigation credits provided by the site (Roach pers. comm.). The New England District of the Corps routinely applies special conditions to highway mitigation projects, specifying that monitoring be conducted yearly at the end of the growing season for the first 3 years after construction. A post-construction assessment of site success must be conducted after the first 5 full growing seasons. Wetland permitting agencies in New Hampshire have not deemed a mitigation site an unsuccessful for failing to achieve invasive species cover performance standards when other performance standards, particularly wetland area, have been met.

The performance standard for the Rocky Pond Mitigation Site is typical of mitigation plans developed by NHDOT: no specific invasive species cover standard was set, but control of invasive species is an explicit condition of the permit. The basis for this invasive control standard is general scientific knowledge and recommendations of regulatory agency experts, who include invasive species control as a necessary practice to create wetlands that will replicate the lost functions and values of wetlands affected by highway projects.

Compliance Strategy

NHDOT generally addresses invasive species control in all aspects of mitigation implementation (Table 17). NHDOT avoids sites with existing weed sources surrounding or upstream of potential mitigation sites, if possible. However, NHDOT projects typically occur in watersheds that are undergoing development and population growth and consequently, invasive species are relatively common. Mitigation sites located in the same watershed as the affect sites are vulnerable to the same kinds of invasive species.

Invasive species are considered during site design, when hydrological conditions are designed to minimize invasive growth. For example, deep open water areas are designed with steep banks to limit common reed and purple loosestrife that can occur along the edge of created pools. During construction, invasive species are minimized by transferring blocks of soils containing established vegetation from uncontaminated wetland areas, and only weed-free topsoil sources are used. After construction, NHDOT manages and monitors invasive species cover along with all other performance standards. Most of NHDOT's mitigation site management activities focus on vegetation management through herbicide treatments, hand pulling and cutting plants, and biological control (for purple loosestrife). NHDOT does not generally perform additional grading, but adjustments to water control structure and outfalls may be done to improve wetland hydrology and to create conditions that will discourage the growth of invasive plants.

Table 17. Invasive Species Controls by Project Phase

Project Phase	Invasive Species Controls
Site selection	• Select sites without established invasive species populations • Select sites that are not vulnerable to invasive colonization • Select sites that are not downstream of invasive species seed sources
Site design	• Design hydrology features to minimize invasive species
Site construction	• Transfer of blocks of soils from uncontaminated wetland areas, • Use only weed-free topsoil sources
Project maintenance	• Manually pull or cut invasive plants • Treat with herbicides • Release beetles to control purple loosestrife

Site Management Costs

NHDOT's costs to construct a mitigation site are between $50,000 and $100,000 per acre, including the price of real estate. Land prices in southern New Hampshire are substantially higher than in the northern part of the state. Monitoring of sites after construction is estimated to cost between $3,000 and $5,000 annually, and up to half of the monitoring effort is typically directed toward measuring invasive species areal cover. Monitoring of mitigation sites is conducted in compliance with the

permit specifications, and is generally conducted by contractors. NHDOT employees or contractors may conduct weed control activities on mitigation sites. The cost of invasive species control once a site is constructed varies greatly, and a cost estimate range was not available.

Summary and Conclusions

The paired sites are located adjacent to one another, support similar wildlife uses, and both sites have very low levels of invasive species. The observed differences in the distribution and interspersion of wetland types could be attributed to the design and age of the constructed wetland. The mitigation site appears to provide wetland functions in terms of water regime, vegetation present, and wildlife habitat value.

NHDOT controls invasive species on its mitigation sites through site selection, careful site construction, an active monitoring program, and implementation of the control plan included in the permit, as needed. NHDOT, the Corps, and the New Hampshire Department of Environmental Services recognize that success in limiting invasive species at mitigation sites is in large part tied to the presence of invasive species in the surrounding landscape. The success of meeting invasive species performance standards is judged on a site-by-site basis. NHDOT personnel were unaware of any sites where mitigation credits were denied on the basis of invasive standards.

Michigan Department of Transportation – Blueberry Farm Wetland Mitigation Site

The Michigan Department of Transportation (MDOT) operates highway, rail, and ferry systems throughout Michigan and oversees the infrastructure for these services. Michigan consists of two large peninsulas and is surrounded by the waters of Lake Erie, Lake Huron, Lake Michigan, and Lake Superior. Many of the state's transportation projects require construction in and around water bodies. MDOT develops concurrent mitigation projects and operates mitigation banks to compensate for project-related impacts. MDOT completes many of these projects but also uses consultants.

The Blueberry Farm Wetland Mitigation Site selected for this study is located in the Lower Peninsula, approximately 1 hour east of Lake Michigan, Allendale Township, Ottawa County. The Blueberry Farm Wetland Mitigation Site was developed to mitigate for a portion of wetland and stream impacts incurred from the reconstruction of the Michigan Highway 45 (M-45) project in Ottawa County, Michigan. The highway project consisted of constructing a new road alignment for M-45 and required two new bridges to span the Grand River, Ottawa Creek, and Sand Creek. The project affected 3.3 acres of palustrine forested wetland, 1.7 acres of palustrine scrub-shrub wetland, and 0.3 acre each of palustrine emergent wetland and open water for a total impact area of 5.6 acres. MDOT mitigated for the losses with a total of 8.6 acres of wetland restoration and

creation. The Blueberry Farm Wetland Mitigation Site was constructed in 2002 and includes a total of 20.8 acres of wetlands. MDOT intends to use the surplus 12.2 acres of restored and created wetlands as mitigation for future projects in the region.

The historic wetlands and upland areas of the Blueberry Farm Wetland Mitigation Site were ditched and/or tiled to provide enough drainage to grow blueberries. Wetland hydrology at the site was restored by blocking or breaking the drain tiles and creating berms to retain water on the site. The upland portion of the site was excavated to create additional wetland area. The site now contains three areas of perennial open water and areas of seasonal inundation. Many of the blueberry plants were left intact on the mitigation site. Remaining areas were planted at density of 400 stems per acre of tree and shrub species, and excavated areas were seeded with a wetland seed mix. Excess water overflows from the site into a county-maintained storm drain.

The reference site is located adjacent to and east of the mitigation site. The paired sites are approximately 200 feet apart and are separated by a rural gravel road. Although this site was not officially used for reference during mitigation site design, it was recommended by MDOT personnel because the site is relatively undisturbed, has similar Cowardin types as the mitigation site, and is located in the same watershed. The reference site is privately owned and is a part of a larger wetland complex.

Field Studies

The paired sites were surveyed for birds, wildlife, and invasive species on July 21 through 23, 2009. Wildlife surveys were performed between 5:00 and 9:00 am on two consecutive days, one day at each site, by the same personnel. At the mitigation site, the permanent MDOT monitoring transects were used for sampling the wetland community characteristics. The total transect interval was 1,600 feet; the individual transect lengths were 500 feet (Transects 2 and 3) and 600 feet (Transect 1). Five transects were established at the reference site for a total transect length of 1,075 feet. The length was limited by the smaller area available for survey. Transects extended west to east through emergent, scrub-shrub, and forested communities. Transects 1 and 2 were each 200 feet in length, Transects 3, 4 and 5 were 225 feet in length.

Wildlife stations were positioned along the transects within different vegetation communities at both the mitigation and the reference site. Site maps showing approximate invasive species transect locations and wildlife stations are shown in Figures 7 and 8. Both the mitigation and reference sites include areas of dense forest, dense scrub-shrub, emergent dominated areas, a seasonal inundation, and an open water component.

Wildlife Use

A comparable number of bird species were observed at the mitigation site (41) and reference site (43), and a slightly greater proportion was categorized as wetland obligates or associates at the mitigation site (44% vs. 40%). All of the species observed in both sites are common summer residents in western Michigan (Northern Prairie Wildlife Research Center 2009) other than the common moorhen and the sandhill crane. The common moorhen was seen only on the mitigation site, and is classified as endangered within the state of Michigan. The sandhill crane was seen on both sites and is classified as a species of special concern in Michigan (Michigan Department of Natural Resources 2009). All species observed during the site reconnaissance the day prior to the formal surveys, as well as species observed while conducting the vegetation sampling component,

were recorded and included in the species list. Birds were assigned a wetland classification based on habitat use (Poole 2009).

Table 18 summarizes the bird observations at both sites. Only the wetland species have been listed in detail; all non-wetland species are summarized in the total number observed by site.

Table 18. Birds Species Observed at Blueberry Farm Wetland Mitigation Site and Reference Site

Species	Scientific Name	Mitigation	Reference	Wetland Use
Barn swallow	*Hirundo pyrrhonota*	X	X	Associated
Belted kingfisher	*Ceryle torquata*	X	X	Obligate; open water
Canada goose	*Branta canadensis*	X		Obligate; PEM, open water
Common moorhen*	*Gallinula chloropus*	X		Obligate; PEM, open water
Common yellowthroat	*Geothlypsus trichas*	X	X	Obligate, PSS, PEM
Great blue heron	*Ardea herodias*	X	X	Obligate; open water
Green heron	*Butorides virescens*	X	X	Obligate; open water
Mallard	*Anas platyrhynchos*	X	X	Obligate; PEM, open water
Northern rough-winged swallow	*Stelgidopteryx serripennis*	X	X	Associated
Northern waterthrush	*Seiurus noveboracensis*		X	Obligate; PSS, PFO
Red-winged blackbird	*Agelaius phoeniceus*	X	X	Obligate; PEM, PSS
Sandhill crane*	*Grus canadensis*	X	X	Obligate; PEM
Song sparrow	*Melospiza melodia*	X	X	Obligate; PSS
Swamp sparrow	*Melospiza georgiana*	X		Obligate; PSS
Tree swallow	*Tachycineta bicolor*	X	X	Associated
Veery	*Catharus fuscescens*		X	Associated
Warbling vireo	*Vireo gilvus*	X	X	Associated
Willow flycatcher	*Empidonax traillii*	X	X	Obligate; PSS
Wood duck	*Aix sponsa*	X	X	Obligate; PFO, PEM, open water
Yellow warbler	*Dendroica petechia*	X	X	Obligate; PFO, riparian zones
Wetland obligate or associated		18	17	
Non-wetland species		23	26	
Total Species Observed at Site		**41**	**43**	
Confirmed breeders		5	2	
Unique to site		4	7	

*Status: Michigan special concern or endangered.

Confirmed breeders: species observed carrying food or with young, or a nest identifiable to that species was observed in the wetland

Unique to site: species observed at either the mitigation or the reference site, but not both.

Note: PEM = palustrine emergent, PFO = palustrine forested, PSS = palustrine scrub-shrub

Bull and northern leopard frogs were observed on both sites and both species were observed chorusing, indicating breeding activity. An intact raccoon skeleton was seen in the forest on the

reference site. Abundant deer, browsed plants, scat, and recently used beds were observed on both sites. Other wildlife species observed at the mitigation site were an eastern gray squirrel near the old abandoned homestead and a striped skunk, seen foraging in the reed canarygrass under the canopy of some old blueberry bushes. The abandoned blueberry bushes found throughout the western portion of the mitigation site attracted various wildlife species, and bird densities and species diversity were notably higher near the blueberry patch.

Table 19 summarizes all observations of non-avian wildlife species at the mitigation and reference sites. Observed wildlife species were assigned a wetland classification based on habitat use (Conant and Collins 1998; Burt and Grossenheider 1976).

Table 19. Non-Avian Species Observed at the Blueberry Farm Wetland Mitigation Site and Reference Site

Species	Scientific Name	Mitigation	Reference	Wetland Use
AMPHIBIANS				
Bullfrog	*Rana catesbeiana*	X	X	Obligate; OW; PEM
Northern leopard frog	*Rana pipiens*	X	X	Obligate; OW; PEM
MAMMALS				
Raccoon	*Procyon lotor*		X	
Eastern gray squirrel	*Sciurus carolinensis*	X		
Striped skunk	*Mephitis mephitis*	X		
White-tailed deer	*Odocoileus virginianus*	X	X	
	Total Species Observed at Site	**5**	**4**	
	Wetland obligate or associated	2	2	
	Unique to site	2	1	

Note: OW = open water, PEM = palustrine emergent

Invasive Species Cover

The performance standards for MDOT mitigation projects state that invasive species must not exceed 10% of the total areal coverage. These standards have been in place since 2004. The Blueberry Farm wetland mitigation site, although constructed in 2002, has been managed to limit cover of invasive species using the same approaches used on current sites. The three species currently considered invasive by MDEQ are reed canarygrass (*Phalaris arundinacea*), common reed, and purple loosestrife. All three of these are aggressive colonizers of seasonally wet areas in Michigan. Only purple loosestrife is on the State of Michigan Noxious Weed List.

No common reed or purple loosestrife was observed on transects at either the mitigation or the reference site, although a few beetle-damaged purple loosestrife plants were observed elsewhere on the mitigation site. Reed canarygrass was observed on transects in both the mitigation and reference sites, and at both sites it exceeded the 10% areal cover performance standard. The areal cover of reed canarygrass at the mitigation site was estimated to be 31%; at the reference site it was estimated to be 14% (Table 20).

Table 20. Invasive Species Cover Comparison

Invasive Species	Mitigation (areal cover)	Reference (areal cover)	Project Performance Standard (areal cover)
Reed canarygrass	31%	14%	<10%
Purple loosestrife	0%	0%	<10%
Common reed	0%	0%	<10%
Total Invasive Cover	**31%**	**14%**	**<10%**


Forested wetland at the reference site.

Areal cover of reed canarygrass was roughly equal in the forested (33%) and emergent areas (35%) at the mitigation site. The scrub-shrub areas had 2% areal cover of invasive species. Areal cover was also roughly equal in the forested (15%) and emergent (11%) areas of the reference sites. Reed canarygrass was not observed in the scrub-shrub portions of the reference site. Table 21 summarizes the distribution of the reed canarygrass by Cowardin class.

Table 21. Invasive Species Cover by Cowardin Classification

	Mitigation Site (areal cover)			Reference Site (areal cover)		
Invasive Species	**Emergent Area**	**Scrub-Shrub Area**	**Forested Area**	**Emergent Area**	**Scrub-Shrub Area**	**Forested Area**
Reed Canarygrass	35%	2%	33%	11%	0%	15%

Other species common to both sites include swamp white oak (*Quercus bicolor*), red maple (*Acer rubrum*), green ash (*Fraxinus pennsyvanica*), solidago (*Solidago gigantea*), flat-top golden top (*Euthamia graminifolia*), and mixed sedges (*Carex vulpinoidea, Carex scoparia*, *Carex* spp.).


Developing forested wetland with native understory at the Blueberry Farm mitigation site.

MDOT last measured invasive species cover in 2006 (Sneed 2007). At that time, reed canary grass cover was estimated to be 59%, nearly twice the cover estimated during this study. The differences in cover between MDOT monitoring and the results of this study are likely due to sampling rigor. MDOT employs a high-intensity sampling method in its monitoring, whereas this study performed a rapid assessment to determine whether the site likely exceeds the 10% invasive species areal cover standard currently applied to MDOT wetland mitigation projects. Although qualitative data has not been collected at the Blueberry Farm Wetland Mitigation Site during the past 3 years, the percentage of reed canarygrass was estimated by MDOT biologists to have remained fairly consistent.

Discussion

The mitigation site and reference site were similar with respect wildlife survey results, native plant species composition and diversity, and habitat types. The mitigation site had smaller seasonally saturated areas but larger areas of open water, compared to the reference site. The vegetation at the reference site was more mature compared to the mitigation site. Both the mitigation and the reference site appear to provide good wildlife habitat; birds and other wildlife were abundant both in number of individuals and number of species present. The differences in the development and structure of the vegetation at the two sites did not seem to significantly affect avian species use. Some species observed only at the reference site (e.g., northern waterthrush, eastern wood pewee, eastern screech owl, ruby crowned kinglet, veery, wood thrush) prefer the wet hardwood forest unique to that site. Alternately, the mitigation site had a larger proportion of open water habitat that attracted some species that were not observed at the reference site (e.g., wood duck, common moorhen, Canada goose, kingfisher).

Other species that were observed exclusively on either site (e.g., house finch, grasshopper sparrow, swamp sparrow, eastern kingbird) use habitat types available at both sites, but were not observed there during the field survey effort. Conditions for amphibians at both sites appear to be favorable; the northern leopard frog was prolific on both sites. Mammals and deer appeared to thrive at both sites as well.

Invasive species cover was higher at the mitigation site, estimated to be 31% areal cover at the mitigation site and 14% at the reference site. Reed canarygrass occupied similar habitats in both sites, primarily seasonally wet areas lacking a dense woody species canopy. The majority of the reed


Native emergent community under dense blueberry shrubs.

canarygrass population occupies emergent areas that did not experience any grading and still contain blueberry plants; these areas are densely filled with reed canarygrass.

The canopy cover is still developing at the mitigation site, and may be on a trajectory toward developing similar characteristics as the reference site.

The surrounding land use for both sites is low-intensity agricultural lands and residential properties with lot sizes of at least 5 acres. Table 22 summarizes the conditions and land uses surrounding the paired sites.

Table 22. Land Uses and Site Characteristics

Attribute	Mitigation Site			Reference Site		
Watershed characteristics	Agriculture, small farms			Same as mitigation site		
HGM class	Depressional			Depressional		
Cowardin class	PFO, PSS, PEM			PFO, PSS, PEM		
Plant diversity	High			High		
Woody debris/habitat structures	Some logs, snags, and LWD in the wetland.			Some logs, snags, and LWD in the wetland.		
Hydrologic conditions	Restricted outlet (30-inch culvert), permanent open water, seasonally flooded, seasonally saturated.			Unrestricted outlet into ditch, Seasonal open water, seasonally flooded, seasonally saturated.		
Surrounding land use (distance from site)	**330 feet**	**825 feet**	**3,300 feet**	**330 feet**	**825 feet**	**3,300 feet**
High Intensity (highways, industrial)	-	-	5%	-	-	-
Moderate Intensity (residential, agriculture, parks)	90%	90%	75%	90%	90%	70%
Low Intensity (pasture, residential with > 5 acre lots)	5%	5%	10%	5%	5%	15%
Undeveloped (open space)	5%	5%	10%	5%	5%	15%
Note: PEM = palustrine emergent, PFO = palustrine forested PSS = palustrine scrub-shrub, LWD = large woody debris						


Beetle damage to purple loosestrife.

Weed control efforts undertaken by MDOT at the mitigation site target reed canarygrass and purple loosestrife. MDOT's efforts to control the spread of invasive species include using biological control with beetles (*Galerucella calmariensis*) for purple loosestrife and chemical herbicides to target the reed canarygrass and common reed.

Both sites would have failed to achieve the 10% areal cover of invasive species required by the Michigan Department of Environmental Quality (MDEQ) based on these field surveys and the most recent MDOT monitoring reports. Estimated areal coverage of invasive species was 31% at the mitigation site and 14% at the reference site. The mitigation site appears to have achieved the intended site goals as stated in the mitigation plan (Michigan Department of Transportation 2000), and the mitigation project appeared successful in creating wetlands that provide similar habitat and vegetative communities to the adjacent reference site. MDOT conducts intensive monitoring on native plant cover and diversity in all Cowardin classes and conducts hydrology monitoring in three monitoring wells on the site. Although no specific cover of invasive species were included in the permit language, which predated MDEQ performance standards, neither this site, nor its reference site, would have achieved the 10% areal cover of invasive species currently required for MDOT wetland mitigation sites.

Implications of Invasive Species Performance Standards

The information presented in the following section was obtained via questionnaire from MDOT personnel experienced with the MDOT mitigation program, unless otherwise cited. This information is not intended to state policy or guidance and only represents responses from MDOT personnel interviewed for this study.

MDEQ began requiring MDOT to comply with a performance standard of 10% areal cover of invasive species on all of its mitigation projects around 2004. Species considered invasive by MDEQ include reed canarygrass, common reed, and purple loosestrife. The Blueberry Farm Wetland Mitigation Site failed to achieve the 10% invasive species cover threshold, despite MDOT's efforts to control the spread of invasive species using biological control (beetles) and chemical herbicides.

MDOT personnel indicate that MDOT routinely has difficultly complying with the areal cover standards for sites that included significant, pre-existing invasive species populations (Sneed pers. comm.). Much of the populated portions of Michigan where most capacity improvement projects occur are highly developed for agriculture or residential development. The landscape alterations caused by these land uses tend to introduce and create conditions that favor invasive species.

Invasive species are widely spread in populated regions of Michigan, and are often present in MDOT's impact sites and potential mitigation sites.

MDOT has proposed alternative approaches for dealing with invasive species to MDEQ. MDOT has begun documenting invasive species cover at impact sites to demonstrate the disparity between the high cover of invasive species at the impact wetlands and the mitigation performance standards. MDOT has also documented their attempts to control invasive species to meet areal cover thresholds required in mitigation performance standards. MDEQ has not cited any specific rationale for their use of the invasive species performance standards. Although there is no official documentation of this goal, MDOT personnel indicate that MDEQ has expressed a desire for mitigation sites to achieve pre-European settlement conditions.

MDEQ requires ongoing invasive species control for mitigation sites that exceed the performance standard for invasive species, or for sites with invasive species cover in excess of 10%. The MDEQ permit for the Blueberry Farm Wetland Mitigation Site did not include a quantitative performance standard for invasive species cover, but the site has not yet been approved because of the presence of reed canary grass. This site, along with other mitigation sites that fail to achieve invasive species cover standards, are continually managed and monitored.

Compliance Strategy

MDOT attempts to manage invasive species during all phases of mitigation, including site selection, construction, and maintenance. MDOT attempts to select sites with low invasive species, but invasive-free properties are often not available. MDOT locates its mitigation sites within the same 9-digit HUC watershed, which is consistent with federal and state guidance. When the watershed characteristics have been altered from development, MDOT often must use highly disturbed sites for mitigation projects, including sites with high invasive species cover.

MDOT pre-treats its mitigation properties with herbicide to control reed canarygrass and common reed, and will also remove topsoil with the invasive species seedbank and establish a cover crop, if necessary. Mitigation design often includes altering site hydrology to reduce habitat for invasive species. MDOT uses biological control for purple loosestrife with good success, and is working with Cornell University to develop biological controls for common reed.

Site Management Costs

MDOT controls invasive species after construction using its own staff or private contractors. Weed control costs approximately $500 per acre annually, and monitoring costs up to $2,000 per site annually (Table 23). Approximately half of MDOT's monitoring effort is expended to assess invasive species performance standards, and includes assessments of the effectiveness of the control efforts.

Table 23. Mitigation Costs for Restored and Constructed Wetlands

Mitigation construction costs per acre (including real estate)	$3,000 to $100,000
Annual invasive species control costs per acre	$500
Annual invasive species monitoring costs per site	$1,500-$2,000

Summary and Conclusions

MDEQ considers the Blueberry Farm Wetland Mitigation Site noncompliant because it exceeds the current permit requirement of less than 10% areal cover of invasive species. This site was established by restoring a blueberry farm to wetlands by excavating, impounding, and filling ditches. A relatively undisturbed site nearby was evaluated as a reference site for this study. The reference site contains a mature vegetation community with an estimated 15% areal cover of reed canary grass, which also exceeds the current 10% performance standards. Wildlife observation and native plant diversity estimates were similar at both sites.

All sites that fail to achieve less than 10% areal cover of invasive species are continually managed and monitored as MDOT seeks permit approval. MDOT controls invasive species using a comprehensive management approach, but has had limited success when mitigation sites are in an invasive species-dominated watershed.

MDEQ invasive species cover performance standards were established in 2004, and dictate that invasive species must account for less than 10% areal cover. MDOT has engaged MDEQ in attempts to develop performance standards that could be met more consistently. MDOT has also begun including invasive species cover in their environmental impact documentation in order to compare invasive cover on impact and mitigation sites.

Minnesota Department of Transportation – Beyer Mitigation Bank

The Minnesota Department of Transportation (Mn/DOT) is responsible for developing and implementing policies, plans, and programs for highways, railroads, commercial waterways, aeronautics, public transit, and motor carriers. To compensate for the impacts of highway projects, Mn/DOT primarily uses credits generated at wetlands mitigation banks created by the Minnesota Board of Water and Soil Resources (BWSR) specifically for roadway impacts. BWSR, which has representation from state and local government agencies, develops mitigation banks for multiple users for similar project types and oversees the implementation of performance standards at these sites.

The Beyer Mitigation Bank was developed by BWSR and is eligible for Mn/DOT or other roadway projects. The mitigation site is located in Traverse County, about 4 miles from the Minnesota-North Dakota border, and 65 miles south of Fargo, North Dakota. This 64.9-acre site is located on private property in the Spring Prairie Township, and includes approximately 32 acres of restored wetlands. Previous to restoration, the parcel was cultivated for more than 30 years. The target wetland communities for restoration included shallow and deep marsh, wet meadow, and mesic prairie uplands. Construction and seeding of the site occurred in fall 2003.

The reference site is located in the Green Waterfowl Production Area (WPA) in the Bois de Sioux watershed, about 20 miles due east of the mitigation site. The WPA


Mitigation site - cattail marsh and open water.

is a complex of six natural pothole wetlands managed by USFWS to provide wildlife habitat. This site was recommended by USFWS personnel as an example of a high quality prairie pothole wetland. The field studies focused on a single pothole located along the eastern edge of the Green WPA.

The county containing the paired sites is heavily developed for agriculture; an informal review of aerial photographs indicates that over 80% of the land is in crop production. Unfarmed areas are generally prairie pothole wetlands that dot the landscape. Other types of development are limited, and consist primarily of low-volume roads, train tracks, and scattered residences. Invasive herbaceous species associated with agriculture are abundant.

Field Studies


Reference site - wet meadow with willow stand.

The paired sites were surveyed for birds, wildlife, and invasive species cover on June 30 and July 1, 2009. Bird surveys were conducted between 5:00 and 9:00 am, with two sets of bird surveys performed at each study site, and all surveys were conducted by the same staff. At the mitigation site, three transects of varying lengths were oriented east-west. At the reference site, four transects of varying lengths were oriented north-northeast and were placed to capture Cowardin classifications similar to the mitigation site. Wildlife stations for the bird point counts were positioned around the edge of the wetlands at both sites, and distributed to minimize overlap between point count stations. Site maps with approximate invasive species transect locations and wildlife stations are shown in Figures 9 and 10.

The mitigation and reference sites include wet meadow, shallow marsh, and open water areas. A small amount of scrub-shrub wetland was present in the reference site.

Wildlife Use

More bird species were observed at the reference site (25) than at the mitigation site (19), but a greater proportion were described as wetland obligates or associates at the mitigation site (84% vs. 71%). Individuals with young or carrying food were observed at both sites, but twice as many species (6 vs. 3) were confirmed as breeders at the reference site, compared to the mitigation site. All the species observed in both sites are common summer residents in the prairie pothole region of Minnesota (U.S. Fish and Wildlife Service 2009). Birds were assigned a wetland classification indicating categories of wetland use based on habitat use (Poole 2009).

Table 24 summarizes the bird observations at both sites. Only the wetland species have been listed in detail; all non-wetland species are summarized in the total number observed by site.

Table 24. Birds Species Observed at the Beyer Mitigation Bank and Reference Site

Species	Scientific name	Mitigation	Reference	Wetland Use
Bald eagle	*Haliaeetus leucocephalus*		X	Obligate; open water
Barn swallow	*Hirundo rustica*		X	Associated
Blue-winged teal	*Anas discors*	X	X	Obligate; PEM, open water
Canada goose	*Branta canadensis*		X	Obligate; PEM, open water
Common grackle	*Quiscalus quiscula*	X	X	Associated
Common snipe	*Gallinago gallinago*	X		Obligate; wetlands w/muddy areas
Common yellowthroat	*Geothlypsus trichas*	X	X	Obligate; PSS, PEM
Double crested cormorant	*Phalacrocorax auritus*		X	Obligate; open water
Great blue heron	*Ardea Herodias*		X	Obligate; open water
Great egret	*Ardea alba*		X	Obligate; open water
Green-winged teal	*Anas crecca*	X		Obligate; PEM, open water
Mallard	*Anas platyrhynchos*	X	X	Obligate; PEM, open water
Marsh wren	*Cistothorus palustris*	X	X	Obligate; PEM - cattail marshes
Northern shoveler	*Anas clypeata*	X		Obligate; PEM, open water
Red-winged blackbird	*Agelaius phoeniceus*	X	X	Obligate; PEM, PSS
Sedge wren	*Cistothorus platensis*	X	X	Obligate; PEM - wet meadow
Song sparrow	*Melospiza melodia*	X	X	Obligate; PSS, PEM
Sora	*Porzana carolina*		X	Obligate; PEM
Swamp sparrow	*Melospiza Georgiana*	X	X	Obligate; PSS, PEM - wet meadow
Tree swallow	*Tachycineta bicolor*		X	Associated
White pelican *	*Pelecanus onocrotalus*		X	Obligate; open water
Willow flycatcher	*Empidonax traillii*		X	Obligate; PSS
Yellow warbler	*Dendroica petechia*		X	Obligate; PFO, riparian zones
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	X	X	Obligate; PEM
Wetland obligate or associated		13	21	
Non-wetland Species		6	4	
Total Species Observed at Site		**19**	**25**	
Confirmed breeders		3	6	
Unique to site		2	11	
Wetland obligate or associated		13	21	

*Status: Minnesota species of special concern

Confirmed breeders = species observed carrying food or with young, or a nest identifiable to that species was observed in the wetland.

Unique to site = species observed at either the mitigation or the reference site, but not both.

Note: PEM = palustrine emergent, PFO = palustrine forested, PSS = palustrine scrub-shrub

Notably, no amphibians were seen or heard at either site. White-tailed deer were observed at both sites, and a coyote and a striped skunk were observed at the mitigation site. Table 25 summarizes the non-avian wildlife observations at the mitigation and reference sites. Observed wildlife species were assigned a wetland classification based on habitat use (Conant and Collins 1998, Burt and Grossenheider 1976).

Table 25. Non-Avian Species Observed at the Beyer Mitigation Bank and Reference Site

Species	Scientific Name	Mitigation	Reference	Wetland Use
AMPHIBIANS				
None				
REPTILES				
None				
MAMMALS				
Striped skunk	*Mephitis mephitis*	X		Opportunistic
Coyote	*Canis latrans*	X		Opportunistic
White-tailed deer	*Odocoileus virginianus*	X	X	Opportunistic
	Total Species Observed at Site	**3**	**1**	
	Wetland obligate or associated	0	0	
	Unique to Site	2	0	

Invasive Species Cover

The mitigation site was constructed to meet the conditions of permits held by the BWSR and the Corps. The permits require that "noxious weeds on the property will be controlled" with the expectation that any infestation be treated, and that invasive species areal cover will be less than 20% with specific reference to reed canarygrass and Canada thistle (*Cirsium arvense*). Canada thistle is listed as both a noxious weed and an invasive species. Reed canarygrass in not on the noxious weed list but is considered an invasive species by BWSR. BWSR requires a predominance of native vegetation on all mitigation sites that it administers. However, BWSR does not include nonnative cattails and clovers in its calculations of areal cover. Broadleaf cattail (*Typha latifolia*) is native throughout Minnesota. Narrowleaf cattail (*Typha angustifolia*) is believed to be native to the eastern region of the United States but not Minnesota. Mitigation banks constructed to offset the impacts of road projects are typically required to maintain less than 20 % cover of invasive species in permit conditions.

At the mitigation site, invasive species represented 16% of the total areal cover, while invasive species represented 37% of the total areal cover at the reference site contained one of these two species. Reed canarygrass was more common than Canada thistle at both sites (Table 26).

Table 26. Invasive Species Cover Comparison

Invasive Species	Mitigation (areal cover)	Reference (areal cover)	Project Performance Standard (areal cover)
Reed canarygrass	13%	31%	< 20%
Canada thistle	3%	6%	< 20%
Total Invasive Cover	**16%**	**37%**	**< 20%**

Reed canarygrass and Canada thistle were observed scattered throughout the emergent wetland areas (shallow marsh, wet meadow) of both sites. Reed canarygrass dominated the understory in the scrub-shrub portion of the reference site (Table 27).

Table 27. Invasive Species Cover by Cowardin Classification

	Mitigation (areal cover)		Reference (areal cover)		
Invasive Species	**Emergent**	**Aquatic Bed**	**Scrub-Shrub**	**Emergent**	**Aquatic Bed**
Reed canarygrass	18%	0%	100%	35%	0%
Canada thistle	4%	0%	0%	7%	0%

Note: Values presented for each Cowardin class do not correspond to the total invasive species cover presented in the previous table because the mitigation and reference sites contain multiple Cowardin classes of varying sizes

Overall, plant diversity at both sites was relatively low, with the shallow marsh at both sites dominated by cattails, including nonnative narrowleaf cattail and narrowleaf - broadleaf hybrids. Twenty species of native and nonnative vegetation were present in the wet meadows, but at both sites this wetland type was dominated by fewer than 10 species. Additional weedy plants that are considered invasive (e.g., sweet clovers [*Melitotus alba, M. officinalis*]), (Minnesota Department of Natural Resources 2010) but not listed in mitigation performance standards, were observed at the mitigation site.

Cattail bed typical of study sites and other nearby wetlands.

Discussion

Both sites appear to provide good avian habitat for wetland-associated species and grassland species that accept mesic conditions. The number of avian species and overall number of individuals were greater at the reference site, reflecting the larger area of wetlands and untilled uplands associated with the Green WPA. Most of the 11 species that were observed only at the reference site either have larger habitat area requirements (e.g., bald eagle, double-crested cormorant, white pelican, sora) or benefit from the presence of scrub-shrub cover a (e.g., Baltimore oriole, willow flycatcher). The greater number of individuals and larger area of suitable habitat at the reference site supports a greater number of breeders. It is noteworthy that, despite suitable habitat conditions, no

amphibians were seen or heard at either site. The sites are within the known range of the northern leopard frog, Great Plains toad, and Canadian toad.

Overall, the mitigation and reference sites are similar in setting and attributes (Table 28). Both sites were dominated by the same wetland classes, with similar distribution of plant species within each wetland class. Plant diversity at both sites was relatively low, although low diversity is probably typical for this watershed because of the widespread agricultural land use. As noted above, the emergent marsh at both sites was heavily dominated by cattails, including nonnative narrowleaf cattail and narrowleaf - broadleaf hybrids. However, BWSR does not include nonnative cattails or sweet clovers when calculating invasive cover of a wetland. Cattails commonly dominate wetland vegetation communities in the region and BWSR recognizes that attempting to control this species would be unachievable. At both sites reed canarygrass and Canada thistle were present in the shallow marsh and wet meadow wetland types. In general, Canada thistle was present at low densities or as scattered individuals, and tended to be present in the drier portions of the wetland. However, it was also observed mixed with cattails, near the edge of the open water at the reference area. At both sites, reed canarygrass had a more consistent presence across a wider range of moisture regimes as compared to Canada thistle. Reed canarygrass occurred at both sites in small to moderated-sized stands, as well as mixed with cattails, other weeds, or native species.

Table 28 summarizes the conditions and land uses surrounding the paired sites.

The most notable difference in vegetation between the two sites was the greater amount of reed canarygrass at the reference site. Construction, seeding, and initial management activities at the mitigation site were carefully timed to minimize invasive species cover, but as the site matures it is likely to develop more invasive species cover unless management activities continue. The agricultural lands surrounding both sites provide a constant source of seeds, propagules, and nutrients.

No evidence of recent management activities was observed at either site, and the Beyer Mitigation Bank 2008 annual monitoring report indicates that mowing to control invasive species was last conducted in 2005. The Beyer Mitigation Bank currently meets performance standards, and the monitoring report recommends weed control measures be implemented to maintain compliance.

Table 28. Land Uses and Site Characteristics

Attribute	Mitigation Site			Reference Site		
Watershed characteristics	The topography of the Bois de Sioux watershed varies from gently rolling to very flat. About 90% of the area is cropland with a small percentage of pasture, wetland areas (1.3%), and woodlands (1.8%).			Same as mitigation site		
HGM Class	Depressional			Depressional		
Cowardin Class	PSS,PEM, PAB			PSS, PEM, PAB		
Plant diversity	Low (> 10 dominants)			Low (> 10 dominants)		
Woody debris/habitat structures	No snags, stumps and logs.			No snags, stumps and logs. Some LWD available in upland edges.		
Hydrologic conditions	Seasonally flooded, permanently saturated			Permanently flooded, permanently saturated		
Surrounding land use (distance from site)	**330 feet**	**825 feet**	**3,300 feet**	**330 feet**	**825 feet**	**3,300 feet**
High Intensity (highways, industrial)	-	-	-	-	-	-
Moderate Intensity (residential, agriculture, parks)	70%	75%	90%	25%	60%	70%
Low Intensity (pasture, residential with > 5 acre lots)	-	-	-	-	-	-
Undeveloped (open space)	30%	25%	10%	75%	40%	30%

Note: PAB = palustrine aquatic bed, PEM = palustrine emergent, PSS = palustrine scrub-shrub, LWD = large woody debris

Implications of Invasive Species Performance Standards

The information presented in the following section was obtained via questionnaire from BWSR personnel experienced with the BWSR road mitigation program, unless otherwise cited. This information is not intended to state policy or guidance and only represents responses from BWSR staff interviewed for this study.

BWSR was established to implement Minnesota's Wetland Conservation Act Rules (MN Rule 8420) through the state's local government units (LGUs) that have land-use authority over the lands in their jurisdiction. In addition to providing oversight to wetland impact and mitigation in general, BWSR works in conjunction with the LGUs to establish wetland banks to mitigate for a range of impacts, including road construction (Strojny pers. comm.).

BWSR wetland permits must be approved by the LGU and the Corps. No other state agencies are involved in the process. Both agencies can set invasive species cover thresholds for replacement wetlands under their jurisdiction. The LGU's standards must not be less restrictive than the state standards, which are established in MN Rule 8420. For all wetland permits, MN Rule 8420 requires a predominance of native vegetation, although nonnative cattails are exempted from this rule. MN Rule 8420 does not apply a single standard to all permits. Instead, performance standards are

project type-specific, and tolerance of invasive species cover depends on the functional goals of the restoration, and the expected credit yield (partial or full credit). In practice, cover performance standards for invasive species vary project by project, and are typically less than 20% cover. Typical species listed on permits include reed canarygrass, Canada thistle, bull thistle (*Cirsium vulgare*), smooth brome grass (*Bromus inermis*), giant ragweed (*Ambrosia trifida*), common ragweed (*Ambrosia artemisiifolia*), quack grass (*Elytrigia repens*), black locust (*Robinia pseudoacacia*), sweet clovers (*Melilotus alba* and *M. officinalis*), nonnative honeysuckles (e.g., *Lonicera* x *bella*), and nonnative buckthorns (*Rhamnus cathartica* and *R. frangula*). Performance standards typically require no purple loosestrife cover at the end of the monitoring period.

BWSR has required a predominance of native vegetation on all replacement wetlands since 2002. Efforts to limit invasive cover to less than 20% on road banks have been implemented since around 2005. Both BWSR and Mn/DOT support and fund research on restoration methods for native vegetation. The research and information from the greater wetland professional community influence the technical standards applied to wetland restorations.

BWSR permits specify vegetation requirements that vary depending on intended functions, the number of mitigation credits generated, and site conditions. BWSR has developed a method for rating wetlands (Board of Water and Soil Resources 2009), which includes thresholds of invasive species cover by quality rating (high, medium, or low). These thresholds vary by wetland type. The amount of credit a bank can grant depends, in part, on its quality rating. Mitigation sites that are deemed failures based on invasive performance standards can still receive partial credit if the creation or increase of other functions (e.g., restoration of hydrology and establishment of perennial cover) is recognized by both the LGU and the Corps.

BWSR and the permitting agencies recognize that aggressive invasive plants are unlikely to be controlled on some sites due to management constraints or difficulty in controlling seed source. In these cases, the functional goals for a site may not include establishment of native species, but focus on other wetland functions such as flood retention, and water quality. For areas that are expected to generate credit for enhancing existing vegetation, a lower tolerance for invasive species is typically in the permit. The amount of credit granted for wetland banks that fall into these categories is adjusted accordingly.

Compliance Strategy

The introduction of invasive species performance standards has altered the way BWSR selects sites, designs and constructs wetlands, and maintains sites (Table 29). In agricultural areas, BWSR prefers sites without perennial species cover. The presence of weed propagules upstream and on adjacent land is also considered. Site choice, preparation techniques, seed mixes, and timing of activities are heavily influenced by the threat of invasive species. During project planning, the site maintenance schedule is designed specifically so that maintenance activities are timed to maximize control of invasive species.

BWSR typically uses the following weed control methods during site preparation: crop rotation timing (begin grading after row crops where agriculture weeds have been controlled), tillage, chemical treatment, and prescribed burning. Crop rotation timing and tillage were used on the mitigation site. After a wetland is established, typical weed control methods include flooding, chemical treatment, mowing, and tillage. The mitigation site was subject to mowing during establishment herbicide treatment one year after seeding. Weed control for the majority of BWSR sites is generally conducted by contractors. However, at the mitigation site, weed control measures

were prescribed by a technical evaluation panel with representation from the LGU, BWSR, and other local technical professionals, and carried out by the landowner.

Table 29. Invasive Species Controls by Project Phase

Project Phase	Invasive Species Controls
Site selection	• Select sites without established perennial cover • Avoid sites adjacent to or downstream from infested areas
Site construction	• Time site preparation to minimize germination and growth
Project maintenance	• Burn, mow or cutting standing plants • Treat with herbicides • Flood invasive plants

Site Management Costs

One of BWSR's primary functions is to administer wetland construction and monitoring, and they closely track costs for the average wetland project. Construction costs for a mitigation site, including real estate, average $5,000 per acre ($3,500 per acre for the easement and $1,500 per acre for construction and seeding). Invasive species control costs average $5,000 per mitigation site per year and can range from $20 to $120 per acre. Post-construction monitoring addresses invasive species performance standards, at an average annual cost per site of $1,000. All monitoring reports include a qualitative assessment of invasive control effort effectiveness. No costs specific to the mitigation site were provided, but all indications are that it is a typical site.

Summary and Conclusions

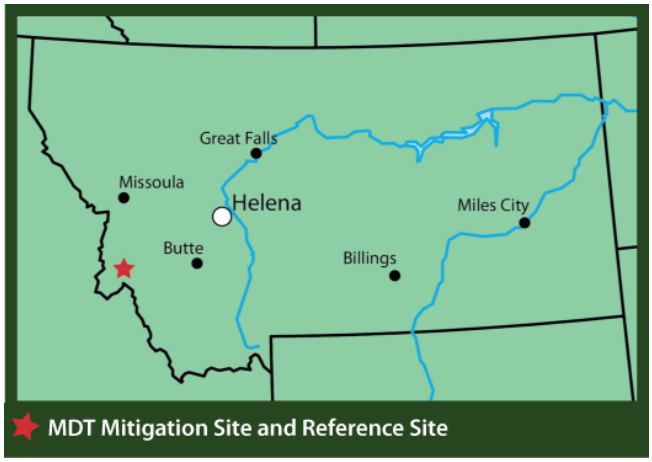
Reed canarygrass and Canada thistle were present at both the mitigation and reference site. The combined total areal cover of these two species exceeded the 20% standard at the reference site, but not at the mitigation site, where the target invasive species cover was estimated to be 16%. Vegetative communities and wildlife are similar at the two sites. The greater amount of wildlife observed at the reference site is attributed to the site's larger size and the presence of shrubby vegetation. BWSR appears to have been successful in establishing the intended vegetation communities and habitat types at the mitigation site, and in meeting invasive species performance standards.

Minnesota has developed invasive species cover standards by wetland type to qualify as the wetland as high, medium, or low quality. These standards partially determine the amount of credit a wetland bank can grant. Mitigation sites that do not meet invasive performance standards can still receive partial credit if the site creates or enhances other wetland functions.

Montana Department of Transportation – Camp Creek Mitigation Site

The Montana Department of Transportation (MDT) oversees highway, rail, and aviation systems and infrastructure throughout Montana. MDT provides mitigation on private, public, and tribal lands, in partnership with land owners or management agencies. The mitigation sites are typically developed 5 to 6 years prior to project impacts through mitigation agreements that function like mitigation

banks. MDT's mitigation sites generate credits depending on the site's achievement of performance standards or mitigation goals and objectives.



The Camp Creek Mitigation Site is located in the southwestern corner of the state, 3 miles south of the small town of Sula and in the historic Camp Creek floodplain, just west of the continental divide. The Camp Creek Mitigation Site was developed in 2002 to mitigate for wetland and stream impacts incurred during the Sula North-South Project, ,which widened and repaired State Highway 93. The mitigation site also serves as a mitigation credit reserve for future MDT projects in the region. As of 2008, the Camp Creek Mitigation Site includes a total of 39.37 acres of wetland and 2.15 acres of Camp Creek open water channel area that were restored to compensate for 11.4 acres of wetland impacts. The goals of the mitigation site are as follows:

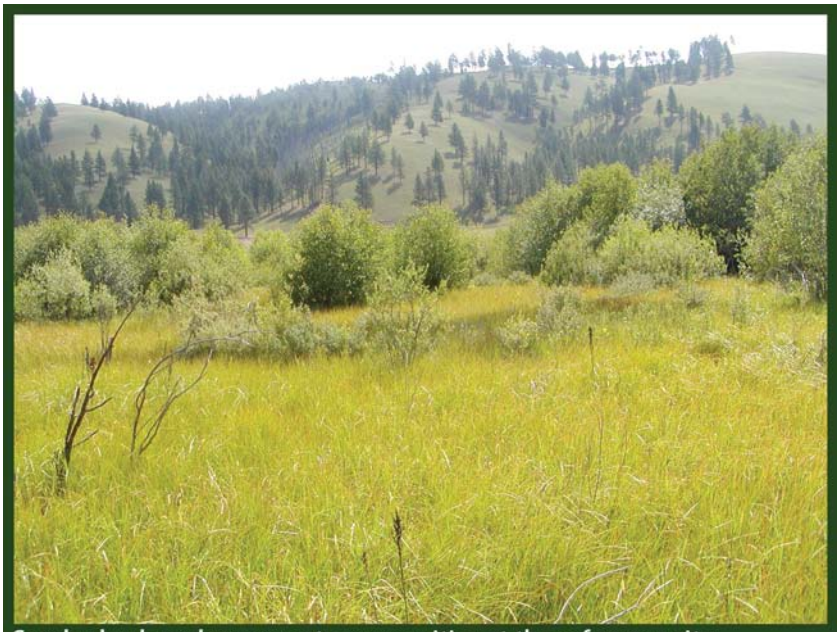
- Return Camp Creek to its historic channel and establish a new channel.
- Restore hydrology and vegetation, and recreate high value wetland habitat along the creek riparian corridor.
- Create emergent and scrub-shrub wetlands in the floodplain margins of the new channel.

Two reference reaches were used during site design: a downstream reach and a large wetland complex located across the highway. Only a small portion of the wetland complex has public access, so this portion was used as the reference site. This reference site is a high-quality wetland, representative of natural conditions prior to the logging and agricultural alterations in the Camp Creek floodplain.

Field Studies

The paired sites were surveyed for birds, wildlife, and invasive species on July 13, 14, and 15, 2009. The sites are located approximately 200 feet apart. Wildlife surveys were performed on two consecutive days at each site between 5:00 and 9:00 a.m. by the same field biologists. Wildlife stations were positioned along the invasive species transects in different vegetation communities at both sites.

Because of the irregular shape of the mitigation site, transects were installed to cross wide areas of site. The mitigation site was sampled using three transects; one 500-foot-long transect and two 900-foot–long transects. The total transect interval length was 2,300 feet. Five transects were established at the reference site, ranging in length from 150 to 300 feet. Given the site's relatively small area with private property access, only 1,075 feet of transect length reasonably fit. Transects were oriented to avoid the large area of deep open water on the site. Site maps with approximate invasive species transect locations and wildlife stations are shown in Figures 11 and 12.


Scrub-shrub and emergent communities at the reference site.

Both sites include areas of dense shrub communities, emergent-dominated areas, a seasonal hydrologic regime, perennial streams, and open water components. Seasonal flooding, perennial creek waters, and groundwater provide the primary hydrology to the sites. Camp Creek flows south to north and eventually drains into the East Fork of the Bitterroot River. Two tributaries flow into Camp Creek within the sites: Andrews and Praine Creek.

Wildlife Use

A comparable number of bird species were observed at the mitigation site (34) and the reference site (32). The proportion of birds categorized as associate or obligate species to total birds observed was slightly higher at the reference site (44%) than at the mitigation site (41%). All of the species observed in both sites are common summer residents of western Montana (Montana Department of Fish, Wildlife and Parks et al. 2007). There were no signs of birds breeding at either site. Birds were assigned a wetland classification based on habitat use (Lenard et al. 2003). All species observed during the site reconnaissance one day prior to the formal survey, as well as species observed while conducting the vegetation sampling component, were recorded and are included in the species list. Table 30 summarizes bird observations both sites. Only the wetland species have been listed in detail; all non-wetland species are summarized in the total number observed by site.

Several terrestrial garter-snakes were observed sunning in the mitigation site. Spotted frogs were observed on both sites. Frog chorusing was not heard at either site, and breeding activity was not confirmed.

Other non-avian species observed (via scat and track) at both sites were mule deer, elk, and coyote. Mule deer were seen on the mitigation site and a mother moose and calf were reported by the landowner to be present at the reference site at the time the study was conducted, but were not directly observed. Moose tracks and scat were observed at the reference site.

Table 30. Birds Species Observed at the Camp Creek Mitigation Site and Reference Site

Species	Scientific Name	Mitigation	Reference	Wetland Use
Bald eagle	*Haliaeetus leucocephalus*	X	X	Obligate; open water
Barn swallow	*Hirundo pyrrhonota*	X	X	Associated
Canada goose	*Branta canadensis*		X	Obligate; PEM open water
Common snipe	*Gallinago gallinago*	X	X	Obligate; wetlands w/muddy areas
Common yellowthroat	*Geothlypsus trichas*	X	X	Obligate; PSS, PEM
Eastern kingbird	*Tyrannus tyrannus*	X	X	Associated
Great blue heron	*Ardea herodias*	X	X	Obligate; open water
Hooded merganser	*Lophodytes cucullatus*		X	Obligate: PFO
Northern harrier	*Circus cyaneus*	X	X	Associated
Northern rough-winged swallow	*Stelgidopteryx serripennis*	X	X	Associated
Red-winged blackbird	*Agelaius phoeniceus*	X	X	Obligate; PEM, PSS
Song sparrow	*Melospiza melodia*	X	X	Obligate; PSS
Spotted sandpiper	*Actitis macularia*	X		Obligate; shoreline
Tree swallow	*Tachycineta bicolor*	X	X	Associated
Willow flycatcher	*Empidonax traillii*	X	X	Obligate; PSS
Yellow warbler	*Dendroica petechia*	X	X	Obligate; PFO, riparian zones
Wetland obligate or associated		14	14	
Non-wetland species		20	18	
Total Species Observed at Site		**34**	**32**	
Confirmed breeders		0	0	
Unique to site		4	2	

Confirmed breeders: no species observed carrying food or with young, or a nest identifiable to that species was observed, possibly due to the late season surveys.

Unique to site: species observed at either the mitigation or the reference site, but not both.

Note: PEM = palustrine emergent, PFO = palustrine forested, PSS = palustrine scrub-shrub

Observed wildlife species were assigned a wetland classification based on habitat use (Conant and Collins 1998; Burt and Grossenheider 1976).

Table 31. Non-Avian Species Observed at the Camp Creek Mitigation Site and Reference Site

Species	Scientific Name	Mitigation	Reference	Wetland Use
AMPHIBIANS				
Spotted Frogs	*Rana luteiventris*	X	X	Obligate; PEM; OW
REPTILES				
Terrestrial gartersnakes	*Thamnophis elegans*	X		
MAMMALS				
Mule deer	*Odocoileus hemionus*	X	X	
Elk	*Cervus canadensis*	X	X	
Coyote	*Canis latrans*	X	X	
Moose	*Alces alces*		X	
	Total Species Observed at Site	**5**	**5**	
	Wetland obligate or associated	1	1	
	Unique to site	1	1	
Note: OW = open water, PEM = palustrine emergent				

Invasive Species Cover

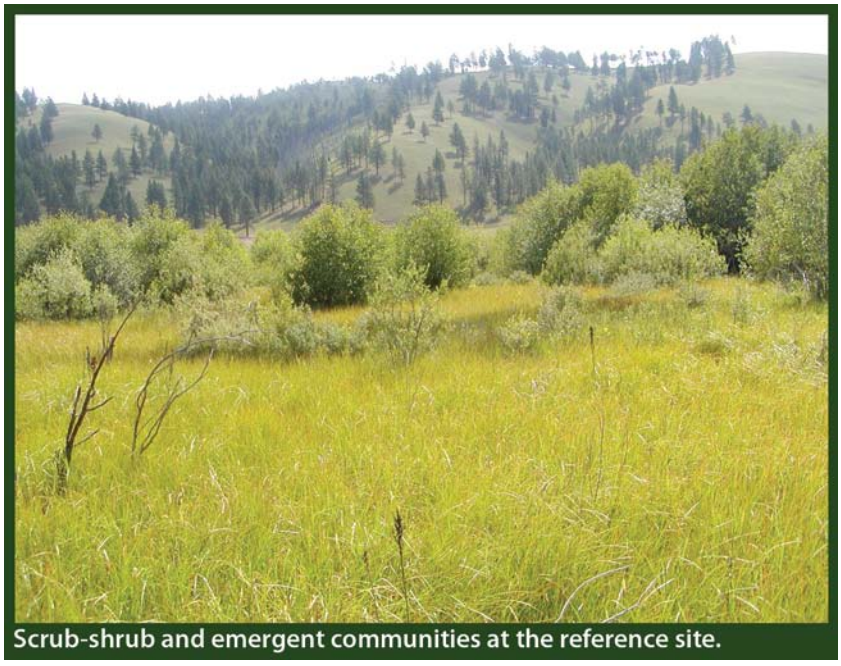
The permit for the Camp Creek Mitigation Site requires the control of noxious weeds during site management, but does not include specific invasive species performance standards. MDT has maintained the mitigation site since 2002, controlling noxious weeds and other known invasive species. The Corps instituted performance standards that limit the combined cover of Garrison creeping foxtail (*Alopecurus arundinaceus)* and reed canarygrass to 10% on mitigation projects beginning in 2005. MDT engaged the Corps to look for alternative performance standards shortly thereafter. To date, Corps permits have set limits for areal cover of reed canarygrass and Garrison creeping foxtail on two MDT mitigation sites. The Camp Creek Mitigation Site was selected for study because it was sufficiently developed to evaluate the effectiveness of invasive species control efforts. This mitigation site has been managed similarly to sites that do include the invasive species performance standards.

Reed canarygrass and Garrison creeping foxtail are problematic across Montana and frequent colonizers of seasonally wet soils. Both species are used to seed seasonally wet or irrigated pastures and are palatable to livestock. Both species have also been used in seed mixes for wetland restoration (Montana State Extension 1999, 2001). Neither species is on the state's noxious weed list.

No Garrison creeping foxtail was observed on either site. Reed canarygrass was observed on transects in the mitigation site and, to a lesser degree, in the reference site. At the mitigation site, reed canarygrass areal cover was 11%, slightly exceeding the current 10% performance standard. All of the reed canarygrass was observed in the emergent areas. At the reference site, reed canarygrass areal cover was 2%, well under the performance standard (Table 32).

Table 32. Invasive Species Cover Comparison

Invasive (non preferred) Species	Mitigation (areal cover)	Reference (areal cover)	Current Corps Performance Standard (areal cover)
Reed canarygrass	11%	2%	<10%
Garrison creeping foxtail	0%	0%	<10%
Total Invasive Species Cover	**11%**	**2%**	**<10%**



Scrub-shrub and emergent communities at the reference site.

The mitigation site was modified in 2006, when MDT constructed a flood channel. This recent disturbance has affected current vegetation conditions somewhat. A shrub-shrub or forest community is developing, and although the shrubs and trees are small, they are coming in densely. This dense growth appears to prohibit colonization by invasive species. Field sampling confirmed that all of the invasive species cover occur in emergent areas. Table 33 summarizes the distribution of reed canarygrass and Garrison creeping foxtail by Cowardin class.

Table 33. Invasive Species Cover by Cowardin Classification

Invasive Species	Mitigation Site (areal cover)			Reference Site (areal cover)		
	Emergent	Scrub-Shrub	Forested	Emergent	Scrub-Shrub	Forested
Reed canarygrass	10%	0%	0%	3%	0%	0%
Garrison creeping foxtail	0%	0%	0%	0%	0%	0%

Other dominants on the mitigation site include thin leaf alder (*Alnus incana*), water birch (*Betula occidentalis*), several species of willows (*Salix spp.*), shrubby cinquefoil (*Potentilla fruticosa*), tufted hairgrass (*Deschampsia caespitosa*), redtop (*Agrostis alba*), quackgrass (*Agropyron repens*), and mixed sedges (*Carex* spp.).


Native plant community at the Camp Creek mitigation site.

The mitigation site is also monitored and managed to control spotted knapweed (*Centaurea stoebe*), Canada thistle (*Cirsium arvense*), ox-eye daisy (*Leucanthemum vulgare*), hound's tongue (*Cynoglossum officinale*), and yellow toadflax (*Linaria vulgaris*). These nonnative species generally colonize more disturbed or upland habitats, are aggressive weedy species, and are all Category 1 noxious weeds in Montana. Scattered populations of these species were observed at the mitigation site.

Discussion

The mitigation site and reference site were similar with respect to wildlife survey results, native plant species composition and diversity, and habitat types. The differences between the sites appeared to be attributable to hydrology, age, and the larger areal cover of invasive species at the mitigation site.

Both the mitigation and the reference site appear to provide good wildlife habitat; birds and other wildlife were abundant both in number of individuals and number of species present. The differences in the development and structure of the vegetation at the two sites did not seem to significantly affect avian species use. More species were observed at the mitigation site compared to the reference site. A few the unique species observed at the mitigation site (e.g., spotted sandpiper, lazuli bunting) prefer or are associated with flowing water, which is only available at the mitigation site. Alternately, the reference site had a large area of open water that attracted species unique to that site (e.g., Canada goose, hooded merganser). The other two species that were observed exclusively on the mitigation (Lewis's woodpecker, western meadowlark) were closely associated with the habitat elements adjacent to the mitigation site (e.g., mature forest and open grass fields). Breeding behaviors were difficult to assess during the site visit because the visit was near the end of the breeding season when most young have already fledged. The forest adjacent to the reference site was recently burned, affecting its habitat value. Conditions for amphibians at both sites appeared to be favorable. Large mammals appeared to thrive on both sites and were similarly represented in both diversity and number of individuals.

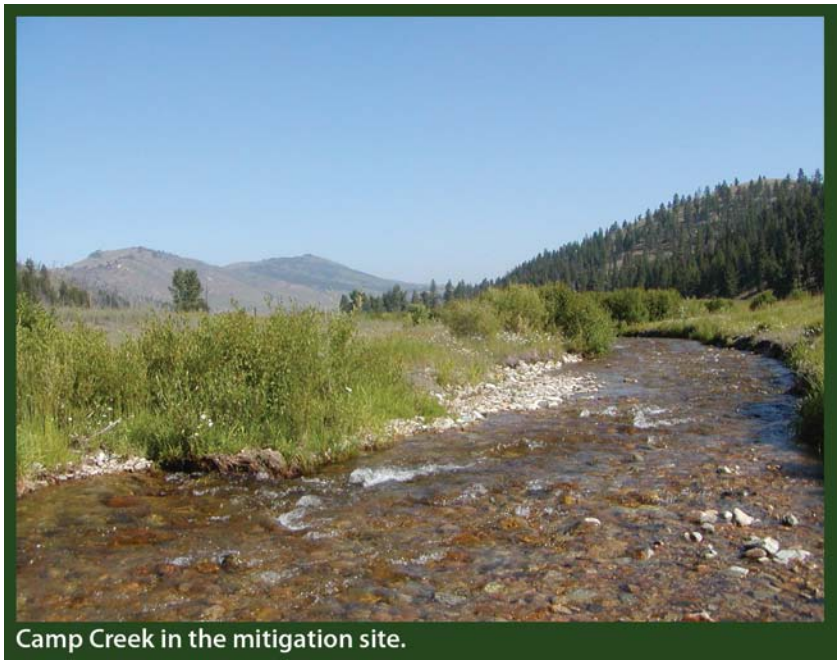
Estimated cover for permit-specific invasive species cover is higher at the mitigation site (11%) compared to the reference site (2%). Most of the invasive species cover occurs on seasonally wet soils or upland fringes. The soils are noticeably wetter at the reference site, where most of the site is saturated, inundated, or has large areas of standing water over the entire site. The Camp Creek Mitigation Site, the reference wetland, and the surrounding uplands were burned in 2000 in the Sula forest fire complex, so the vegetation was comprised of mostly colonizing species.

Table 34 summarizes the conditions and land uses surrounding the paired sites.

Table 34. Land Uses and Site Characteristics

Attribute	Mitigation Site			Reference Site		
Watershed characteristics	Forest, agriculture, open space			Same as mitigation site		
HGM Class	Riverine			Riverine		
Cowardin Class	PSS, PEM			PSS, PEM		
Plant Diversity	High			High		
Woody debris/habitat structures	Some logs, snags, and LWD in the wetland.			Few logs in the wetland.		
Hydrologic conditions	Unrestricted outlet under a bridge, seasonally flooded, seasonally saturated			Restricted outlet (30-inch culvert), seasonally flooded, seasonally saturated		
Surrounding land use (distance from site)	**330 feet**	**825 feet**	**3,300 feet**	**330 feet**	**825 feet**	**3,300 feet**
High Intensity (highways, industrial)	15%	10%	5%	10%	5%	<1%
Moderate Intensity (residential, agriculture, parks)	-	-	-	-	-	-
Low Intensity (pasture, residential with > 5 acre lots)	30%	20%	10%	<1%	<1%	<1%
Undeveloped (open space)	55%	70%	85%	90%	95%%	99%
Note: PEM = palustrine emergent, PSS = palustrine scrub-shrub, LWD = large woody debris						

Invasive species occupy similar habitats in both sites, primarily seasonally wet areas. At the mitigation site, reed canarygrass occupies the drier fringes of the wetland areas or upland islands. The mitigation site has more area with suitable hydrologic conditions for invasive species colonization than the reference site, likely contributing to its higher cover of invasive species. The mitigation site also has more upland area interspersed with the wetland and drier conditions in the wetlands compared to the reference site.



Camp Creek in the mitigation site.

The mitigation site includes the Camp Creek channel, depressions remaining from previous channel migrations, and constructed depressions that provided surface water habitat. The eastern portion of the Camp Creek Mitigation Site is subject to periodic floods from Camp Creek, such as spring runoff and flooding through a constructed flood channel to disperse water into the relic channels and constructed depressions within the landscape. This constructed flood channel was a remedial action taken in 2006 to increase the duration of soil saturation, making it less hospitable to invasive species and noxious weeds. Young populations of sedges and willows are colonizing this new flood channel area.

MDT has been monitoring the Camp Creek Mitigation Site annually since 2002. Although the permit does not specify areal cover performance standards, the standards applied by the Corps on recent sites would not have been met at this mitigation site, the mitigation site appears to have achieved the intended site goals thus far, although it is still being managed. MDT contracts the Ravalli County Weed District for ongoing control of control reed canarygrass and noxious weeds. The mitigation project appears to be successful in creating wetlands that provide similar habitat and vegetative communities to the adjacent reference site, although it has fewer inundated areas than were intended.

Implications of Invasive Species Performance Standards

The information presented in the following section was obtained via questionnaire from MDT personnel experienced with the MDT mitigation program, unless otherwise cited. This information is not intended to state policy or guidance and only represents responses from MDT staff interviewed for this study.

The Corps first began applying performance standards for areal cover of invasive species in 2005, on two MDT mitigation projects. These two projects were not evaluated in this study because the sites have not had sufficient time to develop and would not indicate the ultimate effectiveness of the invasive species control efforts. The performance standards required MDT to maintain less than 10% cover of nonnative species, and specifically referenced reed canarygrass and Garrison creeping foxtail. The Camp Creek Mitigation Site was selected because it is more mature and is managed similarly to the projects where the 10% areal cover performance standards were applied.

After the Corps applied the areal cover performance standards to the two projects, MDT proposed alternative approaches to developing performance standards. MDT has, with help of consultants, developed the Montana Wetland Assessment Method for use in Montana and elsewhere in the western United States. MDT proposes using functional assessment results as the primary mitigation performance criteria rather than emphasizing invasive species cover. MDT targets mitigation projects where historic landscape processes are restored, such as realigning stream channels and restoring natural hydrologic regimes in disturbed or historic wetland sites. MDT proposes that these types of projects provide the greatest functional improvements, but also tend to include pre-existing invasive species communities. MDT expects that many of the potential sites with the greatest opportunities to provide functional lift are infested with non-preferred species such as reed canarygrass and Garrison creeping foxtail; avoiding these sites because of invasive species performance standards would result in lost opportunities to offset functions affected by transportation projects.

The Corps has withheld credits from the two projects subject to the 10% areal cover performance standard. Both projects are actively managed to control reed canarygrass and Garrison creeping

foxtail, but initial monitoring results indicate performance standards are not being met. MDT is currently negotiating with the Corps and proposing the use of functional assessment based performance standards to determine site success.

Compliance Strategy

MDT considers invasive species management during all phases of mitigation, including site selection, construction, and maintenance (Table 35). MDT has a robust and proactive mitigation program and strives to be a mitigation practice leader in Montana. MDT reaches out to DOTs of neighboring states to identify common problems and solutions. In addition to developing the Montana Wetland Assessment Method, MDT trains other government agencies and private consultants in its use (Urban pers. comm.; Gundrum pers. comm.).

MDT stresses replacing affected functions through its mitigation practices and emphasizes establishing appropriate mitigation types and locations. MDT therefore prioritizes functional replacement in its mitigation site selection, locating mitigation projects where significant degradation had occurred. These sites often include existing populations of nonnative and invasive species, making compliance with invasive species performance standards difficult. MDT personnel state that that the presence of invasive species on a mitigation site is not the best measure of mitigation success.

Table 35. Invasive Species Controls by Project Phase

Project Phase	Invasive Species Controls
Site selection	• Balance the replacement of lost functions with developing desirable plant communities
Site construction	• Establish habitat for native plants
Project maintenance	• Treat with herbicides only as required • Treat with biological controls • Alter topography to change site hydrology

Reed canarygrass is considered a nonnative species by many in the wetland community, and is described as a non-preferred (invasive) species by the Corps and state regulatory agencies. MDT personnel indicate that literature surveys and discussions with local botanists at the University of Montana and Montana State University suggest that this species is likely native to Montana and much of the western United States. The U.S. Department of Agriculture (2009) also describes this species as native. Reed canarygrass is mentioned in notes from early explorers in Rocky Mountain region and described as native in local flora inventories. MDT personnel suggest that reed canarygrass cover is over-emphasized in mitigation compliance.

MDT personnel continue to engage the Corps in a cooperative discussion about developing appropriate performance standards for MDT's mitigation projects. MDT personnel are optimistic that reasonable performance standards will be developed in the future.

Site Management Costs

MDT does not have detailed records of the costs required to comply with invasive species cover performance standards. Invasive species are mostly controlled through existing MDT contracts with the county weed control districts that control invasive species on MDT rights-of-way and other

facilities. Site-specific costs are not tracked. Mitigation projects undertaken by MDT often include significant grading to restore natural site hydrology and remove invasive species. MDT estimates mitigation costs at approximately $25,000 per acre, including real estate costs for fee title or perpetual wetland conservation easements (The Camp Creek Mitigation Site is owned by MDT). Sites are also commonly pretreated with chemical herbicide to eliminate existing colonies of invasive species. MDT views the pre-treatment as necessary to provide appropriate vegetation communities to restore wetland functions, as well as to comply with the invasive species performance standards.

Mitigation monitoring for a typical MDT mitigation site is approximately $9,200 per year for a 20- to 40-acre site. This includes hydrologic, vegetation, and wildlife monitoring. Vegetation monitoring, including estimating invasive species cover, is the most labor-intensive mitigation monitoring component. This monitoring includes assessing site conditions and evaluating the effectiveness of control measures and other management activities.

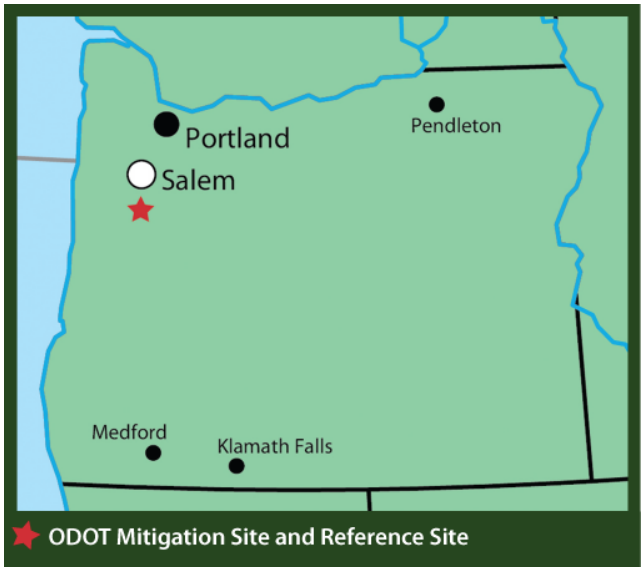
Summary and Conclusions

The invasive species areal cover estimated at the mitigation site was 11%, slightly exceeding the 10% areal cover of invasive species performance criteria that has been applied to other MDT mitigation sites. The adjacent reference site was nearly devoid of invasive species, with 2% estimated cover. Hydrologic conditions at the mitigation site appeared to be more favorable to the targeted invasive species than at the reference site, because the mitigation site includes more seasonally wet areas. Other site characteristics, such as native plant diversity and presence of woody debris, were similar.

MDT emphasizes the assessed functional lift in demonstrating the success of its mitigation projects and indicates that sites with the best opportunities to provide functional lift often include widespread invasive species. After the Corps began requiring invasive species to be controlled to less than 10% areal cover, MDT engaged the Corps an effort to develop functions-based performance standards not directly invasive species cover. MDT is optimistic that achievable performance standards will be developed.

Oregon Department of Transportation – Pacific Highway (I-5) to Railroad Tracks Project (Lebanon)

The Oregon Department of Transportation (ODOT) is responsible for developing and maintaining Oregon's system of highways and bridges, public transportation services, rail passenger and freight systems, and bicycle and pedestrian paths. ODOT manages driver licensing and vehicle registration programs, motor carrier operations, and transportation safety programs, and operates highway and rail systems throughout the state of Oregon. ODOT primarily develops concurrent mitigation projects using their own staff. However, ODOT is currently pursuing the development of watershed-based advanced mitigation sites that would operate similarly to banks, but would be specifically developed for ODOT impacts. ODOT also purchases credits from private banks and uses partnerships with other government agencies to achieve their mitigation needs.



The mitigation and corresponding reference study sites are located near the city of Corvallis, in the Willamette Valley of western Oregon. Western Oregon contains most of the state's population and the state's largest cities. Most of Oregon's population centers, like Portland and Salem, are located along the Interstate 5 (I-5) corridor and are supported by a variety of industries. Outside of cities, rural communities are commonly supported by logging and agricultural activities. Land use in the Willamette Valley is primarily agricultural. The valley produces many varieties of berries and vegetables and most of the grass seed, Christmas trees, and hazelnuts sold in North America (U.S. Department of Agriculture, National Agricultural Statistics Service 2009). Invasive species are widespread throughout Oregon at low elevations, where land use and impacts from human development are most intensive.

Two ODOT-owned properties were developed to mitigate impacts incurred for the Pacific Highway (I- 5) to Railroad Tracks Project near Lebanon, Oregon. Wetland impacts resulted from widening State Highway 34 between Lebanon and I-5, replacing culverts in Little Oak and Burkhart Creeks, and replacing a bridge over Oak Creek. The project affected a total of 7.31 acres of wetlands. ODOT provided mitigation for project impacts at two sites: Mitigation Site 1 and Mitigation Site 2.

At Mitigation Site 1, selected as the mitigation site, ODOT restored 9.06 acres of a grass seed field to palustrine forested and emergent wetland. The site was graded, pretreated for invasive species, seeded with a native seed mix, and planted with native trees and shrubs in 1999.

Mitigation Site 2 was identified as the formal project reference site, and was selected as the reference site for this study. A separate area of Mitigation Site 2 was created and enhanced for additional project mitigation, but was not used in this study. The reference site was identified as appropriate because it is a high-quality wetland prairie with conditions that represent those assumed to be present at the mitigation site prior to agricultural uses. Wetland prairies with stands of Oregon ash (*Fraxinus latifolia*) and associated shrubs historically covered large areas of the Willamette Valley. The reference site was reported to have light grazing at one time, but no past grazing or cultivation was evident.

Field Studies

The paired sites were surveyed for birds, wildlife, and invasive species on June 23 and 24, 2009. Wildlife surveys were performed on two consecutive days between 5:00 and 9:00 am at each site, and surveys were performed by the same staff. The sites are separated by approximately 0.5 mile of farmland.

Because of the irregular shape of the mitigation site, three transects (450, 600, and 1,200 feet each) were oriented toward the west, southwest, and south, for a total of 2,250 feet of transect length. At

the reference site, five short transects (ranging between 140 and 145 feet) were established in a north-to south direction, totaling 1,230 feet of transect length. At both sites, wildlife stations for conducting point counts were positioned along the transects in different vegetation communities. Site maps with the invasive species transect configuration and wildlife survey stations are shown in Figure 13 and 14.

The mitigation site is bordered by Oak Creek, a confined but perennial stream, and also has a seasonal stream that floods seasonally. The reference site has shallow surface inundation and two seasonal, flat-gradient stream channels with culverts at the both the inlet and outlet of the wetland. Both sites indicate a seasonal hydrologic regime and include dense tree canopy, dense shrub communities, emergent-dominated areas, wetland prairie, small patches of palustrine forested, and palustrine scrub-shrub areas. All species planted and seeded at the mitigation site were also observed in the reference area. All vegetation communities were sampled at both sites.

Wildlife Use

The number of bird species observed at the mitigation site (36) was slightly higher than the number observed at the reference site (32). The same proportion of species was categorized as wetland obligates or associates at both sites (25%). Birds were assigned a wetland classification based on habitat use (Poole 2009). All of the species observed in both sites are common summer residents in western Oregon and the Willamette Valley (Lane County Audubon 2006).

All species observed during the site reconnaissance one day prior to the formal survey, as well as species observed while conducting vegetation sampling, were recorded and are included in the species list. Table 36 summarizes bird observations at both sites. Only wetland species have been listed in detail; all non-wetland species are summarized into the total number observed by site.

Table 36. Birds Species Observed at the Oregon Mitigation Site and Reference Site

Species	Scientific Name	Mitigation	Reference	Wetland Use
Bald eagle	*Haliaeetus leucocephalus*		X	Obligate; open water
Barn swallow	*Hirundo pyrrhonota*	X	X	Associated
Blue-winged teal	*Anas discors*	X		Obligate; PEM open water
Common yellowthroat	*Geothlypsus trichas*	X		Obligate: PSS, PEM
Great blue heron	*Ardea herodias*	X	X	Obligate; open water
Mallard	*Anas platyrhynchos*	X	X	Obligate, PEM
Red-winged blackbird	*Agelaius phoeniceus*	X	X	Obligate; PSS, PEM
Song sparrow	*Melospiza melodia*	X	X	Obligate; PSS, riparian zones
Willow flycatcher	*Empidonax traillii*	X	X	Obligate; PSS
Yellow warbler	*Dendroica petechia*	X	X	Obligate; PFO, riparian zones
Wetland obligate or associated		9	8	
Non-wetland species		27	24	
Total Species Observed at Site		**36**	**32**	
Confirmed breeders		1	3	
Unique to site		10	6	

Confirmed breeders: species observed carrying food or with young, or a nest identifiable to that species observed in the wetland.
Unique to site: species observed at the either the mitigation or the reference site, but not both.
Note: PEM = palustrine emergent, PFO = palustrine forested, PSS = palustrine scrub-shrub

Few other wildlife species were observed during the site visits, likely due to the close proximity of Highway 34. Tree frogs were observed on the mitigation site and were heard chorusing, indicating breeding activity. A nutria was observed swimming in Oak Creek at the mitigation site. Nutria dens were also apparent along the banks of the creek. Deer sign, including scat and recently used beds, were observed on both the reference and mitigation sites.

Non-avian wildlife species observed at both sites are summarized in Table 37. Observed wildlife species were assigned a wetland classification based on habitat use (Conant and Collins 1998; Burt and Grossenheider 1976).

Table 37. Non-Avian Species Observed at the Oregon Mitigation Site and Reference Site

Species	Scientific Name	Mitigation	Reference	Wetland Use
AMPHIBIANS				
Pacific tree frog	*Pseudacris requilla*	X		Associate; PEM, PSS
MAMMALS				
Black-tailed deer	*Odocoileus hemionus columbianus*	X	X	
Nutria	*Myocastor coypus*	X		
	Total Species Observed at Site	**3**	**1**	
	Wetland obligate or associate	1	0	
	Unique to site	1	0	
Note: PEM = palustrine emergent, PSS = palustrine scrub-shrub				

Invasive Species Cover

The performance standards for this project require less than 10% areal cover of the three invasive species Himalayan blackberry (*Rubus armeniacus)*, cut-leaf blackberry (*Rubus laciniatus*), and reed canarygrass. Reed canarygrass is an aggressive, widespread colonizer of seasonally wet soils in Oregon. Reed canarygrass is abundant in uncultivated areas surrounding the sites, making seed or rhizomes readily available via flooding or other conveyance mechanisms. Both blackberry species are also capable of growing in seasonally wet areas, often initially rooting on hummocks around the perimeter of wetlands to become established, and then colonizing wetter areas in dense thickets.

Cover for the three targeted invasive species at both sites was estimated to be below the 10% areal cover performance standard. Two small patches of reed canarygrass were observed on the mitigation site, each less than 5 square feet and both outside of sampled transects. No reed canarygrass was observed on the reference site. Field biologists anecdotally note that the absence of this species may be due to dense shrub or tree cover and dense herbaceous community consisting mostly of tufted hairgrass (*Deschampsia caespitosa).* Himalayan blackberry accounted for less than 1% areal cover at the mitigation site and 2% areal cover at the reference site. Cut-leaf blackberry accounted for 1% areal cover at the reference site and was not present at the mitigation site. Table 38 summarizes invasive species cover at both sites.


Dense community of tufted hairgrass at the mitigation site.

Table 38. Invasive Species Cover Comparison

Invasive Species	Mitigation (areal cover)	Reference (areal cover)	Project Performance Standard (areal cover)
Reed canarygrass	0%	0%	<10%
Himalayan blackberry	<1%	2%	<10%
Cut-leaf blackberry	0%	1%	<10%
Total Invasive Species Cover	**<1%**	**3%**	**<10%**

At the mitigation site, the estimated combined cover of blackberry species was similar across Cowardin classes and less than 3% in any Cowardin class. At the reference site, estimated areal cover of both blackberry species was strongly associated with Cowardin classification in the reference site, where the scrub-shrub communities had the highest levels (100%), and much lower amounts in the emergent (4%) and forested (1%) areas of the site. The site included a relatively small amount of scrub-shrub community, likely affecting the estimates. Table 39 summarizes the distribution of combined blackberry species by Cowardin class.

Table 39. Invasive Species Cover by Cowardin Classification

	Mitigation (areal cover)			Reference (areal cover)		
Invasive Species	**Emergent**	**Scrub-Shrub**	**Forested**	**Emergent**	**Scrub-Shrub**	**Forested**
Combined blackberry species	<1%	2%	0%	4%	100%	1%

Note: Values presented for each Cowardin class do not correspond to the total invasive species cover presented in the previous table because the mitigation and reference sites contain multiple Cowardin classes of varying sizes.

Mitigation site planted scrub-shrub and emergent communities.

Other species found on both sites include Oregon ash, tufted hairgrass (*Deschampsia cespitosa*), spike bentgrass (*Agrostis exerata*), meadow foxtail (*Alopecurus pratensis*), common velvetgrass (*Holcus lanatus*), and mixed sedges (*Carex* spp.). Patches of scrub-shrub were generally dominated by mixed willows (*Salix* spp.) and young Oregon ash.

ODOT last surveyed invasive species cover in 2004, 5 years after site planting. At that time, there was no reed canarygrass in the mitigation

site. Neither blackberry species were found in ODOT plots or transect data, but both were observed elsewhere on site in small amounts. The ODOT monitoring report recommended additional management or invasive species control.

Discussion

The sites are similar in the total numbers of bird and wildlife species and individuals observed and the proportion of birds that were categorized as wetland obligates or associates. Both sites appear to provide good quality wildlife habitat. The larger mitigation site includes a perennial stream that provides additional habitat complexity and is located farther from the highway. The reference site includes some larger trees, snags, and large stumps. While these features were absent from the mitigation site, they were present on the adjacent parcel. These differences in the development and structure of the vegetation at the sites do not seem to result in a difference in avian species presence at the two sites. Although more species were observed at the mitigation site than the reference site, this is attributed to the small size of the reference site and its lack of open water.

Species observed exclusively on one site or the other (e.g., Steller's jay, red-breasted nuthatch, white-breasted nuthatch, mourning dove, downy woodpecker, bushtit, Swainson's thrush, white-crowned sparrow) are all common residents and could have been present on either site based on available habitat, but were simply not observed there during the field survey.

Conditions for amphibians at both sites appeared to be favorable; although, none were observed on the reference site and only one species (Pacific tree frog) was observed on the mitigation site. The slow-moving, channelized stream corridors of Oak Creek provide ideal habitat for nutria. Nutria dens and trails were observed in multiple locations along the banks of Oak Creek. Deer appeared to thrive at both sites as well.

Invasive species occupied similar habitats in both sites: blackberry occurred most frequently on the fringes of scrub-shrub areas and to a lesser degree in dried areas of the emergent areas. Seasonal flooding, a dense emergent community, and dense scrub-shrub or forests apparently exclude reed canarygrass on both sites. No additional invasive species of concern were observed on the sites.

Dense Oregon ash canopy and scrub-shrub communities limiting herbaceous plant growth in a seasonally inundated swale.

Table 40 summarizes the conditions and land uses surrounding the paired sites.

Table 40. Land Uses and Site Characteristics

Attribute	Mitigation Site			Reference Site		
Watershed characteristics	Agricultural			Same as mitigation site		
HGM class	Depressional			Depressional		
Cowardin class	PFO, PSS, PEM			PFO, PSS, PEM		
Plant Diversity	High			High		
Woody debris/habitat structures	Few snags, stumps and logs. Most exist in the palustrine, forested component of the wetland; a few logs are apparently flood debris. Older living forest and LWD in the PFO adjacent to this wetland.			Some snags, stumps, and logs.		
Hydrologic conditions	Restricted (30-inch culvert) and unrestricted outlets, seasonally flooded, seasonally saturated			Restricted outlet (30-inch culvert), seasonally flooded, seasonally saturated		
Surrounding land use (distance from site)	**330 feet**	**825 feet**	**3,300 feet**	**330 feet**	**825 feet**	**3,300 feet**
High Intensity (highways, industrial)	10%	5%	<1%	20%	15%	<1%
Moderate Intensity (residential, agriculture, parks)	65%	70%	80%	30%	45%	85%
Low Intensity (pasture, residential with > 5 acre lots)	25%	20%	15%	30%	30%	10%
Undeveloped (open space)	-	5%	5%	20%	10%	5%

Note: PEM = palustrine emergent, PSS = palustrine scrub-shrub, LWD = large woody debris

The mitigation site appears to be developing the structure and vegetation community complexity observed at the reference site. At both sites, invasive species occupied isolated upland areas on the edges of the scrub-shrub areas. The prairie communities appear to have a density that precludes the spread of reed canarygrass into the wetlands.

The mitigation site underwent a fairly rigorous site preparation and maintenance regime, and this may have played a part in the lack of invasive species observed. The mitigation project appeared successful in creating wetlands that provide similar habitat and vegetative communities to the reference site. Invasive species estimated areal cover was comparable between the two sites, accounting for less than 1% at the mitigation site and 3% at the reference site, well below the areal cover performance standard of 10%, as specified in the permit. The mitigation site appears to have achieved the intended site goals, and was deemed successful by ODOT. Permitting agencies have not requested any further invasive species control or other site management.

Implications of Invasive Species Performance Standards

The information presented in the following section was obtained via questionnaire and other communication with ODOT personnel experienced with the ODOT mitigation program, unless otherwise cited. This information is not intended to state policy or guidance and only represents responses from ODOT personnel interviewed for this study.

The Corps and the Oregon Department of State Lands (DSL) have required invasive species performance standards on ODOT mitigation projects since the mid 1990s. The performance standards apply to invasive species in general, or specifically referenced canarygrass. A 10% invasive species cover performance standard has been applied to all ODOT mitigation projects regardless of location, existing conditions, or condition of the impact area. This mitigation site did achieve its invasive species cover performance standards, although many ODOT mitigation projects have not met the same standard. Reed canarygrass is not on the state noxious weed list (Oregon Department of Agriculture 2010) but is still considered an invasive weed by the Corps and DSL.

The invasive species performance standards applied to ODOT mitigation projects have since been revised. ODOT has proposed alternative standards such as overall cover of native species or areal cover performance standards for noxious weeds listed by the Oregon State Department of Agriculture. Alternative approaches have been accepted on some projects, but invasive species cover performance standards are still applied to many ODOT projects. The Corps and DSL now commonly require a 20% or less areal cover performance standard for invasive species.

ODOT constructs, manages, and monitors its mitigation sites to comply with all performance standards, including invasive species cover. ODOT routinely manages vegetation on its mitigation sites, primarily focusing on invasive species control. ODOT personnel were not aware of any mitigation projects considered noncompliant specifically for failing to meet the invasive species cover standards. The only ODOT projects considered noncompliant by permitting agencies were considered noncompliant because of a shortage of wetland area.

Compliance Strategy

ODOT considers invasive species management during all aspects of mitigation, including site selection, construction, and maintenance (Table 41). ODOT personnel indicated that, while invasive species-dominated sites could usually be avoided, ODOT employs a rigorous control program when such sites are selected (Caswell pers. comm.; Carder pers. comm.). For example, this mitigation site was sprayed for invasive species, excavated to remove rhizomes and seed, and sprayed again for regrowth. After these control measures, mitigation sites are typically seeded with hand-collected native seed. Once a mitigation site is constructed, ODOT continues invasive species control throughout the monitoring period. Control measures include using herbicides and hand-pulling small populations. Invasive species control is performed by ODOT maintenance staff or contracted to the private sector.

Table 41. Invasive Species Controls by Project Phase

Project Phase	Invasive Species Controls
Site selection	• Select sites in areas where invasive species are absent or sparse
Site construction	• Treat existing invasive species with herbicides • Excavate during construction.
Site maintenance	• Treat with herbicides • Remove invasive species mechanically

Site Management Costs

ODOT invasive species control costs an average of approximately $1,000 per acre, per year. Costs vary depending on the level of invasive species cover, whether control work is done by ODOT staff or contractors, and site location.

The monitoring required for each mitigation site varies, dependent on site location, design, and performance standards. The monitoring typically includes assessment of vegetation community development, including monitoring invasive species cover. ODOT estimates that annual monitoring costs for each mitigation site are between $3,000 and $7,000. Half of this monitoring effort is devoted to assessing invasive species performance standards. Monitoring reports typically address invasive species cover, maintenance activities for invasive species control, and a qualitative assessment of the maintenance effectiveness.

Summary and Conclusions

Both sites had less than 10% areal cover of targeted invasive species, and had similar vegetation types and species and similar wildlife use. ODOT appears to have been successful in establishing the intended vegetation communities and habitat types at the mitigation site. The mitigation site met the performance standard of less than 10% areal cover of invasive species according to DSL and Corps permit requirements.

ODOT attempts to locate their mitigation projects on sites that do not have existing populations of invasive species, often using agricultural fields. Region 1, where the study site was located, reports that they are often successful in finding sites that are relatively invasive-free. When mitigation sites do have invasive species, ODOT implements controls throughout site construction and monitoring. ODOT personnel have suggested alternative performance standards for vegetation, including invasive species, some of which have been accepted by the Corps and DSL on a case-by-case basis.

Washington State Department of Transportation – Blaine Mitigation Site

The Washington State Department of Transportation (WSDOT) operates highway, rail, and ferry systems throughout Washington. WSDOT develops most of its mitigation projects internally, or by working closely with consultants. WSDOT primarily uses concurrent mitigation sites, but also operates three active mitigation banks. WSDOT has also purchased mitigation credits from private banks.

Population density is highest in the Puget Sound region; density is lower in the coast and Cascade foothills that are supported by logging and agricultural economies. Eastern Washington is arid with a mostly agricultural economy, which depends on regional irrigation systems. Invasive species are widespread throughout both western and eastern Washington at low elevations, where land use and human development are most intense. The WSDOT site used for this study is located in the far northwestern corner of the state.

The Blaine Mitigation Site was developed to mitigate impacts incurred for a high-speed rail project near Blaine, Washington. The 4.7-acre site was constructed in 1996 and graded, seeded with a native seed mix, and planted with native trees and shrubs. Adjacent to the mitigation site and separated by an infrequently used railroad right-of-way is a 23.6-acre preservation area. The preservation area was selected as a suitable reference site because it is the same HGM class with

similar vegetation communities, is within the same watershed, and is considered a high quality wetland. Preservation sites are, by definition, considered high quality wetlands by the Corps and Washington Department of Ecology (Granger et al. 2005). All woody species planted at the mitigation site were also observed in the preservation site.

Field Studies

The paired sites were surveyed for bird, wildlife, and invasive species on June 8, 9, and 10, 2009. Wildlife surveys were performed on two consecutive days at each site between 5:00 and 9:00 am, by the same staff. At both sites, transects were oriented north-south. At this mitigation site, Five 300-foot transects were established; at the reference site, three 500-foot transects were established, for a total transect length of 1,500 feet at each site. Transects were evenly spaced across both sites, with randomly located positions. The reference site was accessed from the railroad on the southern boundary. Wildlife stations were positioned along the transects in different vegetation communities. Site maps with approximate invasive species transect locations and wildlife stations are shown in Figures 15 and 16.

The mitigation site has emergent, scrub-shrub, forested, and upland forested communities. The reference site is a mature forested wetland that includes a segment of California Creek, a seasonal flat-gradient stream, and palustrine scrub-shrub and emergent areas. Beavers have dammed portions of the reference site; dammed areas were avoided for surveys. Both sites include areas of dense tree canopy and seasonal and perennial hydrologic regimes.

Wildlife Use

A comparable number of bird species were observed at the mitigation (54) and the reference sites (56). A lower proportion was categorized as wetland obligates or associates at the mitigation site (24% vs. 29%). Birds were assigned a wetland classification based on habitat use (Poole 2009). All of the species observed at both sites are common summer residents in northwestern Washington (Seattle Audubon 2009).

All species observed during the site reconnaissance one day prior to the formal survey, as well as species observed while conducting vegetation sampling, were recorded and are included in the species list. Table 42 summarizes bird observations at both sites. Only wetland species have been listed in detail; all non-wetland species are summarized into the total number observed by site.

Table 42. Birds Species Observed at the Blaine Mitigation Site and Reference Site

Species	Scientific Name	Mitigation	Reference	Wetland Use
Bald eagle	*Haliaeetus leucocephalus*	X	X	Obligate; open water
Barn swallow	*Hirundo rustica*	X	X	Associated
Canada goose	*Branta canadensis*	X	X	Obligate; PEM, open water
Wilson's snipe	*Gallinago delicata*		X	Obligate; wetland w/muddy areas
Common yellowthroat	*Geothlypis trichas*	X	X	Obligate; PSS, PEM
Fox sparrow	*Passerella iliaca*		X	Associated (Sooty only)
Great blue heron	*Ardea herodias*	X	X	Obligate; open water
Green-winged teal	*Anas crecca*		X	Obligate; PEM, open water
Mallard	*Anas platyrhynchos*	X	X	Obligate; PEM
Northern rough-winged swallow	*Stelgidopteryx serripennis*	X	X	Associated
Red-winged blackbird	*Agelaius phoeniceus*	X	X	Obligate; PSS, PEM
Song sparrow	*Melospiza melodia*	X	X	Obligate; PSS, riparian zones
Tree swallow	*Tachycineta bicolor*	X	X	Associated
Violet-green swallow	*Tachycineta thalassina*	X	X	Associated
Willow flycatcher	*Empidonax traillii*	X	X	Obligate; PSS
Yellow warbler	*Dendroica petechia*	X	X	Obligate; PFO, riparian zones
Wetland obligate or associated		13	16	
Non-wetland species		41	40	
Total Species Observed at Site		**54**	**56**	
Confirmed breeders		1	0	
Unique to site		3	6	

Confirmed breeders: species observed carrying food or with young, or a nest identifiable to that species observed in the wetland.
Unique to site: species observed at either the mitigation or the reference site, but not both.
Note: PEM = palustrine emergent, PFO = palustrine forested, PSS = palustrine scrub-shrub

Bull and tree frogs were observed on both sites and both species were heard chorusing, indicating breeding activity. Rough-skinned newts were observed in emergent areas of the reference site. Cottontail rabbits were observed in emergent areas in the mitigation site. Deer sign and recent beaver activity were also apparent at both sites, although active beaver denning was observed only in the reference site. Many recently cut stumps and partially cut trees were observed at both sites. Notably, in the near future the mitigation site may be altered by increased ponding resulting from beaver activity. Beaver are common in rural Washington, and are typically considered beneficial to wetland function.

Non-avian wildlife observed at both sites is summarized in Table 43. Observed wildlife species were assigned a wetland classification based on habitat use (Conant and Collins 1998; Burt and Grossenheider 1976).

Beaver activity at the Blaine Mitigation Site.

Table 43. Non-Avian Species Observed at the Blaine Mitigation Site and Reference Site

Species	Scientific Name	Mitigation	Reference	Wetland Use
AMPHIBIANS				
Bullfrog	*Rana catesbeiana*	X	X	Obligate; PEM, PAB
Pacific tree frog	*Pseudacris regilla*	X	X	Associate; PEM, PSS, PFO
Rough-skinned newt	*Taricha granulosa*		X	Obligate; PEM
MAMMALS				
Beaver	*Castor canadensis*	X	X	Obligate; PFO, PSS, open water
Cottontail rabbit	*Sylvilagus floridanus*	X		
Black-tailed deer	*Odocoileus hemionus columbianus*	X	X	
Total Species Observed at Site		**5**	**5**	
Wetland obligate or associate		3	4	
Unique to Site		1	1	

Note: PEM = palustrine emergent, PFO = palustrine forested, PSS = palustrine scrub-shrub

Invasive Species Cover

The performance standard specifies that reed canarygrass account for 10% or less areal cover in the mitigation site. This is the only species specifically addressed by performance standards. This species is known as an aggressive colonizer of seasonally wet areas and is common throughout the western United States. Reed canarygrass is abundant in the areas surrounding the sites, making seed or rhizomes readily available via flood or other conveyance mechanism.

Estimated areal cover of reed canarygrass was higher at the mitigation site (31%) than at the reference site (15%). No other regionally significant invasive species were observed at either site.

Table 44. Invasive Species Cover Comparison

Invasive Species	Mitigation (areal cover)	Reference (areal cover)	Project Performance Standard (areal cover)
Reed canarygrass	31%	15%	10%

Higher levels of reed canarygrass cover were observed on the mitigation site in emergent wetland areas (43%) than in either scrub-shrub (25%) or forested (28%); these cover estimates exceed the 10% areal cover limit required by permitting agencies.

Estimated areal cover was more strongly associated with Cowardin classification in the reference site, where emergent areas were primarily vegetated by reed canarygrass (88%), with much lower reed canarygrass cover in the scrub- shrub (14%) and forested areas (2%). Table 45 summarizes the distribution of reed canarygrass by Cowardin class.

Table 45. Invasive Species Cover by Cowardin Classification

	Mitigation (areal cover)			Reference (areal cover)		
Invasive Species	Emergent	Scrub-Shrub	Forested	Emergent	Scrub-Shrub	Forested
Reed canarygrass	43%	25%	28%	88%	14%	2%

Note: Values presented for each Cowardin class do not correspond to the total invasive species cover presented in the previous table because the mitigation and reference sites contain multiple Cowardin classes of varying sizes.

Native dominants common to both sites include western redcedar (*Thuja plicata*), Pacific willow (*Salix lucida ssp. lasiandra),* Sitka willow (*Salix sitchensis*), red alder (*Alnus rubra*), mixed rose (*Rosa* spp.), horsetail (*Equisetum* spp.), and slough sedge (*Carex obnupta*). Upland buffer areas at both sites contain Douglas-fir (*Pseudotsuga menziesii*) and common snowberry (*Symphoricarpos albus).*

When WSDOT last monitored reed canarygrass cover in 2001, 5 years after site planting, cover as accounted for 21% areal cover(CI 0.90 ± 0.15; Bergdolt et al. 2002) In the mitigation site; cover was not estimated in the reference area.

Discussion

The sites are similar with respect to wildlife survey results, native plant species composition, and habitat types. Both sites appear to provide good quality wildlife habitat; birds and other wildlife were abundant in number of individuals and species. Differences in the development and structure of the vegetation at the two sites did not seem to significantly affect avian species use. Slightly more species were observed at the reference site. Two of the species observed only in the reference site (e.g., pileated woodpecker, Vaux's swift) prefer the mature forest and abundance of large snags that are unique to that site. Other species observed exclusively on one site or the other (e.g., Anna's hummingbird, sharp shinned hawk, common snipe, green-winged teal, black-throated gray warbler) use available habitat types of both sites, and therefore could have been present but undetected during the relatively brief survey.

Conditions for amphibians at both sites appear to be favorable, although bullfrogs are invasive throughout the Pacific Northwest and can out-compete most native amphibians in freshwater marsh habitats. Beaver and deer appear to thrive at both sites. Beaver activity at both sites is creating woody debris, altering habitat and hydrology.

The two sites are similar in species composition, distribution of hydrologic regimes, interspersion of vegetation types and wildlife use. The differences between the mitigation site and the reference site are primarily the age of the plant communities, the size of the site (the reference site is much larger), and the presence of a seasonal stream channel that was dry during fieldwork. The reference site includes larger trees, more extensive tree canopy, snags and large stumps, and seasonal and perennial ponding. The sites are separated by an infrequently used rail corridor that likely does not limit overlapping use by birds and larger mammals. Both sites are surrounded by agricultural lands (cultivated crops and pastureland), forests, and low intensity development (few residences with lots of at least 5 acres).

Hardstem bulrush growing without reed canarygrass in seasonally ponded areas at the mitigation site.

Reed canarygrass was observed on both study sites in similar habitats; seasonally wet areas with open to partially closed tree canopy. Reed canarygrass cover is lowest in the forested portions of the reference site (2%), where mature trees provide the most canopy shading. The tree canopy of the mitigation site is less dense than in the reference site. Reed canarygrass cover also does not occur in areas with perennial ponding at both sites. Field crews noted that reed canarygrass is absent or scarce in both sites under full tree canopy (both deciduous and coniferous), in areas with dense shrub thickets, and in areas that were still inundated at the time of survey that were dominated by hard-stemmed bulrush and sedges. Field crews did not observe any purple loosestrife or yellow flag iris (*Iris pseudacorus*) at either study site, both of which were treated during the 5-year maintenance program for the site.

Table 46 summarizes the conditions and land uses surrounding the paired sites.

Table 46. Land Uses and Site Characteristics

Attribute	Mitigation Site			Reference Site		
Watershed characteristics	Mixed agricultural and forested			Same as mitigation site		
HGM class	Depressional			Depressional		
Cowardin class	PFO, PSS, PEM			PFO, PSS, PEM		
Plant diversity	Moderate			High		
Woody debris/habitat structures	Few snags, stumps and logs.			Many snags, stumps, and logs. Several fallen trees still growing and dense shrub patches.		
Hydrologic conditions	Restricted outlet (36-inch culvert); seasonally flooded, seasonally saturated			Restricted outlet (48-inch culvert), seasonally flooded, seasonally saturated		
Surrounding land use (distance from site)	**330 feet**	**825 feet**	**3,300 feet**	**330 feet**	**825 feet**	**3,300 feet**
High Intensity (highways, industrial)	-	-	-	-	-	-
Moderate Intensity (residential, agriculture, parks)	-	-	-	-	-	-
Low Intensity (pasture, residential with >5 acre lots)	75%	85%	95%	60%	60%	20%
Undeveloped (open space)	25%	15%	5%	40%	40%	80%

Note: PEM = palustrine emergent, PFO = palustrine forested, PSS = palustrine scrub-shrub, LWD = large woody debris

Invasive species occupy similar habitats in both sites: seasonally inundated areas with open to partially closed tree canopy. Dense scrub-shrub at the mitigation site and areas at both sites with dense ponded emergent communities frequently have no reed canarygrass present. The mitigation site appears to be developing the structure and vegetation community complexity observed at the reference site. The presence of beaver activity observed at both sites will likely result in similar hydrologic regimes: seasonal and permanent inundation and ponding. The dense Douglas-fir upland forest community at the mitigation site may also limit the transport of

Dense willow community on the Blaine Mitigation Site.

propagules into both sites by creating a dense buffer from the surrounding roads and farms.

Between 1986 and 2001, the Blaine Mitigation Site was aggressively maintained to limit invasive species cover. The site was mowed about five times annually, and crews were employed to pull purple loosestrife and yellow flag iris. The last maintenance on the mitigation site was from May to October 2001, when crews of up to ten workers spent a total of 64 hours treating these species.

Both study sites would fail the performance standard of 10% areal cover of invasive species required in the original Corps permit. Invasive species areal cover at the mitigation site (31%) was approximately twice the areal cover at the reference site (15%). The mitigation project appeared successful in creating wetlands that provide similar habitat and vegetative communities to the adjacent reference site, and was deemed successful by Ecology and the Corps.

Implications of Invasive Species Performance Standards

The information presented in the following section was obtained via questionnaire from WSDOT personnel experienced with the WSDOT mitigation program, unless otherwise cited. This information is not intended to state policy or guidance and only represents responses from WSDOT personnel interviewed for this study.

Performance standards for areal cover of invasive species have been required by the Corps, Ecology, and local governments throughout Washington since the late 1980s. The performance standards applied to the Blaine Mitigation Site are typical of mitigation plans developed in the 1990s, including a requirement of 10% or less areal cover of reed canarygrass. This mitigation site failed to achieve the 10% areal cover performance standard. All other project objectives appear to have been met, such as wetland area and establishing the desired plant communities. The reference site, where reed canarygrass cover is lower, supports mature vegetation communities, with similar species composition. Washington is one of two states contacted for this study that reported a decreasing trend in invasive species cover requirements in project performance standards. Most WSDOT mitigation projects are typically required to maintain a specific list of invasive species below 20 to 25% areal cover, whereas the cover requirement in the 1990s was typically 5 to 10% areal cover.

Invasive species cover performance standards are still routinely applied by permitting agencies in Washington, but cover thresholds have been relaxed and do not only target reed canarygrass. The invasive species identified in performance standards vary by location and permitting agency. Performance standards typically include limiting cover of all state-listed Class A noxious weeds, and a list of other species. Reed canarygrass is a Class C noxious weed because it is widespread, but limiting reed canarygrass cover is still commonly included in performance standards. In some recent WSDOT mitigation plans, permits require control of Class A noxious weeds, limit invasive species to a 20 to 25% areal cover, and require that reed canarygrass be controlled, but with no specific areal cover limit.

Permitting agencies have cited scientific papers and monitoring results to demonstrate the need for invasive species performance standards, noting invasive species capacities to prohibit the growth of plantings and to degrade habitat functions. The referenced studies typically relate to either quality of habitat or horticultural success of plantings, and are not specific to evaluating mitigation effectiveness. WSDOT has a robust mitigation program and has worked with permitting agencies to develop alternatives to the use of invasive species cover performance standards on all mitigation projects. WSDOT has advocated correlating performance standards to functions assessment indicators, committing to invasive control programs without a specific cover threshold, or

establishing cover thresholds for native vegetation (Bergdolt pers. comm.; Salisbury pers. comm.; Bush pers. comm.).

WSDOT manages and monitors invasive species cover along with all other performance standards. WSDOT reports on its invasive species controls in its annual monitoring reports, which disclose the method of invasive species control, the cover of the species targeted for control, and a qualitative assessment of the control effort effectiveness. WSDOT includes invasive species control as part of its adaptive management practice, taking action on the results of monitoring data, and monitoring the effectiveness of the action. Wetland permitting agencies in Washington State have not deemed a mitigation site a failure specifically for failing to achieve invasive species cover performance standards when other performance standards, particularly wetland area, have been met.

Compliance Strategy

WSDOT considers invasive species management during all phases of mitigation, including site selection, construction, and maintenance (Table 47). WSDOT emphasizes replacing lost functions in its mitigation approach, but avoids sites downstream of or surrounded by invasive species sources. WSDOT's ability to avoid sites with existing invasive species populations depends on the impact location because WSDOT provides mitigation in the same watershed as the impact site. Watersheds that have undergone substantial development often have widespread invasive species populations. Such watershed characteristics often support invasive species because of altered hydrologic regimes and high nutrient loads from agriculture or development.

Most of WSDOT's remediation and management work involves vegetation management such as replacing and supplementing plantings, adjusting planting plans, and controlling invasive species. WSDOT also takes action to correct any shortcomings in wetland area, such as performing additional grading. WSDOT treats invasive species aggressively during site construction by minimizing soil disturbance and designing sites to have conditions suited to native species. Disturbed soils are seeded and irrigated, carbon to nitrogen ratios in compost are evaluated, and contractors are required to perform weed control during site construction. WSDOT often plants native plants densely, 3 to 6 feet on center, to aggressively shade out invasive species.

Table 47. Invasive Species Controls by Project Phase

Project Phase	Invasive Species Controls
Site selection	• Avoid sites with high invasive species cover • Avoid sites that are vulnerable to invasive colonization • Avoid sites that are downstream of invasive species seed sources
Site construction	• Increase the carbon to nitrogen ratio in compost to suppress nonnative species • Apply bark mulches and weed mats • Perform weed control during construction
Site maintenance	• Use integrated vegetation management techniques (biological, physical, chemical) • Apply techniques in the context of an adaptive management approach

Site Management Costs

Cost estimates for invasive species control were not available for this mitigation site; however, WSDOT generates average costs for mitigation in western Washington (Table 48). The cost

estimates do not include real estate costs because those vary greatly across the state. These estimates also do not reflect any of the costs for time associated with site selection or site design.

The cost of managing invasive species after construction varies primarily by site size, site age, and distance from sources of expertise in site management. As with all aspects of mitigation, the economy of scale lowers cost. Site management tends to be most intensive in the earlier phases. WSDOT employs their own weed control crews in some regions, keeping their annual costs relatively low.

Table 48. Mitigation Costs for Restored and Constructed Wetlands (per acre)

Site grading (5,000 cubic yards), clearing, and grubbing	$53,000
Initial planting and 1-year plant establishment	$70,000
Plant establishment, years 2-10	$42,000
Invasive species control, years 2-10	$12,500
Percentage of site construction and management costs for invasive species management	7.5 %
Note: estimated costs do not include real estate costs.	

WSDOT has a robust monitoring program with five full time staff members that develop sampling methods, analyze data, and develop monitoring reports. WSDOT employs 12 to 20 interns from The Evergreen State College for summer field data collection, providing a stipend to interns who also receive graduate-level college credit. The internship provides substantial cost savings to WSDOT by adding short-term assistance during the busy vegetation monitoring season.

Approximately one-third of WSDOT's vegetative field monitoring effort is spent addressing invasive species performance standards. However, the proportion of the work spent on invasive species is relatively small compared to the overall monitoring workload when factoring travel time, data analysis, report writing and other components of the monitoring program. WSDOT estimates that an annual cost to monitor an average mitigation site is approximately $6,000.

Summary and Conclusions

Both sites exceeded the invasive species cover performance standards required in the project permit. The mitigation site failed to achieve mitigation performance standards for invasive species cover during compliance monitoring; cover was estimated at 21% in the final year of site monitoring. Although the performance standard was not achieved, WSDOT was successful in creating a relatively high quality wetland area that has continued to develop and remain self-sustaining in the 9 years since formal monitoring ended. The paired sites demonstrate similar wildlife use.

WSDOT has selected sites, constructed, and managed mitigation projects to minimize invasive species cover. The agency has also engaged permitting authorities to develop performance standards for mitigation projects that are achievable and meaningful. Over time, the invasive species cover requirements have evolved, becoming more achievable and more consistent with existing state noxious weed law. WSDOT expressed no difficulties in gaining agency approval of their mitigation projects.

State Data Summary

Invasive species areal cover at the eight pairs of sites ranged from a complete absence of invasive species to 31% areal cover. The mitigation sites with the lowest areal cover of invasive species tended to be paired with reference sites that also included relatively low cover of invasive species. Table 49 summarizes the invasive species cover estimated at the paired site.

Table 49. Summary of Invasive Species Areal Cover at All Paired Sites

State	Mitigation Site (areal cover)	Reference Site (areal cover)	Invasive Species Performance Standard (total areal cover)
VA	<1%	0%	<5%
NY	18%	35%	<5%
NH	2%	0	"shall not dominate"
MI	31%	14%	<10%
MN	16%	37%	< 20%
MT	11%	2%	<10%
OR	<1%	3%	<10%
WA	31%	15%	<10%

Bird species observed during surveys were generally similar between paired study sites. Bird survey results for all study sites are summarized in Table 50.

Table 50. Summary of Bird Observations at All Paired Sites

	Mitigation Site		Reference Site	
State	Wetland Dependent	Total	Wetland Dependent	Total
VA	9	26	8	25
NY	7	14	10	19
NH	8	19	7	19
MI	18	41	17	43
MN	13	19	21	25
MT	14	34	14	32
OR	9	36	8	32
WA	13	54	16	56

Discussion

This study included qualitative and quantitative information from the following sources:

- a nationwide survey of state DOT wetland mitigation programs to identify where invasive species performance standards are applied to mitigation projects,
- field studies performed at mature mitigation sites and corresponding reference sites, and
- questionnaires completed by state DOT personnel providing regarding the implications of complying invasive species performance standards.

All selected mitigation sites are managed to minimize invasive species cover and represent typical site conditions for their respective states. The participating state DOTs comply with quantitative invasive species performance standards ranging from 5 to 20% areal cover throughout the monitoring period. Because of the small number of paired sites, for the purposes of further discussion, all sites are compared to a 10% areal cover threshold to focus the discussion common problems and strategies; 10% aerial cover represents an approximate mid-point of the standards applied to mitigation projects as well.

Nationwide Application of Invasive Species Performance Standards

The nationwide survey of mitigation programs indicates that DOTs in at least 16 states, located mostly along both coasts and the Great Lakes, are currently required by the local Corps district or state regulatory agency to include performance standards for the control of invasive species on all mitigation projects. Invasive species performance standards have been applied to projects since the late 1980s in Washington, and several other states have required performance standards since the early 1990s.

The practice of requiring of invasive species performance standards appears to be spreading geographically. Several states contacted during the site selection process reported that invasive species performance standards are a new requirement. No states reported that invasive species performance standards were required in the past, but are no longer required by permitting agencies.

Invasive species performance standards vary in specificity, either by prescribing specific species and cover thresholds or by using more general descriptions of site conditions. Most performance standards specifically limit the areal cover of species listed in the mitigation plan or permit. The species identified as invasive species in performance standards typically do not directly correspond to state noxious weed lists; two species identified as invasive by multiple states, reed canarygrass and cattails, are considered to be native by the U. S. Department of Agriculture (2009).

Only two of the 45 states surveyed reported that invasive species performance standards are applied on a project-specific or site-specific basis (16 states were unresponsive). All other contacted states indicate that performance standards are applied to all projects, or are not used at all. The decision to apply performance standards appears to be at the discretion of permitting agency staff, according to state DOT personnel. For example, the only written guidance recommending the use of

invasive species performance standards identified during DOT personal communications was from the New England District of the Corps. No other regions have written guidance formalizing the use of invasive species performance standards. .

State DOT personnel typically do not consider mitigation projects to be failures if they achieve site objectives but fail the invasive species performance standards. State DOT personnel report that they apply prudent measures to limit areal cover of invasive species throughout the mitigation project, but that invasive species cover often exceeds the performance standards. This failure to meet performance standards is attributed to on-site conditions that favor invasive species growth. Permitting agencies were not queried on whether mitigation projects that fail to meet invasive species performance standards are considered failures. Only one state DOT reported that a permitting agency has required invasive species control after the compliance monitoring period specifically because invasive species performance standards had not been met. States with banking or similar crediting mechanisms in place have had mitigation credits withheld for failing to achieve invasive species performance standards.

Wildlife Use at Mitigation Sites

Each of paired sites appeared to offer relatively similar wetland habitat in terms of quality. The difference in the number of wetland obligate or associated species, non-wetland species, and total species observed between each pair of sites was small, ranging from zero to five species. When considered as a group, neither the mitigation sites nor the reference sites tended to have more wetland species or total number of species. This conclusion of similar habitat quality between the paired sites is reinforced by the frog species observations. Five of the eight paired sites had exactly the same suite of frog species present at both sites. Only in New Hampshire site were frogs observed at one site but not the other, and this difference was likely a function of different weather conditions when these two sites were surveyed.

All wetlands sampled appeared to provide appropriate habitat, as most to all of the typical wetland-associated species for that region were present in all sites sampled. However, for avian species observed, there were variations between the reference and the mitigation sites, and these variations ranged from a net difference of six (Montana) to 34 (Virginia) species. The variations in the bird species present reflect differences in wetland sizes, age, and the habitats surrounding the wetlands. For example, the 17 species unique to each site in Virginia likely reflect differences in the surrounding habitats. The reference site is surrounded by mature forest while the mitigation site is surrounded by abandoned farmland and low-density development. More forest and brushy habitat-associated bird species were present at the reference site, while more open habitat-associated species were present at the mitigation site. Similarly, more species were observed at the Minnesota reference site, which was larger and surrounded by more undisturbed, upland habitat compared to the mitigation site. Nearly all the additional species observed at the reference site were species with large habitat requirements.

Achievability of Invasive Species Performance Standards

Four paired sites were observed to have invasive species cover exceeding 10% on both the reference and mitigation sites. Invasive species on one additional mitigation site did not meet the

10% areal cover standard. Invasive species occur in similar hydrologic regimes across all sites, most commonly in seasonally wet areas that lack tree or shrub canopy. Two of the targeted invasive species, common cattail and reed canarygrass, are considered native in the area where they are controlled (U.S. Department of Agriculture 2009). These species are well known as aggressive colonizers that respond to disturbance.

Site Selection

All DOT personnel cited mitigation site selection as a primary contributing factor in the likelihood of achieving invasive species performance standards. Invasive species control is far more difficult in watersheds where invasive species are widespread, such as watersheds that have been widely altered for agricultural or residential development. Capacity improvement projects are the most likely projects to incur wetland impacts and commonly occur in areas with expanding or high existing populations, as the state DOT responds to capacity needs.

Avoiding sites with existing colonies of invasive species limits opportunities for mitigation. State DOT personnel demonstrated a very good understanding of the factors that contribute to invasive species colonization. Sites that have existing invasive species populations may provide the greatest mitigation opportunity for functional lift of these degraded wetlands, but are more likely to be avoided as mitigation projects because of the difficulty in meeting invasive weed performance standards.

Site Design

Most state DOT personnel reported informally using reference sites to guide mitigation site design in order to establish suitable growing conditions for intended native plant communities. Reference sites are used to develop planting and grading plans to help restore intended functions at the mitigation site. Of the eight reference sites identified in this study, four exceeded 10% areal cover of invasive species. Mitigation projects designed to create similar conditions as the reference sites would appear prone to invasive species colonization.

Field biologists were able to identify mitigation design components for all mitigation sites, indicating that the state DOTs were able to implement mitigation sites as planned and that the mitigation wetland generally provides the desired habitat types described in the wetland mitigation plan.

Effort and Costs of Compliance

State DOTs reported that it was difficult to identify specific costs stemming from invasive species performance standards. Projects are constructed and managed in a variety of ways, often dependent on partnering opportunities and available state DOT resources near the mitigation project. Most state DOTs indicated that maintenance is performed by a combination of state DOT staff and contractors, depending on site location.

Complying with invasive species performance standards requires attention to site selection, site design, construction, monitoring, and maintenance. State DOTs consistently reported invasive species considerations in all aspects of their programs. Sites are often pre-treated for invasive plants, topsoil may be removed to eliminate seed or propagule sources, or the sites may be excavated to alter the hydrologic regime to discourage invasive species colonization. All state DOTs stated that invasive species control was the primary maintenance cost at their mitigation sites. Costs

vary depending on site size, location, and labor source. Assessing invasive species cover performance standards is commonly the costliest component of compliance monitoring.

Post-construction invasive species management typically includes herbicide treatment and mechanical control. State DOTs have also used water level control and biological control, such as using insects known for their ability to target specific invasive weeds (e.g., purple loosestrife and *Galerucella* beetles).

Alternative Approaches

Several of the state DOTs have proposed alternatives to performance standards for invasive species require low cover thresholds. The alternatives generally focus on using functions assessments or relating the invasive species cover at the impact sites to the invasive species cover requirements at the mitigation site. Most surveyed state DOTs have engaged permitting agencies in proposals to change the invasive species performance standards applied to their projects. Virginia, Washington, Montana, and Oregon report that progress has been made in adjusting mitigation performance standards to be more achievable. Performance standards in Minnesota are currently adjusted depending on the intended function to be provided at the mitigation site.

Conclusions

The conclusions of this study of performance standards are briefly summarized below.

- ***A performance standard limiting areal cover of invasive species to 10% appears too stringent to be applied to all DOT mitigation projects.***

  Four of the eight reference sites used in this study exceeded 10% areal cover of invasive species, and five of the eight mitigation sites also exceeded 10% areal cover. All mitigation sites underwent comprehensive control efforts for invasive species, and all reference sites were considered high quality, with minimal disturbance relative to the surrounding watershed.

  DOT personnel in the eight states that completed questionnaires for this study expressed concern that a 10% invasive species cover performance standard is difficult to achieve in areas with existing populations of invasive species, which includes population centers that are common locations for capacity improvement projects. DOT personnel expressed confidence in the agency's ability to comply with low-threshold areal cover performance standards for mitigation projects located where the surrounding landscape comprises mostly native vegetation. Many suggested that invasive species cover performance standards be adjusted by, or applied to, case-by-case circumstances.

- ***The use of invasive species performance standards limits site selection.***

  State DOTs report that the need to comply with invasive species performance standards affects their site selection, prioritizing sites that are relatively free of invasive species. By avoiding some of the more degraded sites because the sites include invasive species, state DOTs may not be implementing the best mitigation opportunities available.

  Two species, common cattail and reed canarygrass, identified as invasive species in performance standards of some states are native species according to the U.S. Department of Agriculture (2009). Although these species are well-known as aggressive colonizers, both provide water quality and hydrologic functions. Avoiding these widespread, native species would limit mitigation site selection to relatively few sites and would increase costs and time necessary to locate good mitigation sites.

- ***Wildlife species and biodiversity goals can be achieved in compensatory mitigation sites.***

  Wildlife survey results for all eight mitigation sites were comparable to results in their high quality, naturally occurring reference wetlands. Site goals for vegetation and hydrologic regimes appear to have been met at all eight mitigation sites. Vegetation communities established at mitigation sites were comparable to communities at the reference sites with respect to general species diversity. These are indicators that habitat is present for wildlife use.

- ***Compliance with invasive species performance standards requires significant resources***

  State DOTs must emphasize invasive species control throughout the mitigation process above other criteria due to the need to comply with performance standards. Site selection was identified as the most important factor for achieving invasive species performance standards; site selection can be limited due to project timelines or lack of available land. State DOTs spend up to half of their monitoring costs assessing invasive species performance standards. All state DOTs reported that invasive species management was the primary management activity

performed on mitigation projects after construction. Despite the effort expended by state DOTs, many mitigation sites fail to meet invasive species performance standards, particularly in areas where invasive species are common.

Recommendations for Future Study

Further study of invasive species standards could provide a scientifically based approach for assessing appropriate invasive species performance standards. Most state DOT personnel indicated that they were not aware of how permitting agencies set invasive species performance standards, and none identified specific scientific studies established to identify appropriate mitigation performance standards for invasive species. The following recommendations could be implemented to identify a scientifically supportable method for setting invasive species performance standards.

- ***Base invasive species performance standards on accepted functional assessment methods.***

  Survey accepted functions assessment methods in selected areas and identify invasive species cover thresholds used to determine the effects of invasive species cover on wetland functions.

- ***Quantify the existing invasive species cover in future impact sites.***

  Estimate areal cover of invasive species in potential impact areas for a sample of planned DOT improvement projects. Use these estimates to set typical impact area cover thresholds.

- ***Calibrate invasive species performance standards based on scientific rationale.***

  Consider factors such as landscape position, natural reference wetland conditions, and functions that need to be replaced in lieu of native plant assemblages.

- ***Identify alternative approaches to controlling the spread of invasive species.***

  Evaluate mechanisms to ensure that invasive species are controlled to an appropriate level. Adopt programmatically approved invasive control programs or memoranda of understanding to set standardized methods for control of invasive species.

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Appendix A

Bird Survey Results

Table A-1. Virginia Bird Survey Results

Species	Mitigation	Reference	Wetland Use
American crow		x	
American goldfinch	x		
Barn swallow	x	x	associated
Blue jay		x	
Blue grey gnatcatcher		x*	
Canada goose	x		obligate; PEM, open water
Carolina chickadee	x	x	
Carolina wren	x	x	
Common gallinule		x	PEM
Common grackle	x	x	associated
Common yellowthroat	x	x*	obligate; PSS, PEM
Downy woodpecker	x		
Eastern kingbird		x	associated
Eastern phoebe	x		
Eastern towhee		x	
Eastern wood peewee		x	
Field sparrow	x		
Gray catbird		x	
Great blue heron	fo	x	obligate; open water
Great crested flycatcher		x	
Great egret	x		obligate; open water
Indigo bunting	x		
Killdeer	x		
Mallard duck	fo		obligate; PEM, open water
Mourning dove	x		
Northern cardinal	x	x	
Northern flicker	x	x	
Northern mockingbird	x	x	
Northern parula	x		
Orchard oriole	x		
Pileated woodpecker	x		
Pine warbler		x	
Purple martin	x		associated
Red-bellied woodpecker		x	
Red-eyed vireo	x		
Red-winged blackbird	x*	x	obligate; PEM, PSS
Scarlet tanager		x	
Tree swallow		x*	associated
Tufted titmouse	x	x	
White-eyed vireo	x		
Yellow-throated vireo		x	
Yellow warbler	x		obligate; PFO, riparian zones
Total in wetland	26	25	
Total fly-overs	2	~	
Total confirmed breeders	1	3	

Species	Mitigation	Reference	Wetland Use
Unique to site (no fo)	16	15	
Wetland dependant	10	8	

Table A-2. New York Bird Survey Results

Species	Mitigation	Reference	Wetland Use
American crow		fo	
American goldfinch	x	x	
American robin	x	x	
Black-capped chickadee		x	
Brown-headed cowbird	x	x	
Cedar waxwing	x	x	
Common grackle	fo	x*	associate
Common yellowthroat	x	x	obligate; PSS, PEM
Eastern kingbird	x		associate
Gray catbird	x*	x*	
Least flycatcher	x*	x	
Mallard duck		x	obligate, PEM
Marsh wren		x	obligate, PEM, open water
Mourning dove		x	
Red-winged blackbird	x	x	obligate; PEM, PSS
Song sparrow	x*	x	obligate; PSS, riparian zones
Swamp sparrow	x	x	obligate; PSS, PEM
Tree swallow	x*	x	associate
Warbling vireo	x	x	
Willow flycathcher		x	obligate; PSS
Yellow warbler	x	x*	obligate; PFO, riparian zones
Total in wetland	14	19	
Total fly-overs	1	0	
Total confirmed breeders (*)	4	3	
Unique to site (no fo)	1	6	
Wetland obl. or assoc.	8	10	

Table A-3. New Hampshire Bird Survey Results

Species	Mitigation	Reference	Wetland Use
American crow	fo		
Alder flycatcher	x		obligate; PSS
American goldfinch	x	x	
American robin	x		
Baltimore oriole		x	
Black-capped chickadee	x		
Blue jay	x		
Brown-headed cowbird	x	x	
Cedar waxwing	fo	fo	
Common grackle	x	x	associate
Common yellowthroat	x	x	obligate; PSS, PEM
Downy woodpecker		x	
Eastern kingbird	x	x	associate
Eastern phoebe	x		
European starling		x*	
Field sparrow	x	x	
Gray catbird	x	x	
Least flycatcher	x	x	
Mourning dove		x	
Northern flicker		x	
Prairie warbler	x		
Red-eyed vireo		x	
Red-winged blackbird	x	x	obligate; PEM, PSS
Rose-breasted grosbeak	x	x	
Song sparrow	x	x	obligate; PSS, riparian zones
Tree swallow	x	x	associate
Yellow warbler	x	x	obligate; PFO, riparian zones
Total in wetland	19	19	
Total fly-overs	2	1	
Total confirmed breeders (*)	1	1	
Unique to site (no fo)	7	3	
Wetland obl. or assoc.	8	7	

Table A-4. Minnesota Bird Survey Results

Species	Mitigation	Reference	Wetland Use
American crow	fo		
American robin		x	
Bald eagle		fo	obligate; open water
Baltimore oriole		x*	
Barn swallow		x	associated
Blue-winged teal	x*	x	obligate; PEM, open water
Bobolink	x*	x	
Brewer's blackbird		x	
Brown-headed cowbird	x	x	
Canada goose		x	obligate; PEM, open water
Clay-colored sparrow		x*	
Common grackle	x*	x*	associated
Common snipe	x		obligate; wetlands w/muddy areas, cover
Common yellowthroat	x	x*	obligate; PSS, PEM
Double crested comerant		fo	obligate; open water
Great blue heron		fo	obligate; open water
Great egret		fo	obligate; open water
Green-winged teal	x		obligate; PEM, open water
Killdeer	x	fo	
Mallard duck	x	x	obligate; PEM, open water
Marsh wren	x*	x	obligate; PEM - cattail marshes
Mourning dove	x	x	
Northern shovler	x		obligate; PEM, open water
Red-winged blackbird	x	x*	obligate; PEM, PSS
Red-tailed hawk	fo		
Ring-necked pheasant	x	x	
Sedge wren	x	x	obligate; PEM - wet meadow
Savahnna sparrow	x	x	
Song sparrow	x	x	obligate; PSS, PEM
Sora		x	obligate; PEM
Swamp sparrow	x	x*	obligate; PSS, PEM - wet meadow
Tree swallow		x	associated
White pelican		fo	obligate; open water
Willow flycatcher		x	obligate; PSS
Yellow warbler		x	obligate; PFO, riparian zones
Yellow-headed blackbird	x	x	obligate; PEM
Total in wetland	19	25	
Total fly-overs	2	6	
Total confirmed breeders (*)	3	6	
Unique to site (no fo)	2	11	
Wetland dependant	12	12	

Table A-5. Michigan Bird Survey Results

Species	Mitigation	Reference	Wetland Use
American Crow	x	x	
American Goldfinch	x	x	
American Robin	x	x	
Baltimore Oriole	x	x	
Barn Swallow	x	x	associate
Belted Kingfisher	x	x	obligate; open water
Black-capped chickadee	x	x	
Brewer's Blackbird	x	x	
Brown-headed Cowbird	x	x	
Canada Goose	x		obligate; PEM, open water
Cedar Waxwing	x	x	
Common Moorhen	x		obligate; PEM, open water
Common Yellowthroat*	x	x	obligate, PSS, PEM
Downy woodpecker	x	x	
Eastern Kingbird*		x	associate
Eastern Screech Owl		x	
Eastern Wood Pewee*		x	
European Starling	x	x	
Grasshopper Sparrow	x	x	
Gray Catbird	x	x	
Great Blue Heron	x	x	obligate; open water
Green Heron	x	x	obligate; open water
Hermit Thrush	x	x	
House Finch	x		
Indigo Bunting	x	x	
Killdeer	x	x	
Least Flycatcher	x	x	
Mallard	x	x	obligate; PEM, open water
Mourning Dove	x	x	
Northern Cardinal	x	x	
Northern Rough-winged Swallow	x	x	associate
Northern Waterthrush		x	obligate; PSS, PFO
Red-winged Blackbird	x	x	obligate; PEM, PSS
Rock Dove	x	x	
Rose Breasted Grosbeak	x	x	
Ruby Crowned Kinglet		x	
Sandhill Crane	x	x	obligate; PEM
Savannah Sparrow	x		
Song Sparrow	x	x	obligate; PSS
Swamp Sparrow	x		obligate; PSS
Tree Swallow	x	x	associate
Veery		x	associate
Warbling Vireo	x	x	associate
Willow Flycatcher	x	x	obligate; PSS
Wood Duck	x	x	obligate; PFO, PEM, open water
Wood Thrush		x	
Yellow Warbler*	x	x	obligate; PFO, riparian zones
Yellow-rumped warbler	x	x	

Species	Mitigation	Reference	Wetland Use
Total in wetland	41	43	
Total fly-overs			
Total confirmed breeders (*)			
Unique to site (no fo)	4	7	
Wetland obl. or assoc.	18	17	

Table A-6. Montana Bird Survey Results

Species	Mitigation	Reference	Wetland Use
American Crow	x	x	
American Kestrel	x	x	
American Robin	x	x	
Bald Eagle	x	x	obligate; open water
Barn Swallow	x	x	associate
Black-billed Magpie	x	x	
Brewer's Blackbird	x	x	
Brown-headed Cowbird	x	x	
Canada Goose		x	obligate; PEM, open water
Cedar Waxwing	x	x	
Common Raven	x	x	
Common Snipe	x	x	obligate; wetlands w/muddy areas
Common Yellowthroat	x	x	obligate; PSS, PEM
Eastern Kingbird	x	x	associate
European Starling	x	x	
Great Blue Heron	x	x	obligate; open water
Hammond's Flycatcher	x	x	
Hooded Merganser		x	obligate: PFO
Killdeer	x	x	
Lazuli Bunting	x		
Lewis's Woodpecker	x		
Northern Flicker	x	x	
Northern Harrier	x	x	associate
Northern Rough-winged Swallow	x	x	associate
Red-tailed Hawk	x	x	
Red-winged Blackbird	x	x	obligate; PEM, PSS
Song Sparrow	x	x	obligate; PSS
Spotted Sandpiper	x		obligate; shore line
Spotted Towhee	x	x	
Tree Swallow	x	x	associate
Turkey Vulture	x	x	
Western Kingbird	x	x	
Western Meadowlark	x		
Western Wood-Pewee	x	x	
Willow Flycatcher	x	x	obligate; PSS
Yellow Warbler	x	x	obligate; PFO, riparian zones
Total in wetland	34	32	
Total fly-overs			
Total confirmed breeders (*)			
Unique to site (no fo)	4	2	
Wetland obl. or assoc.	13	13	

Table A-7. Oregon Bird Survey Results

Species	Mitigation	Reference	Wetland Use
American Crow	x	x	
American Goldfinch	x	x	
American Kestrel	x	x	
American Robin	x	x	
Bald Eagle		x	obligate; open water
Barn Swallow	x	x	associated
Black-capped Chickadee	x	x	
Black-headed Grosbeak	x	x	
Blue-winged teal	x		obligate; PEM, open water
Brewer's Blackbird	x	x	
Bushtit	x		
Cedar Waxwing	x	x	
Common Yellowthroat	x		obligate: PSS, PEM
Dark-eyed Junco		x	
Downy Woodpecker	x		
European Starling	x	x	
Great Blue Heron	x	x	obligate;open water
House Sparrow	x	x	
House Wren	x	x	
Killdeer	x	x	
Lazuli Bunting	x		
Mallard	x	x	obligate, PEM
Mourning Dove		x	
Northern Flicker	x	x	
Red-breasted nuthatch		x	
Red-tailed Hawk	x	x	
Red-winged Blackbird	x	x	obligate; PSS, PEM
Ruby Crowned Kinglet	x	x	
Savannah Sparrow	x	x	
Scrub Jay	x	x	
Song Sparrow	x	x	obligate; PSS, riparian zones
Spotted Towhee	x	x	
Steller's Jay		x	
Swainson's Thrush	x		
Turkey Vulture	x	x	
Vesper Sparrow	x		
Western Kingbird	x		
Western Wood-pewee	x		
White-breasted Nuthatch	x		
White-crowned sparrow		x	
Willow Flycatcher	x	x	obligate; PSS
Yellow Warbler	x	x	obligate; PFO, riparian zones
Total in wetland	36	32	
Total fly-overs			
Total confirmed breeders (*)			
Unique to site (no fo)	10	6	
Wetland obl. or assoc.	9	8	

Table A-8. Washington State Bird Survey Results

Species	Mitigation	Reference	Wetland Use
American Crow	x	x	
American Goldfinch	x	x	
American Kestrel	x	x	
American Robin	x	x	
Anna's Hummingbird	x		
Bald Eagle	x	x	obligate; open water
Barn Swallow	x	x	associated
Black-capped Chickadee	x	x	
Black-headed Grosbeak*	x	x	
Black-throated Gray Warbler		x	
Brewer's Blackbird	x	x	
Brown-headed Cowbird	x	x	
Bushtit	x	x	
California Quail	x	x	
Canada Goose	x	x	obligate; PEM, open water
Cedar Waxwing	x	x	
Chestnut-backed Chickadee	x	x	
Common Snipe		x	obligate; wetland w/muddy areas
Common Yellowthroat	x	x	obligate; PSS, PEM
Cooper's Hawk	x	x	
Dark-eyed Junco	x	x	
Downy Woodpecker	x	x	
European Starling	x	x	
Fox Sparrow		x	associated (Sooty sub pop only)
Great Blue Heron	x	x	obligate; open water
Green-winged teal		x	obligate; PEM, open water
Hairy Woodpecker	x	x	
Hammond's Flycatcher	x	x	
House Finch	x	x	
House Sparrow	x		
House Wren	x	x	
Killdeer	x	x	
Mallard	x	x	obligate, PEM
Northern Flicker	x	x	
Northern Rough-winged Swallow	x	x	associated
Pileated Woodpecker		x	
Pine Siskin	x	x	
Purple Finch	x	x	
Red-breasted Sapsucker	x	x	
Red-tailed Hawk	x	x	
Red-winged Blackbird	x	x	obligate; PSS, PEM
Rock Dove	x	x	
Ruby Crowned Kinglet	x	x	
Rufous Hummingbird	x	x	
Scrub Jay	x	x	
Sharp-shinned Hawk	x		
Song Sparrow	x	x	obligate; PSS, riparian zones
Spotted Towhee	x	x	
Steller's Jay	x	x	

Species	Mitigation	Reference	Wetland Use
Swainson's Thrush	x	x	
Townsend's Warbler	x	x	
Tree Swallow	x	x	associated
Turkey Vulture	x	x	
Vaux's Swift		x	
Violet-green Swallow	x	x	associated
Western Tanager	x	x	
White-crowned sparrow	x	x	
Willow Flycatcher	x	x	obligate; PSS
Winter Wren	x	x	
Yellow Warbler	x	x	obligate; PFO, riparian zones
Total in wetland	54	57	
Total fly-overs			
Total confirmed breeders (*)			
Unique to site (no fo)	3	6	
Wetland obl. or assoc.	14	17	

Appendix B

Related Studies Abstracts and Summaries

Matthews, J. W. and A. G. Endress (2008). "Performance Criteria, Compliance Success, and Vegetation Development in Compensatory Mitigation Wetlands [electronic resource]." Environmental management **41**: 130.

The US Army Corps of Engineers often requires wetland creation or restoration as compensation for wetlands damaged during development. These wetlands are typically monitored post construction to determine the level of compliance with respect to site-specific performance standards. However, defining appropriate goals and measuring success of restorations has proven difficult. We reviewed monitoring information for 76 wetlands constructed between 1992 and 2002 to summarize the performance criteria used to measure progress, assess compliance with those criteria, and, finally, to evaluate the appropriateness of those criteria. Goals were overwhelmingly focused on plant communities. Attributes used to assess the quality of restored plant communities, including percent native species and the Floristic Quality Index, increased over time but were apparently unrelated to the number of species planted. Compliance frequencies varied depending on site goals; sites often failed to comply with criteria related to survival of planted vegetation or requirements that dominant plant species should not be exotic or weedy, whereas criteria related to the establishment of cover by vegetation or by wetland-dependent plants were often met. Judgment of a site's success or failure was largely a function of the goals set for the site. Some performance criteria were too lenient to be of value in distinguishing failed from successful sites, whereas other criteria were unachievable without more intensive site management. More appropriate goals could be devised for restored wetlands by basing performance standards on past performance of similar restorations, identifying consistent temporal trends in attributes of restored sites, and using natural wetlands as references.

Sabine Tischew, (2008). "Evaluating Restoration Success of Frequently Implemented Compensation Measures: Results and Demands for Control Procedures." Restoration Ecology.

This article summarizes the results of a comprehensive evaluation of frequently implemented compensation measures used to counteract environmental impacts in the course of road construction. Examination of planning documents and compensation areas revealed that 26 of 57 compensation areas had to be excluded from further evaluations either because of insufficient goal setting with regard to habitat functions and/or poor descriptions of the measures, unrecognizable implementation, or because the measures were simply not carried out. In the remaining 31 compensation areas, we examined 119 compensation sites and analyzed their success in relation to 326 defined compensation goals. Only 33% of the goals set were fully or mostly achieved, whereas 67% were reached only partly, mostly not, or not at all. Deficiency inquiries and analyses revealed that (1) in addition to unsuitable site conditions, improper implementation methods as well as deficient follow-up management proved to be of significant influence for goal achievement and (2) a considerable portion of the pitfalls could be avoided by faster integration of state-of-the-art ecological restoration practices. Therefore, we recommend a standardized control procedure, which includes planning, implementation, as well as monitoring of goal achievement and follow-up management for maintenance of target conditions to improve compensation success. This should help to avoid planning and implementation errors, detect flawed development, and correct it in time.

Tabatai, Fari. (1998). NATIONAL WETLAND MITIGATION BANKING STUDY The Early Mitigation Banks: A Follow-up Review .WORKING PAPER Institute for Water Resources Water Resources Support Center U.S. Army Corps of Engineers Alexandria, Virginia.

National Wetland Mitigation Banking Study (thereafter referred to as National Study) was conducted by the U.S. Army Corps of Engineers Institute for Water Resources (IWR) under the authority of Section 307(d) of the Water Resources Development Act of 1990 (WRDA '90). In 1992, as part of the National Study, IWR conducted detailed case studies of approximately one-half of the population of the then existing mitigation banks in the nation. The results of those case studies are presented in the National Study Report entitled "Wetland Mitigation Banking: Resource Document" (IWR Report 94-WMB-2). The current report is prepared as a followup survey on the status of the eight case study mitigation banks that were experiencing technical deficiencies during the implementation phase. This report describes the overall progress of mitigation effort and management status rather than quantitative assessment of success. The term "success" in this report is defined as meeting the stated goals of the mitigation bank and does not necessarily involve specific determination of ecological success. A qualitative or quantitative field evaluation was not conducted by the authors. Interviews were conducted in 1996 with regulatory and resource agency personnel and project sponsors who have conducted the most recent field evaluation to determine the current status of the bank. Some of those banks deemed "successful" in the 1992 case studies also experienced problems. For example, the Minnesota Department of Transportation Bank Program experienced negative balances in the first few years throughout much of the multi-site system. However, by the time the National Study began, those problems had been resolved. In another example, the Company Swamp Bank in North Carolina experienced credit accounting problems. While permitted wetland losses were authorized by the Corps, the bank's "books" had not been officially debited as of 1992 due to the fact that signatories had not yet signed any debiting forms as required by the terms of the bank's Memorandum of Understanding. However, this problem was small given the large size (i.e., credit base) of the bank relative to the small size of the debits.

Wilkinson J. and Jared Thompson. (2006) 2005 Status Report on Compensatory Mitigation in the United States. Environmental Law Institute. Washington DC.

In 2005, the Environmental Law Institute (ELI) distributed a survey1 to all 38 districts of the U.S. Army Corps of Engineers (Corps) requesting information on the nature of the compensatory mitigation being conducted in their districts and to update ELI's database of mitigation banks, in-lieu-fee mitigation programs, and umbrella banking agreements.2 ELI received complete survey responses from all of the Corps' 38 districts. A subsequent verification of the initial data was returned or commented on by 31 of the 38 Corps districts, for an 82 percent response rate. The initial surveys were distributed in August 2005 and were submitted to ELI between late August 2005 and early October 2005. The verification letters were distributed in December 2005 and returned to ELI between December 2005 and February 2006. This is the third study that ELI had conducted on the status of mitigation banks and the second study that seeks to track trends in off-site compensatory mitigation in the U.S. In 1993, ELI published, *Wetland Mitigation Banking*, which was part of the Army Corps, Institute for Water Resources' "National Wetlands Mitigation Banking Study."3 The study provided data on the number of proposed and existing mitigation banks in existence in the U.S. The data provided in the report were compiled and verified in July 1992 (hereinafter 1992 study). In 2002, ELI published *Banks and Fees: The Status of Compensatory Mitigation in the United States.* The report provided data on the number

of mitigation banks, in-lieu-fee mitigation programs, and umbrella agreements in existence in the U.S. The data in the report were verified in November and December 2001 (hereinafter 2001 study). Similar studies on mitigation trends have been conducted by the U.S. Army Corps of Engineers, Institute for Water Resources.4. Having collected these data at three distinct periods in time allows us to present information that will, we hope, provide the reader with some insight into current trends in compensatory mitigation in the U.S.

Faber-Langendoen, D., G. Kudray, C. Nordman, L. Sneddon, L. Vance, E. Byers, J. Rocchio, S. Gawler, G. Kittel, S. Menard, P. Comer, E. Muldavin, M. Schafale, T. Foti, C. Josse, J. Christy. 2008. Ecological Performance Standards for Wetland Mitigation: An Approach Based on Ecological Integrity Assessments. NatureServe, Arlington, VA. + Appendices.

Wetland mitigation and restoration practitioners, as well as scientists and policy makers, have been calling for stronger ecological performance standards to guide the wetland mitigation process. Here we present two methods for setting those standards: a) a watershed approach and b) ecological performance standards based on ecological integrity assessment methods. A watershed approach can assist the process of wetland mitigation. The following criteria can be used to create an informal watershed approach.

4. Landscape integrity index – integrate cumulative impacts of past development activities, focusing on ecosystems.
5. Fish faunal intactness index – address cumulative impacts of past development on aquatic species.
6. Locations of critically imperiled (G1) and imperiled (G2) species and rare or high-quality ecosystem types – address presence and need of sensitive species and rare wetland types.
7. Ecosystem maps of the watershed. These are similar to wetland profiles, but integrate both biotic and abiotic aspects of wetlands. These maps will also help identify wetland types throughout the watershed, in order to avoid, where possible, permitting impacts to wetlands that are difficult or impossible to restore, such as fens or bogs, or may have a long time to recovery, such as forested wetlands. We recommend using the U.S. National Vegetation Classification (NVC) formation and NatureServe Ecological Systems levels for mapping, combined with maps of hydrogeomorphic (HGM) classes.
8. Information on high priority conservation sites identified by a variety of
9. conservation and wildlife agencies, and state and federal agencies.

Our ecological integrity assessment method for establishing performance standardsfor mitigation builds on the variety of existing wetland rapid assessment methods. It emphasizes metrics that are condition-based, separate from those that are stressorbased. The assessment uses the following steps.

Develop a conceptual model with key ecological attributes and identify indicators for wetland types, at multiple classification scales (NVC formation, NatureServe ecological system, coupled with HGM and Cowardin classifications).

Use a three-level approach to identify a suite of metrics, including Level 1(remote sensing), Level 2 (rapid field-based), and Level 3 (intensive fieldbased) metrics.

Identify ratings and thresholds for each metric based on "normal' or "natural range of variation" benchmarks for each formation.

Provide a scorecard matrix by which the metrics are rated and integrated into an overall assessment of the ecological integrity of the ecosystem.

Provide tools for adapting the metrics over time as new information and methods are developed.

We provide an overview of the metrics and their ratings for the various assessment levels, as well as detailed protocols and scorecards for metrics at Level 1 and Level 2. Level 3 metrics are incomplete at this time, but we provide several examples. The objective in setting performance standards and in conducting subsequent monitoring is to collect sufficient data to answer the hypothesis: has the mitigation wetland met the performance goal within the monitoring period? The performance standards developed above include a broad range of structural and functional measures, including hydrology, vegetation and soils, and rely on reference wetlands as a model

for the dynamics of created or restored sites. We use several examples to show how ecological integrity assessments can be used to set ecological performance standards for mitigated sites, so that a more definitive answer can be given regarding the ecological success of mitigation efforts. Our methods point towards the kinds of ecological applications that are needed for mitigation. Future studies are needed to advance these methods and test them on a variety of wetland mitigation sites.

Prehmus, Cyndie, Bob Thomas, and Paul Wagner. "Effective Wetland Mitigation Site Management: Plant Establishment to Closeout". In Proceedings of the 2007 International Conference on Ecology and Transportation, edited by C. Leroy Irwin, Debra Nelson, and K.P. McDermott. Raleigh, NC: Center for Transportation and the Environment, North Carolina State University, 2007. pp. 81-87.

Wetland mitigation projects in Washington State are developed using well defined and documented guidance in the design, permitting and construction phases. Traditionally, there has been little guidance for post construction management of these sites. Post-construction management has largely been left to the discretion of the permit holder. There were no methods in place to effectively determine when regulatory requirements were achieved, or a standard to certify that the site was considered complete. Over the last decade, the Washington State Department of Transportation (WSDOT) has developed standardized mechanisms and processes for site management, reporting, and closeout procedures. These include establishment of site management crews, predictable funding sources for management activities, monitoring and reporting methods, and inter-disciplinary adaptive management teams that develop strategies for short and long-term site management. Recently, WSDOT partnered with local U. S. Army Corps of Engineers staff to develop a process for closing out mitigation sites with fulfilled permit requirements. These process improvements provide predictability for our mitigation efforts and long-term budget requirements to support site management activities. They also increase our credibility with the resource agencies by demonstrating the effectiveness of our adaptive management. These overall improvements also benefit future mitigation project proposals. We intend to use our monitoring data to increase the scientific knowledge about mitigation site development and management practices, and to continue the process of fine-tuning ecologically meaningful performance measures for future mitigation projects.

Patricia Johnson, Dana L. Mock, Andy McMillan, Lauren Driscoll, and Tom Hruby **(**2002) Washington State Wetland Mitigation Evaluation Study Phase 2: Evaluating Success. Washington State Department of Ecology Shorelands & Environmental Assistance Program, Lacey, WA

Publication No. 02-06-009

The Washington State Wetland Mitigation Evaluation Study was developed in two phases to evaluate the success of projects intended to compensate (mitigate) for wetlands lost to development activities in the state of Washington. Phase 1 of the study, conducted in the fall of 1999, examined the compliance of 45 randomly selected projects with their permit requirements. Phase 2 examined the ecological success of a subset of the projects from Phase 1. The study did not include any Washington State Department of Transportation mitigation projects. Over all, 24 compensatory wetland-mitigation projects (at 31 sites) were evaluated in Phase 2. Eighteen projects were located west of the Cascade Mountains, and six projects were located east of the Cascade crest. The goal of Phase 2 of the Wetland Mitigation Evaluation Study was to determine the success of wetland mitigation projects from an ecological perspective. The overall success of mitigation projects in Phase 2 was evaluated based on two factors, each with its own criteria.

- Achievement of ecologically relevant measures:
  - Establishing the required acreage of mitigation.
  - Attaining ecologically significant performance standards.
  - Fulfilling appropriate goals and/or objectives.
- Adequate compensation for the loss of wetlands:
  - Contribution of the mitigation activity to the potential performance of functions.
  - Comparison of the type and scale of functions provided by the mitigation project with the type and scale of lost wetland functions. In addition to evaluating the success of mitigation projects, the Phase 2 study also examined:
- Wetland resource trade-offs (e.g., in-kind/out-of-kind, on-site/off-site, etc.).
- Ecological condition (e.g. surrounding land uses, buffer condition, extent of invasive species, etc.).
- Factors that were associated with project success (or lack of success).

Three projects (13%) were found to be fully successful; eight projects (33%) were moderately successful; eight (33%) were minimally successful; and five (21%) were not successful. The results of the Phase 2 study indicate that "created wetlands" are more successful than previous studies have shown, since 60 percent of them were at least moderately successful, and only one project (10%) was not successful. However, only 65 percent of the total acreage of wetlands lost was replaced by creating or restoring new wetland area, thereby resulting in a net loss of 24.18 acres of wetland area. *Wetland Mitigation Evaluation Study Phase 2: Evaluating Success* No enhancement projects were fully successful, while eight out of nine (89%) enhanced wetlands were minimally or not successful. Nearly two-thirds of the total acreage of mitigation that was established resulted from enhancement activities. In addition, mitigation projects designed and implemented by public entities1 fared worse than projects done by private entities: 71 percent of private mitigation projects were judged to be fully or moderately successful, while 35 percent of public mitigation projects were judged to be fully or moderately successful. Seventy-nine

percent of mitigation projects were at least somewhat achieving their ecologically relevant measures, while 63 percent of projects at least partially compensated for the permitted wetland losses. This implies that, although projects may be doing a better job of achieving ecologically relevant permit requirements, these requirements are not always sufficient indicators of whether mitigation projects adequately compensate for the permitted loss of wetlands. Phase 2 findings suggest that follow-up by regulatory agencies results in more-successful mitigation projects. Responses to a consultant questionnaire indicated that 75 percent of the fully and moderately successful projects experienced some degree of agency follow up, while only 27 percent of the minimally and not-successful projects had some follow up. It was interesting to note that being out of compliance with permits did not necessarily mean a mitigation project ultimately would be unsuccessful. In fact, 66 percent of the projects that ultimately were fully successful were not in compliance in Phase 1. However, all of the projects that ultimately did not succeed also were not in compliance with their permits. The primary key to success appears to be follow-up, monitoring, and maintenance to make sure the mitigation actions have a chance to work. Based on these results, the authors recommend that the Department of Ecology improve the follow-up on wetland mitigation projects by developing and implementing a compliance tracking system. Additionally, Ecology should work collaboratively with other regulatory agencies, applicants, and their consultants to come up with new guidance to improve mitigation at every step in the process, from choosing an appropriate site to monitoring and performing site maintenance. By working together, those involved in wetland mitigation can develop solutions and approaches that improve wetland mitigation, and thereby help to protect the state's valuable wetland resources.

Celedonia, Mark T. 2002. Benchmarks for Stand Development of Forested and Scrub-

Shrub Plant Communities at Wetland Mitigation Sites in the Lowlands of Western

Washington. Washington State Department of Transportation, Olympia, WA.

Establishing reasonable and achievable success standards for wetland mitigation projects is currently hindered by a lack of data regarding the development of desired features at mitigation sites. In order to help bridge this gap, this study documented and evaluated features of 29 forested and scrub-shrub plant communities established at mitigation wetlands in western Washington. The main purpose of this study was two-fold: 1) document structural characteristics of woody plant stands at completed mitigation projects; and, 2) use this information to recommend reasonable and achievable benchmark standards that may be used for evaluating success of future mitigation projects. Main objectives of the study were:

- Document aerial cover of native woody species and identify a benchmark standard for time to achieve 80% aerial cover;
- Document and evaluate abundance of woody nonnative invasive species and reed canarygrass, and propose benchmark standards as appropriate; and,
- Document and evaluate other structural attributes, and propose benchmark standards as appropriate.

These included stem density of woody species, various measures of species richness and dominance, and establishment of planted and volunteer species. These specific attributes were chosen because they are often used to help evaluate mitigation success in western Washington and/or because they represent basic stand development characteristics. This study did not

attempt to identify an entire set of attributes that should be used to evaluate mitigation success, nor did it seek to recommend, identify or evaluate the ppropriateness of specific attributes for evaluating wetland functions or mitigation success. Mitigation sites between 6 and 11 years of age were evaluated for these purposes. *Timeseries curves* were onstructed from the data to evaluate age-related change in certain attributes. These curves provided pertinent information in evaluating stand development and proposing benchmark standards. Other relationships were evaluated independent of site age. These included: 1) influence of canopy cover and woody plant stem density on reed canarygrass cover; and, 2) influence of planting density on various plant community features. Results were used to identify benchmark standards and to consider management implications.

VanDeWalle, T. et al. 2008. ECOLOGICAL ASSESSMENT OF COMPENSATORY WETLAND MITIGATION - Final Report. Prepared for: U.S. Environmental Protection Agency

Intensive biological inventories were used to evaluate ecological performance at 12 Iowa Department of Transportation mitigation wetlands and three reference wetlands in Iowa. Species richness and abundance data were collected on algae, protozoa, aquatic invertebrates, vascular plants, butterflies, amphibians, reptiles, birds and mammals at each site. Species richness and diversity at mitigation sites and reference sites were compared to determine if mitigation wetlands are performing differently than reference wetlands in Iowa. In addition, abiotic factors having the potential to influence biological diversity were also studied, including water quality and physical and landscape characteristics (local and watershed level) at each study site.

The results of this comprehensive study of the ecological performance of wetland mitigation sites suggest that mitigation sites in Iowa are performing similarly to reference wetlands ecologically. Reference wetlands and mitigation wetlands in Iowa are similar in terms of water quality; landscape processes; site conditions; diversity of algae/protozoa/aquatic invertebrates, amphibians, birds, mammals, reptiles; and overall plant and animal diversity. No significant difference was found in overall diversity or within a species group, with the exception of butterflies, as estimated by effective number of species at mitigation and reference wetlands. Because the effective number of species is a measure of the number of common species at a site, this result suggests that the number of common species within each species group is approximately equal between mitigation and reference sites.

Significant differences were found between mitigation and reference wetlands in terms of butterfly diversity and plant composition and floristic quality. Mitigation wetlands were found to have higher butterfly species richness and a significantly greater number of rare butterfly species than reference wetlands. In contrast, reference wetlands were found to have more native plant species, fewer exotic plant species, contained species with wetter indicator status, and more importance of *Carex* species.

The study also evaluated selected existing rapid assessment methods to determine the appropriateness of each for assessing and characterizing ecological performance of mitigation sites and to develop a conceptual framework for developing a new, or adapting an existing, rapid assessment method for use by the Iowa DOT. An existing rapid assessment tool, the *Wetland Mitigation Quality Assessment*, was found to provide the best measure of ecological performance as measured by biodiversity of the four rapid assessment methods evaluated in this study. The

WMQA has the potential be used as both a performance measure for wetland mitigation sites and an assessment tool for wetland impact studies.

The results of this study are valuable for building and expanding the tools and knowledge necessary to effectively assess and manage the ecological performance of compensatory mitigation wetlands and improve the ecological effectiveness of wetland mitigation.

Appendix C

DOT Staff Questionnaire for FHWA Invasive Species Study

DOT Staff Questionnaire for FHWA Invasive Species Study

Please answer the following questions to the best of your ability. Your information will be incorporated into the final project report and will be presented as opinions or estimations. *Please consider that the information you provide may be presented to the general public.*

Invasive Species Requirements - Statewide/Program Level Invasive Species

Which agencies require invasive species cover thresholds on your projects (Corps, State, other)?

What are the species that are considered "invasive" and what are the typical cover requirements?

How long have invasive species cover requirements been required? Are they required on all wetland mitigation projects?

What justifications or rationale have been provided to explain the need for these standards (Scientific papers, recommendations by experts)?

Have alternative approaches been proposed by your agency? Describe the response:

Implementation

Have invasive species performance standards altered the way your agency approaches:

- Site Selection?
- Site Design & Construction?
- Site Maintenance?

Have permitting agencies considered any of your mitigation sites failures (non-compliant) specifically due to invasive species cover (when all other site conditions were met)?

What weed control methods are typically used during site preparation? Where those methods used on the specific study site?

How much does weed control cost on a typical mitigation site per acre on average for 1 year?

How much does mitigation site construction cost per acre, including real estate?

What weed control methods are typically used during site management? Were these same methods used on this specific study site?

Who performs the weed control for the majority of your sites? Did they perform weed control on this specific study site?

Monitoring

How much of your monitoring effort is spent addressing invasive species performance standards (minimal, half, majority)?

What is the average cost to monitor a typical mitigation site per year?

Does your monitoring reporting include assessment of invasive control effort effectiveness?