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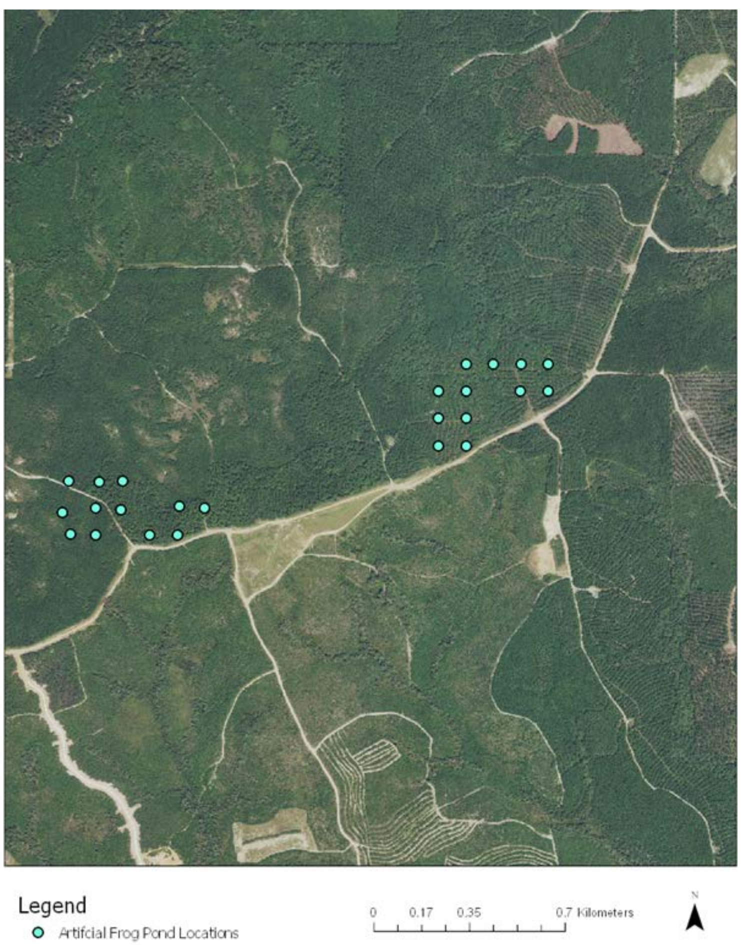
Conspecific Attraction as a Management Tool for Endangered and At-Risk Species on Military Lands

Jinelle H. Sperry, Brett A. DeGregorio, Stephen A. Tyndel, and Michael P. Ward

September 2019



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Conspecific Attraction as a Management Tool for Endangered and At-Risk Species on Military Lands

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Abstract

Movements of wildlife species and associated colonization of habitats is often unpredictable, potentially leading to ineffective management and/or interference with military training. Habitat restoration for wildlife management on military lands is a common, yet expensive, response to federal conservation and mitigation mandates, yet viable wildlife populations often fail to become established on restored habitat. Conspecific attraction, using the tendency for individuals of the same species to settle near one another, can be a cost-effective means of attracting animals to newly created or restored habitats. This work demonstrated the use of conspecific attraction as an alternative tool for encouraging colonization of restored habitats by at-risk birds and amphibians. Conspecific attraction was relatively straightforward to employ, but its effectiveness varied among species. We demonstrated clear success in attracting some bird (northern bobwhite; *Colinus virginianus*) and frog (wood frogs; *Lithobates sylvaticus*) species into our target areas but other species showed a neutral response. Conspecific attraction presents a cost-effective alternative to current management practices such as translocation or colonization after habitat is created or restored. Only minimal equipment costs (<$300/broadcast station) and nominal work-hours are required to set up the equipment, and total cost was ~$1,200 per demonstration plot annually.

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Preface

Funding for this demonstration was provided by the Environmental Security Technology Certification Program (ESTCP) under Resource Conservation and Resiliency (RC) Project RC-201615, "Conspecific Attraction as a Management Tool for Endangered and At-Risk Species on Military Lands." The ESTCP program manager was Dr. Kurt Preston.

This work was conducted by the Ecological Processes Branch (CNN), Installations Division (CN), Construction Engineering Research Laboratory (CERL), Engineer Research and Development Center (ERDC). Dr. Chris Rewerts was Chief, CEERD-CNN, and Michelle J. Hanson was Chief, CEERD-CN. The associated Technical Director was Alan Anderson, CEERD-CZT. The Deputy Director of ERDC-CERL was Dr. Kumar Topudurti and the Director was Dr. Lance D. Hansen.

We thank the ESTCP for funding this project. We also thank the ESTCP staff, especially Kurt Preston, for support throughout this project. We thank Timothy Wilder, Susan Vos, and Sarah Pearce for being enthusiastic and helpful demonstration site partners. We had many excellent postdoctoral associates, graduate students, and technicians assist with this project and thank Sasha Tetzlaff, Dr. Loren Merrill, Daniel Kovar, Kyle Van den Bosch, Dr. Valerie Buxton, Hannah Olsen, Paul Liu, Nick Shiltz, Joel Throckmorton, Erin Riley, Casey Weissburg, Aswini Cherukuri, Suzanne Trammel, Aaron Johnson, Charles Jacobi, Araks Ohanyan, Anna Enderle, and Heidi Faulkner. All work was approved by the University of Illinois' Institutional Animal and Care and Use Committee (protocol #16022) and permits from Wisconsin (Department of Natural Resources [DNR] permit #SCP-SOD-006-2017 and SRLN-18-037) and U.S. Geological Survey (USGS) Bird Banding Lab permit #23959 under Dr. Michael P. Ward.

COL Teresa A. Schlosser was Commander of ERDC, and Dr. David W. Pittman was the Director.

Executive Summary

Introduction

Most U.S. Army installations reside on lands that provide refuge for federally listed or at-risk plant and animal species. Federal mandates (e.g., Endangered Species Act, Clean Water Act) often require installations to establish viable populations of these species in restored or mitigated habitats. To meet these requirements, the U.S. Department of Defense (DoD) expends considerable funding and effort in restoring habitats for species of conservation concern.

However, the movements of wildlife species and the resulting colonization of habitats is often unpredictable, and viable wildlife populations often fail to become established on restored habitat. In the case of federally listed or at-risk species on military installations, this unpredictable movement can make effective management difficult, and in some cases, when these species establish populations on training lands, their presence can interfere with military training. Installation land managers have used a range of strategies to encourage animals to colonize restored habitat. Methods for achieving this goal range from no active management (i.e., “build it and they will come”) to translocation of adults or eggs/young (Scott et al. 2001). These methods are often ineffective and/or expensive.

Conspecific attraction, which uses the tendency for individuals of the same species to settle near one another (Stamps 1988), may provide an alternative, cost-effective management tool for attracting animals to newly created or restored habitats. For species that communicate via auditory signaling, conspecific attraction can attract individuals to suitable yet unoccupied or underutilized habitat by broadcasting prerecorded conspecific vocalizations (Ward and Schlossberg 2004). Although most previous work on conspecific attraction has been done with birds (e.g., Ward and Schlossberg 2004, Ward et al. 2011, Hahn and Silverman 2006), a recent study has shown that broadcasting conspecific calls can also be used to attract pond-breeding amphibians to newly created ponds (Buxton et al. 2015). This suggests that conspecific attraction is not only a viable option for managing and restoring bird populations, but also for restoring amphibian communities to wetlands, a previously difficult outcome to achieve.

Compared to currently available methods, conspecific attraction can be a very effective management tool for attracting focal species to restored habitats. This passive means of moving animals minimizes the risks associated with more invasive methods (e.g., decreased survival associated with translocation). Conspecific attraction requires minimal financial and time investment to not only lure at-risk species to target habitats but to establish long-term viable populations. The method could be used to attract species within an installation to established conservation areas, or to partner lands located well away from military training areas.

Objectives of the demonstration

Our work had two primary objectives:

1. To demonstrate the use of conspecific attraction as a cost-effective management tool for encouraging colonization of restored habitats by target at-risk bird and amphibian species
2. To test the use of conspecific attraction to establish populations following cessation of the broadcast calls.

Grassland and shrubland species have experienced precipitous declines across the continent (Brennan and Kuvlesky 2005) and use of novel management tools such as conspecific attraction could provide effective strategies for military land managers. Preference was given to species that were present on/near restoration sites and that presumably occur in low to moderate abundances.

Our demonstration sites of Fort McCoy, Wisconsin and Fort Polk, Louisiana, encompass a variety of species, habitats, and restoration strategies. At Fort McCoy, we targeted grassland and shrubland restoration sites and associated focal species likely to use such habitats, including the grasshopper sparrow (*Ammodramus savannarum*), savannah sparrow (*Passerculus sandwichensis*), golden-winged warbler (*Vermivora chrysoptera*), upland sandpiper (*Bartramia longicauda*), and a suite of amphibian species including the American Toad (*Anaxyrus americanus*), eastern grey tree frog (*Hyla versicolor*), and wood frog (*Lithobates sylvaticus*).

At Fort Polk, we targeted recently clear-cut lands that were a target for longleaf pine restoration. We focused on shrub associated species that were likely to use these habitats including the prairie warbler (*Setophaga discolor*), eastern towhee (*Pipilo erythrophthalmus*), northern bobwhite

(*Colinus virginianus*), blue grosbeak (*Passerina caerulea*), brown thrasher (*Toxostoma rufum*), painted bunting (*Passerina ciris*), Cope's grey tree frog (*Hyla chrysoscelis*), and Eastern Narrow-mouthed Toad (*Gastrophryne carolinensis*).

Technology description

Conspecific attraction can be used as a management tool for species that rely on acoustic social information (e.g., birds and anuran amphibians). For conspecific attraction, prerecorded vocalization of the target species is broadcast from a playback system within the focal area. A playback system consists of a game caller (call box) on a timer, powered by a battery (Figure ES-1). Vocalizations are broadcast throughout the focal species breeding season from the restored habitat, thereby encouraging individuals to settle and breed near the playback system.

Conspecific attraction presents an extremely cost-effective alternative to current management practices that often rely on creating habitat and then simply hoping that individuals locate and settle at the site. In many cases, the method incurs only minimal equipment costs (<$300/broadcast station) and nominal work-hours to set up the equipment. For species that exhibit site fidelity, it may be sufficient to broadcast only for a single breeding season to establish a long-term population (although this is as yet an understudied aspect of conspecific attraction).

Figure ES-1. Call box, timer, and battery used to broadcast calls for conspecific attraction.

Performance assessment

Conspecific attraction of birds

For avian species, we established a minimum of 12 demonstration plots per installation. Half of the plots were randomly assigned to a treatment group where conspecific calls were broadcast, and half were silent controls. Vocalizations were broadcast in year 2 at all treatment plots (birds) and ponds (amphibians). In year 3, we switched treatment and control plots for the species that demonstrated a response to playback in year 2 (northern bobwhites and grasshopper sparrows). Plot size was based on the territory sizes of the focal species and the extent of appropriate habitat.

For most bird species, the plots included areas large enough to accommodate three to eight breeding pairs and range from 3 to 10 ha. Plots were placed a minimum of 500 m apart to avoid overlapping of territories and noise contamination. For birds, our playback methods mimicked those successfully used in Ward and Schlossberg (2004) and Hahn and Silverman (2006). Vocalizations were broadcast from an hour before sunrise until 10:30 a.m. at volumes reflecting natural levels (80–90 dB, as measured with a sound level meter). Songs were broadcast daily from the early settlement period through the breeding season (March–August). Broadcast tracks included ~70 minutes of bird songs (rotating through focal species) followed by 10 minutes of silence. Because each focal species had unique call types and combinations (e.g., golden-winged warbler type 1 and 2 songs), broadcast calls included numerous song types from each species. Exemplars used were from at least five unique individuals. Calls used for treatment were recorded in year 1 using a parabolic microphone (Wildtronics, LLC) and recorder.

Abundance was estimated using point count data and territory monitoring. To assure that habitat variables did not differ among treatment and control plots, we measured a variety of habitat features known to be important to avian breeding including canopy cover, shrub cover, and ground cover. We did not find any differences between treatment and control plots for any of these variables (MANOVA* Wilk's Lambda, F = 0.78, P = 0.67). Avian abundance was compared among treatment and control plots, as well as year (if applicable) using generalized linear models in R 3.1.3 (R Core Team 2017). We monitored avian productivity by documenting the

* Multivariate Analysis of Variance

fates of nests (i.e., until eggs hatched or a nest failed due to predation, parental abandonment, or destruction by weather).

For grasshopper sparrows at Fort McCoy, overall abundance was higher on treatment (playback) plots compared to silent controls in the first year of playbacks, and when treatment and control plots were rotated in the second year, abundances increased in the treatment plots and remained high in the control plots (previously treatment plots; Figure ES-2). Although playback treatment alone was not a significant predictor of grasshopper sparrow abundance ($F = 1.80$, $P = 0.18$), we found a significant interaction between year and treatment ($F = 4.92$, $P = 0.01$). Overall abundance did not change between years ($F = 0.87$, $P = 0.35$). Of five monitored grasshopper nests, two were successful (40%). One successful nest was in a treatment plot, and the other was in a control area. The three failed nests were in control plots.

Northern bobwhite detections at Fort Polk were also significantly and positively associated with playback ($F = 9.06$, $P < 0.01$; Figure ES-3). Before playback treatment, we conducted 201 point counts for northern bobwhites in 2016 at 35 sites and detected bobwhites only during two point counts at two sites. In 2017, the year we instituted playback, we conducted 155 point counts at 31 sites and documented 15 total detections (14 in playback sites and one at control sites). In 2018, we conducted 190 point counts at the same sites. In 2018, when treatment and control sites were switched, there were four detections on control (treatment sites in 2017) and 10 on treatment sites. There was no significant interaction between year and playback treatment ($F = 1.11$, $P = 0.29$).

There were slightly more prairie warblers on treatment (75 birds) compared to control plots (60 birds) at Fort Polk in 2017 although differences were not significant ($z = 1.00$, $P = 0.32$). A total of 46 prairie warbler nests were located and monitored. Twenty-one prairie warbler nests were found in treatment plots and 25 were found in control areas. Four nests (three in treatment areas and one in a control plot) had undetermined fates. Of the 42 nests with known fates 15 (36%) were successful. Four of 18 (22%) nests on treatment plots were successful and 11 of 24 (46%) nests in control areas were successful.

Figure ES-2. Grasshopper sparrow (*Ammodramus savannarum*) detections per point count in treatment (playback) and control (no playback) plots at Fort McCoy, Wisconsin.

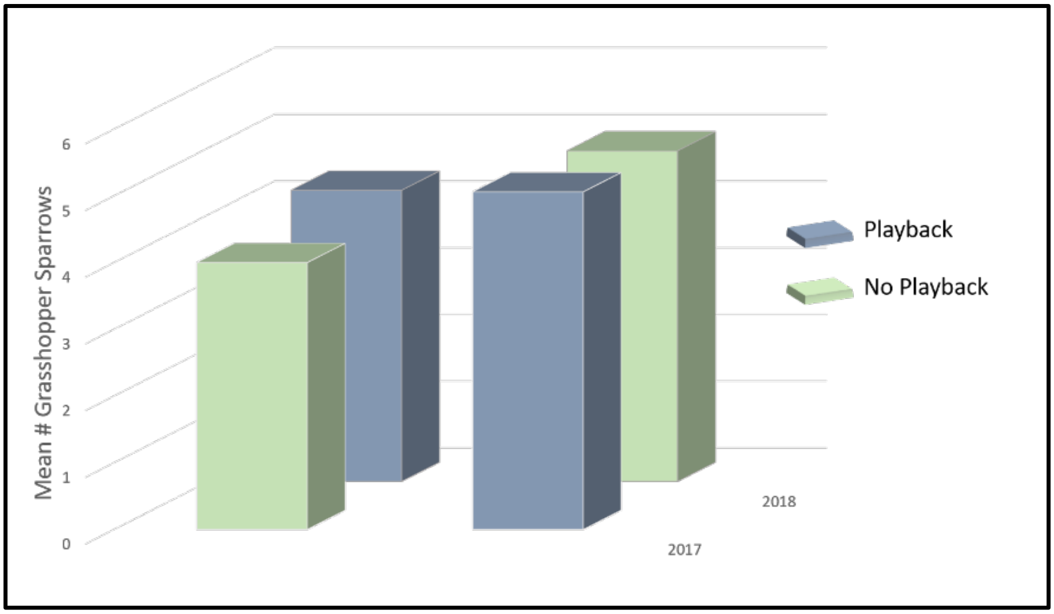
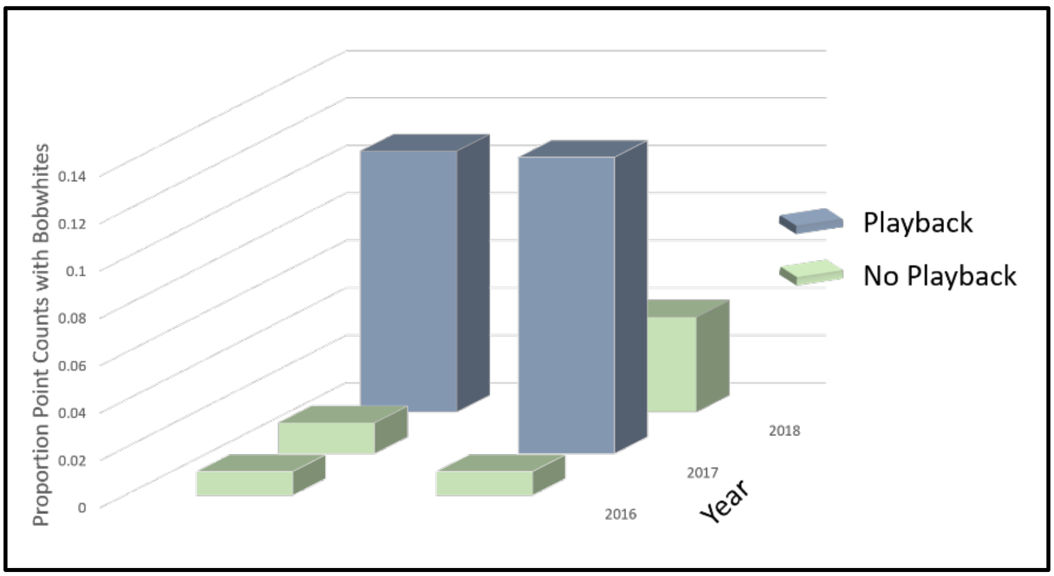


Figure ES-3. Proportion of northern bobwhite (*Colinus virginianus*) counts in control (no playback) and treatment (with playback) plots from 2016–18.



We did not document a response to playback for any of the other bird species we tested. Abundances of golden-winged warblers, upland sandpipers, blue grosbeaks, and brown thrashers all were unaffected by playback treatment (all $P > 0.37$). Although eastern towhees were detected in lower abundances on control compared to treatment plots (47 towhee detections in control plots and 31 detections in treatment plots; $z = -2.08$, $P = 0.04$), there was no change in the number of birds on either the treatment or control plots when comparing before and during treatments (all $P > 0.90$), indicating that the count was not an effect of the treatment, but rather of the higher number of birds initially found on the control plots. No painted buntings were detected in any of the study plots (control or treatment). We did not find enough nests of any of these species to evaluate productivity.

Conspecific attraction of frogs

For amphibian species, we installed a minimum of 18 small artificial garden ponds (approximately 1.7 m x 1.2 m, 91-gal capacity) in a grid throughout the demonstration area on each installation (Figure ES-4). The demonstration area was positioned near (<500 m) already occurring water bodies. Ponds were dug into the ground so that the lip of the pond was flush with the ground surface. Ponds were placed a minimum of 150 m apart to avoid overlapping of territories and noise contamination. Ponds were filled with water from nearby water bodies, and leaf litter and branches were placed in the ponds to provide structural support for egg masses and to facilitate growth of algae as a food source for tadpoles. Many of the existing small ephemeral pools that our experimental ponds simulate have a similar substrate of leaf litter with little to no emergent vegetation.

Figure ES-4. Example experimental pond and treatment/control pond arrangement for amphibian conspecific attraction (Buxton et al. 2015). Dark circles indicate treatment ponds (with conspecific calls) and open circles indicate silent control ponds.

We measured canopy cover over the ponds as an index of habitat structure and found no differences between treatment and control ponds ($t = -0.07$; $P = 0.95$). Although future application of this technology would likely be in association with natural or created ponds or wetlands, the limited availability of newly created or uncolonized ponds would make a robust demonstration infeasible. However, we believed that a demonstration of the technology using artificial ponds would allow a controlled, replicated experiment and that the results would be applicable to naturally occurring breeding ponds. All of our target amphibian species (or closely related species) have been documented breeding in shallow ephemeral pools, including artificial pools (Buxton et al. 2015); thus, the size and characteristics of our artificial ponds is unlikely to deter oviposition.

For frogs, our playback methods mimicked those successfully used in Buxton et al. (2015). Vocalizations were broadcast daily from an hour before sunset until midnight at volumes reflecting natural levels (measured using a sound level meter), with 15 minutes of silence after 60 minutes of calling to prevent habituation to playbacks. Vocalization tracks consisted of five different exemplars obtained from recordings downloaded from the Macauley Library.[*] Exemplars contained calls of individuals and calls of a chorus but did not contain heterospecific calls. Each exemplar was clipped to 2 minutes and repeated six times on a 60-minute track. Abundance for amphibian species was estimated based on categorical frog call surveys and number of egg masses present in ponds. The proportion of colonized treatment and control ponds was compared using Fisher's exact tests.

To evaluate productivity for frogs, we counted egg masses in ponds and compared the number of egg masses between treatment and control ponds using t-tests. In 2017, we broadcast playback for Cope's grey tree frogs at Fort Polk and American toads at Fort McCoy. Because we did not detect any toads in 2017, we switched species in 2018 (the final year of the demonstration) to broadcast playback for wood frogs and eastern grey tree frogs at Fort McCoy. Although we were able to compare treatment and control plots for these two species, we were not able to determine abundances in the year following treatment.

For eastern grey tree frogs at Fort McCoy, over 30% of treatment ponds were colonized compared to no colonization documented in ponds (0%) without playback (controls; Figure ES-5). Because it was likely due to

[*] Macauley Library, Cornell Lab of Ornithology, Ithaca, NY, https://www.macaulaylibrary.org/how-to/use-media/.

small sample sizes, this difference was not statistically significant ($\chi^2 = 2.57$; P = 0.11). We were not able to survey these ponds in the year following the playback.

For wood frogs, approximately 10% of artificial ponds without playback were colonized by adults, whereas more than 40% of treatment ponds were colonized (Figure ES-6) although the difference was not statistically significant ($\chi^2 = 2.49$; P = 0.11). Only one wood frog egg mass was detected, and it was found in a treatment pond. We were not able to survey these ponds in the year following playback.

Figure ES-5. Proportion of treatment and control ponds colonized by eastern grey tree frogs (*Hyla VERSICOLOR*) at Fort McCoy, Wisconsin.

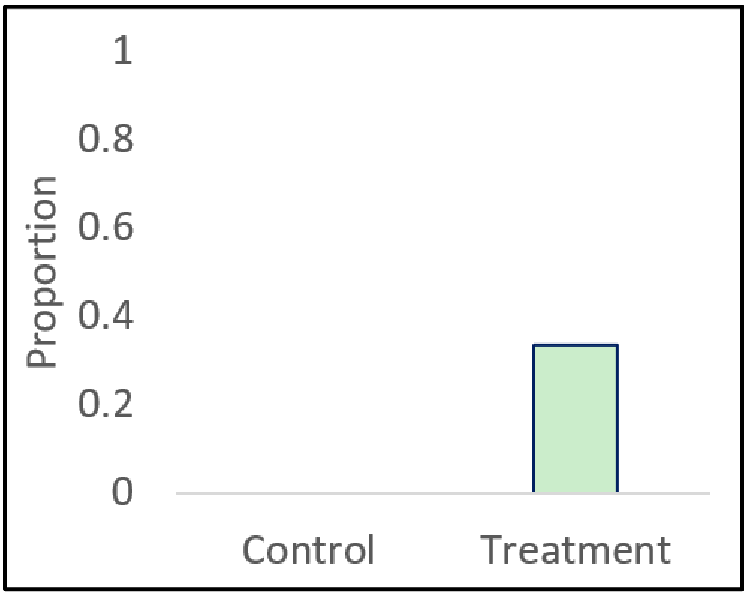
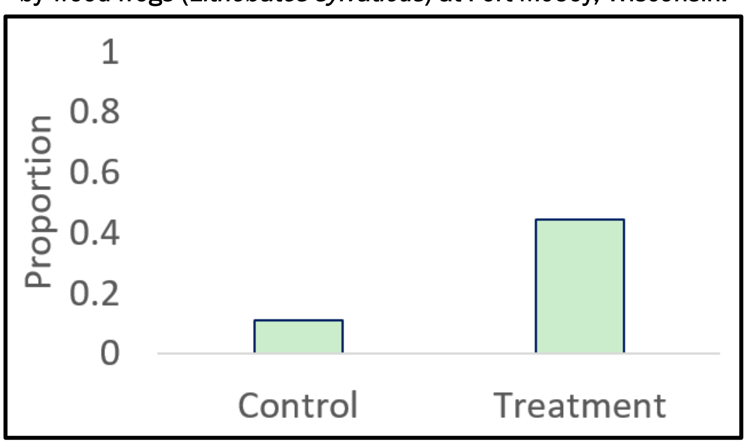


Figure ES-6. Proportion of treatment and control ponds colonized by wood frogs (*Lithobates sylvaticus*) at Fort McCoy, Wisconsin.



At Fort Polk, all ponds were colonized by Cope's grey tree frogs in the first year of playback. We thus did not conduct a statistical analysis for this species as the proportion of colonized ponds would not differ between treatment and control ponds. We found slightly more egg masses in treatment ponds compared to control ponds (mean = 72.14 ±12.54 and 52 ±13.72, respectively; t = 1.08; P = 0.29). Nearly all ponds (96%; 24/25) were again colonized in year 3 and more egg masses were found in treatment compared to control ponds (mean = 226.88 ±80 SE and 43.75 ±25.77; t = 2.16; 0.04).

No ponds (control or treatment) were colonized by American toads at Fort McCoy. We thus were unable to conduct a statistical analysis for this species. Similarly, we detected no eastern narrow-mouthed toads at artificial ponds at Fort Polk despite conducting playback experiments.

Cost assessment

Cost estimates for the demonstration were based on equipment, labor, installation, and maintenance costs. All costs were combined into a cost per unit area. This cost unit was qualitatively compared to published accounts of translocation costs and to no active management (based on the data from our control plots). Conspecific attraction costs little more than $1,000 per plot. Comparable, albeit much more drastic and invasive, alternative management actions such as translocation cost between $10,000 to well over $1,000,000 annually, particularly for high-profile species (Fischer and Lindenmayer 2000). Thus, the annual costs of conspecific attraction are approximately 0.1% to 10% of the costs of a comparable translocation.

Implementation issues

As a wildlife management tool, conspecific attraction was relatively straightforward to employ. All required equipment is commercially available and the calls can either be recorded on site or acquired through publicly available sources (e.g., the Macaulay library). Required maintenance was minimal and was limited primarily to battery replacement (every 3 weeks). Total costs were little more than $1,000 per demonstration plot, far below costs associated with alternative management techniques such as translocation (Fischer and Lindenmayer 2000).

The primary implementation issue encountered was the variation in effectiveness across the numerous species tested. We demonstrated clear success in attracting some bird and frog species into our target areas. In particular, northern bobwhite detections increased dramatically on our treatment plots and remained relatively high following cessation of calls. Similarly, the number of ponds colonized by wood frogs was much higher for ponds with calls (40% of ponds) compared to silent controls (10% of ponds). We also found trends of higher use of treatment plots for grasshopper sparrows and eastern grey tree frogs. Species that are at low or moderate abundances appear to be more likely to respond to playback.

However, other species did not show responses to playback, particularly those that were very rare near our sites. Painted buntings and eastern narrowmouth toads were in the general area but did not colonize either treatment or control plots during our demonstration. In contrast, Cope's grey tree frogs were very abundant at Fort Polk and colonized all available ponds, regardless of whether playback was conducted. American toads, although present near our sites, may have shown no response because they generally rely on permanent water bodies for breeding and thus may have limited behavioral plasticity for selecting alternate breeding sites (Buxton et al. 2015). Species-specific life history and abundances should be considered when evaluating this technique.

We did not find enough nests to conduct robust analyses of productivity but we found that overall nest survival estimates were similar to previously published accounts. We found that prairie warbler nest survival was lower on treatment plots, but since we did not see a response to playback, it is unlikely that reproductive success was linked to treatments. More work is needed to evaluate any possible effects of playback on productivity.

In an attempt to understand the disparity in responses, we compiled results from all published work examining conspecific attraction for habitat selection.* We conducted a review of the literature and found 149 studies investigating conspecific attraction across eight taxa (Figure ES-7). We found that conspecific attraction is widespread; between 50% and 80% of studies documented positive associations, depending on taxa (Figure ES-8). This included studies that used a wide range of cue types including acoustic cues (similar to our demonstration here) and chemical cues.

* V. Buxton, J. Kelly, J. Sperry, and M. Ward. 2019. *A Review of Conspecific Attraction for Habitat Selection across Taxa—What Are We Missing?* In review.

The ubiquity of published accounts of conspecific attraction would indicate that this could be a viable management tool across a wide variety of taxa. Our results affirm this result although we found the effectiveness was much more variable (25% of bird species and 50% of amphibian species). This discrepancy could reflect a publication bias that makes studies demonstrating a response more likely to be published.

Figure ES-7. Timeline of conspecific attraction studies by taxonomic group from 1960-2017.

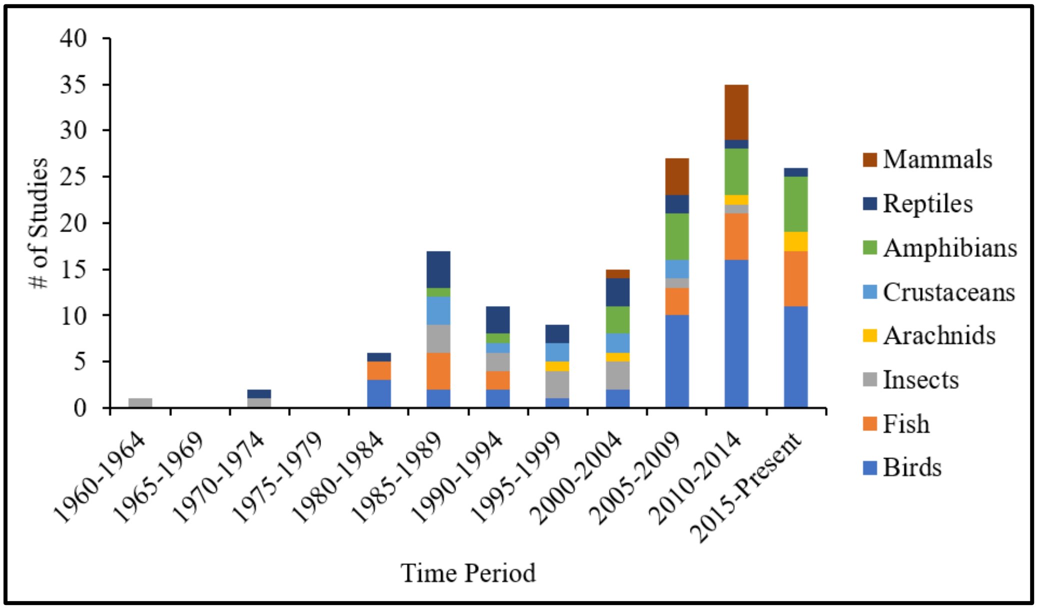
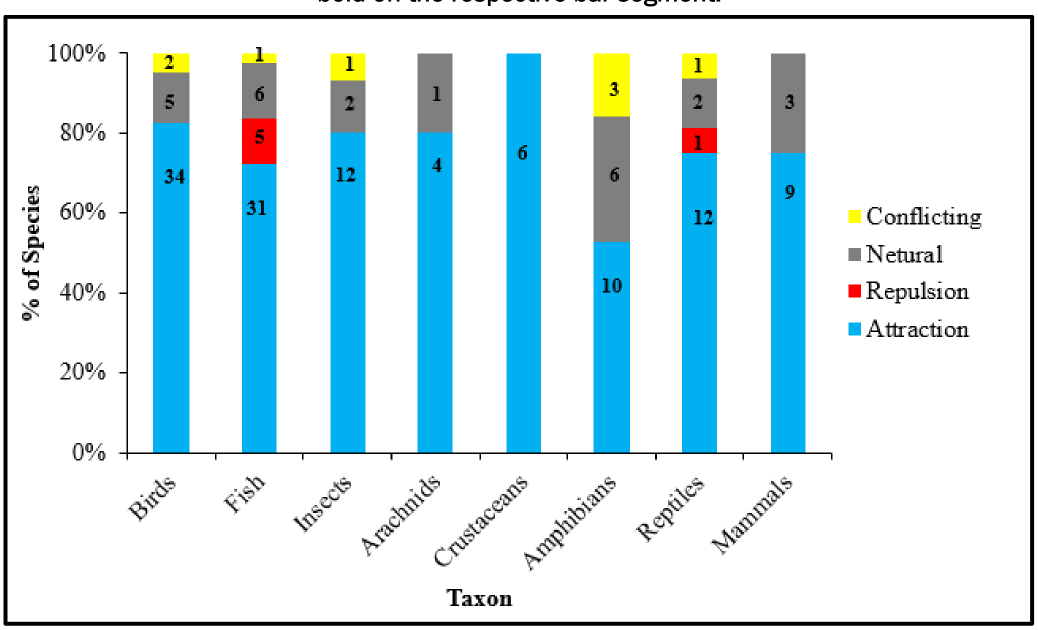


Figure ES-8. Percentage of species showing attraction, repulsion, or no response (neutral) to conspecific cues grouped by taxa. “Conflicting” indicates that a species showed a differential response to conspecific cues in two or more studies. Sample size for each category is listed in bold on the respective bar segment.



Although responses varied among species, our work demonstrated the utility of this method for species management on military lands. Since it requires little effort and resources for deployment, playback appears to be a viable tool for encouraging colonization or for increasing abundances of focal species into restored habitats. Because responses can be variable, we recommend using this method for targeting multiple species simultaneously (e.g., rotating playback of multiple species) with the understanding that it is unlikely to be effective for all species. Conversely, if restoration is aimed at particular species (e.g., threatened and endangered species [TES]), we would recommend attempting this non-invasive method before attempting more invasive and expensive techniques such as translocation. A large number of species have been included in studies examining conspecific attraction* and so a literature search on the effectiveness of this technique for particular species may yield information on how responsive specific species may be and, therefore, how effective playback may be in eliciting species-specific responses.

* V. Buxton, J. Kelly, J. Sperry, and M. Ward. 2019. *A Review of Conspecific Attraction for Habitat Selection across Taxa—What Are We Missing?* In review.

1 Introduction

1.1 Background

Most U.S. Army installations reside on lands that provide refuge for federally listed or at-risk plant and animal species. Federal mandates (e.g., Endangered Species Act, Clean Water Act) often require installations to establish viable populations of these species in restored or mitigated habitats. To meet these requirements, the U.S. Department of Defense (DoD) expends considerable funding and effort in restoring habitats for species of conservation concern.

However, the movements of wildlife species and the resulting colonization of habitats is often unpredictable, and viable wildlife populations often fail to become established on restored habitat. In the case of federally listed or at-risk species on military installations, this unpredictable movement can make effective management difficult, and in some cases, when these species establish populations on training lands, their presence can interfere with military training. Installation land managers have used a range of strategies to encourage animals to colonize restored habitat. Methods for achieving this goal range from no active management (i.e., "build it and they will come") to translocation of adults or eggs/young (Scott et al. 2001). These methods are often ineffective and/or expensive.

Conspecific attraction, which uses the tendency for individuals of the same species to settle near one another (Stamps 1988), may provide an alternative, cost-effective management tool for attracting animals to newly created or restored habitats. For species that communicate via auditory signaling, conspecific attraction can attract individuals to suitable yet unoccupied or underutilized habitat by broadcasting prerecorded conspecific vocalizations (Ward and Schlossberg 2004). Although most previous work on conspecific attraction has been done with birds (e.g., Ward and Schlossberg 2004, Ward et al. 2011, Hahn and Silverman 2006), a recent study has shown that broadcasting conspecific calls can also be used to attract pond-breeding amphibians to newly created ponds (Buxton et al. 2015). This suggests that conspecific attraction is not only a viable option for managing and restoring bird populations, but also for restoring amphibian communities to wetlands, a previously difficult outcome to achieve.

Compared to currently available methods, conspecific attraction can be a very effective management tool for attracting focal species to restored habitats. This passive means of moving animals minimizes the risks associated with more invasive methods (e.g., decreased survival associated with translocation). Conspecific attraction requires minimal financial and time investment to not only lure at-risk species to target habitats but to establish long-term viable populations. The method could be used to attract species within an installation to established conservation areas, or to partner lands located well away from military training areas.

1.2 Objective of the demonstration

Our work had two primary objectives:

1. To demonstrate the use of conspecific attraction as a cost-effective management tool for encouraging colonization of restored habitats by target at-risk bird and amphibian species
2. To test the use of conspecific attraction to establish populations following cessation of the broadcast calls.

Grassland and shrubland species have experienced precipitous declines across the continent (Brennan and Kuvlesky 2005) and use of novel management tools such as conspecific attraction could provide effective strategies for military land managers. Preference was given to species that were present on/near restoration sites and that presumably occur in low to moderate abundances.

Our demonstration sites of Fort McCoy, Wisconsin and Fort Polk, Louisiana, encompass a variety of species, habitats, and restoration strategies. At Fort McCoy, we targeted grassland and shrubland restoration sites and associated focal species likely to use such habitats, including the grasshopper sparrow (*Ammodramus savannarum*), savannah sparrow (*Passerculus sandwichensis*), golden-winged warbler (*Vermivora chrysoptera*), upland sandpiper (*Bartramia longicauda*), and a suite of amphibian species including the American Toad (*Anaxyrus americanus*), eastern grey tree frog (*Hyla versicolor*), and wood frog (*Lithobates sylvaticus*).

At Fort Polk, we targeted recently clear-cut lands that were a target for longleaf pine restoration. We focused on shrub associated species that were likely to use these habitats including the prairie warbler (*Setophaga discolor*), eastern towhee (*Pipilo erythrophthalmus*), northern bobwhite (*Colinus virginianus*), blue grosbeak (*Passerina caerulea*), brown thrasher (*Toxostoma rufum*), painted bunting (*Passerina ciris*), Cope's grey tree frog (*Hyla chrysoscelis*), and Eastern Narrow-mouthed Toad (*Gastrophryne carolinensis*).

1.3 Regulatory drivers

The primary regulatory driver for this demonstration is the U.S. Endangered Species Act (ESA), which requires DoD and other federal agencies to manage and conserve endangered species and their habitats. Habitat restoration is a commonly employed strategy for endangered species management. Alternatively, conspecific attraction could be an effective, cost-efficient method for encouraging focal species use of restoration sites that would enable installations to more quickly and effectively reach ESA goals. In addition, sections 401 and 404 of the Clean Water Act can require compensatory mitigation of adverse impacts on wetlands. Compensatory mitigation can include restoration, establishment, enhancement, and/or preservation of wetlands, streams, and other aquatic resources. Amphibian communities have been used as an assessment tool to show functioning properties of mitigated wetlands following restoration or construction. Conspecific attraction, which could decrease the latency of amphibian colonization of wetlands, would also aid in meeting Clean Water Act requirements.

2 Technology/Methodology Description

2.1 Technology/methodology overview

Conspecific attraction can be used as a management tool for species that rely on acoustic social information (e.g., birds and anuran amphibians). For conspecific attraction, prerecorded vocalization of the target species is broadcast from a playback system within the focal area. A playback system consists of a game caller (call box) on a timer, powered by a battery (Figure 1). Vocalizations are broadcast throughout the focal species breeding season from the restored habitat, thereby encouraging individuals to settle and breed near the playback system.

Conspecific attraction presents an extremely cost-effective alternative to current management practices that often rely on creating habitat and hoping individuals locate and settle at the site. In many cases, only minimal equipment costs (<$300/broadcast station) and nominal work-hours are required to set up the equipment. Although generally an understudied aspect of conspecific attraction, some work has suggested it may be sufficient to broadcast for only a single breeding season to establish a long-term population, especially for species that exhibit site fidelity (Ward and Schlossberg 2004; Buxton et al. 2015).

Figure 1. Call box, timer, and battery used to broadcast calls for conspecific attraction.

Conspecific attraction has been effectively used as a management tool for a variety of colony nesting birds (e.g., Kress and Nettleship 1983) and, more recently, passerine birds (Ward and Schlossberg 2004, Hahn and Silverman 2006) and amphibians (Buxton et al., 2015). Conspecific attraction has resulted in colonization of unoccupied habitats (Ward and Schlossberg 2004) and in increased abundance of target species in areas with already established populations (Hahn and Silverman 2006). However, use on DoD lands has been very limited, likely due either to lack of technological transition to DoD land managers or because published reports do not provide sufficient detail for replication. We demonstrated the use of this method for wildlife management on DoD lands and provide detailed guidance on its use.

2.2 Advantages and limitations of the technology/methodology

Wildlife restoration projects typically employ one of two general strategies: either restoration of wildlife through active manipulation of wildlife movement (e.g., translocation) or passive restoration through creation/improvement of habitat (Scott et al. 2001). The vast majority of efforts employ the second strategy and rely on the natural ability of focal animals to find and colonize recently restored habitats. The obvious advantage to this strategy is the lack of additional costs above those conferred by restoration activities. However, depending on the focal species and the goals of the restoration, this “build it and they will come” strategy may be insufficient (Scott et al. 2001). In addition to more obvious impediments to colonization, such as dispersal limitations or physical barriers, a recent review of passive wildlife restoration techniques identified social facilitation as a potential constraint of colonization (Scott et al. 2001). Use of playback calls has been demonstrated to overcome that behavioral constraint by encouraging colonization of conspecifics.

Although the practice of restoring habitats without any additional management is the most commonly used management strategy for species conservation, translocation is another management tool that should be considered in an evaluation of conspecific attraction. Translocation is a commonly used tool for avian species. As of 2012, translocation efforts were completed for 201 species, 766 release sites, and 2,359 individuals (Avian Reintroduction and Translocation Database; http://www.lpzoosites.org/artd).

Many of these species are migratory, with relocation sites within the dispersal capability of the species. Conspecific attraction provides a tool for encouraging colonization of sites, particularly of migratory species, by providing the social cues necessary for individuals to recognize and settle in unoccupied habitats (Ward and Schlossberg 2004; Ahlering et al. 2010). Furthermore, translocation efforts have had very mixed results (Griffith et al. 1989, Wolf et al. 1998, Fischer and Lindenmayer 2000), even within a single species (Singer et al. 2000). Many translocation efforts are unsuccessful for a variety of reasons including predation at relocation sites and extensive movements and/or homing behavior of translocated animals (reviewed in Fischer and Lindenmayer 2000). Relocations can also be very expensive with published costs regularly exceeding $1M (reviewed in Fischer and Lindenmayer 2000).

Using conspecific attraction as a management tool to encourage colonization and/or abundance of target species at restoration sites can be a viable alternative strategy. Conspecific attraction has been shown to decrease the latency of colonization (Ward and Schlossberg 2004) as well as the abundance (Hahn and Silverman 2006) of target species in sites where conspecific calls were broadcast. Given that individuals are moving to these areas of their own volition, it is unlikely that they would evidence the excessive and erratic movements that have been documented following translocation. Finally, the costs associated with conspecific attraction can be nominal, particularly when compared to translocation costs. The cost of a single call box station is less than $300, and installation and maintenance of the box require very little time or effort.

Conspecific attraction may not be effective for all species or in all habitats. For example, species particularly reliant on social cues for habitat selection, such as species that breed in ephemeral habitats, or those that have high dispersal capability, may be particularly responsive to artificial calls (Ahlering et al. 2010, Buxton et al. 2015).* Conversely, species that rely on late succession habitats or that have low dispersal (e.g., resident species) may be less responsive. In addition, habitats for which perceived habitat quality includes highly variable environmental parameters may not be good candidates for conspecific attraction as a management tool. For ex-

* also V. Buxton, J. Kelly, J. Sperry, and M. Ward. 2019. *A Review of Conspecific Attraction for Habitat Selection across Taxa—What Are We Missing?* In review.

ample, species reliant on wetland habitats have been shown to be less responsive to conspecific cues, likely because they favor environmental cues such as surface area or depth of water (Ahlering et al. 2010) over social cues. Further, care should be taken to ensure that habitats to which individuals are attracted are high quality habitats. In instances where sites were formerly occupied, efforts should be made to address any underlying issues that resulted in removal of species (e.g., pollutants, insufficient habitat characteristics, disease, etc.). Finally, conspecific attraction has been most often demonstrated through colonization of unoccupied habitats but has also shown to be effective for increasing abundances in underutilized or protected habitats. Depending on the objectives of a land manager, either scenario may be of interest although issues associated with density dependence should be considered when augmenting existing populations.

3 Performance Objectives

Our first performance objective, for both birds and frogs, was aimed at quantifying timing and the use of treatment (broadcast calls) sites, compared to silent controls (Tables 1 and 2). Vocalizations were broadcast in year 2 at all treatment plots (birds) and ponds (amphibians). In year 3, we switched treatment and control plots for the bird species that demonstrated a response to playback (northern bobwhite and grasshopper sparrows). For birds, vocalizations were broadcast from approximately an hour before sunrise until 10:30 a.m. at volumes reflecting natural levels. Songs were broadcast daily from the early settlement period through the breeding season (March – August). For frogs, our playback methods mimicked those successfully used in Buxton et al. (2015). Vocalizations were broadcast daily from an hour before sunset until midnight at volumes reflecting natural levels (measured using a sound level meter). We initiated vocalizations at the start of each species respective breeding season and continued until all breeding activity for that species ceased (based on surveys in year 1—March–June).

Bird and frog surveys were used to determine if abundances or colonization rates were higher at treatment sites, compared to control sites. The criteria for success for birds varied depending on whether or not individuals were already present on the demonstration sites, before initiation of treatment. If no individuals were present in year 1 before the demonstration, then the success criterion was considered as colonization of the unoccupied treatment sites within 1 year of broadcast calls. If sites already had at least one individual detected in year 1, then the success criterion was considered as 30% increase in abundance on the treatment sites following broadcast calls (Table 1). In some cases, it was necessary to change locations of study plots between years 1 and 2, thereby not allowing comparison of before versus after treatment. In these instances, we only compared treatment versus control sites. Our success criteria were based on previously published accounts of conspecific attraction as a management tool and the strength of response documented in these studies (Ward and Schlossberg 2004, Hahn and Silverman 2006). For frogs, ponds were created for this demonstration and so had no colonization history. Based on previous accounts of playback calling at breeding sites for amphibians, colonization of both treatment and control ponds is possible but we considered success to be a 50% increase number of treatment ponds with egg masses compared to control ponds (Table 3). This is smaller than the documented success for Cope's grey treefrogs (*Hyla chrysoscelis*) in Indiana, where treatment ponds were 21 times more likely to be colonized by than control ponds (Buxton et al. 2015) but is similar to results for southwestern pond-breeding amphibians (Buxton et al. 2018).

The value of conspecific attraction as a management tool for DoD land managers is highly context dependent. For species of conservation concern, augmentation of populations by even a small number of individuals (<5) can drastically increase population viability (e.g., Haig et al. 1993). In cases of unoccupied habitats, attraction of a single breeding pair would be of great interest. For example, Wisconsin Department of Natural Resources conducted experiments using conspecific attraction to attract Kirtland's warblers to areas that have not been occupied since 1978 and the attraction of a single breeding pair in 2015 was considered a resounding success (Anich and Ward 2017). Similarly, the success of conspecific attraction to decrease colonization time and associated relevant metrics is dependent on the objectives of the land manager. For example, land managers held to conservation mandates via ESA or the Clean Water Act may have specific time requirements for restoring species to restored habitats whereas others may have no strict timelines for management.

Our second performance objective was aimed at determining whether or not the conspecific attraction demonstration can result in establishment of a population on treatment sites (Tables 1 and 2). For this objective, we used estimates of abundance (bird and frog surveys) and productivity (avian nest survival) to determine population stability and continued use of treatment sites in year 3 (following cessation of broadcast calls). Our success criterion was equivalent or increased abundances from year 2 to year 3. The majority of previous work on conspecific attraction as a management tool discontinued monitoring of sites following completion of broadcast calls (Ahlering et al. 2010). For this demonstration, we evaluated the impacts of conspecific attraction both for long-term establishment on the treatment sites and for productivity. Because of potential concern of attracting individuals to low quality habitats (Ahlering et al. 2010), we compared our estimates of productivity between treatment and control sites as well as to published accounts for our focal species. Although there is likely site-specific variation in productivity, all of our focal species have been extensively studied and so there is a wide body of literature from which we could make comparisons.

Our third performance objective was based on comparisons of cost and effectiveness of conspecific attraction as a management tool compared to traditional methods (Tables 1 and 2). The two primary strategies for wildlife restoration is habitat restoration alone (passive) or translocation of individuals. Translocation effectiveness is very species- and site-specific and so our comparison here was focused on cost comparisons. Because published translocation costs for birds are so high (Finseth and Conrad 2014), success for this demonstration was considered a 90% reduced cost. To compare effectiveness of conspecific attraction and restoration alone, we compared colonization time and/or abundance between treatment and control sites (in the same manner as performance objective one, above) since control sites were equivalent to a restoration alone strategy.

In summary, technology performance was evaluated based on comparisons of abundance and density of focal species on treatment and control plots (mimicking traditional methods with no management or translocation). These analyses demonstrate the use of conspecific attraction as a management tool to both attract animals to newly restored habitats and to maintain populations following cessation of broadcast calls. The technology was evaluated based on species abundance and productivity within the plots, abundances following cessation of treatment, and cost effectiveness.

Success criteria were quantitatively defined following the suggestions of Hall and Fleischmann (2010) and based on previously published accounts of the use of conspecific attraction (Ward and Schlossberg 2004, Hahn and Silverman 2006, Buxton et al. 2015) and avian translocation costs (Finseth and Conrad 2014).

Table 1. Performance objectives for bird species.

Performance Objective	Metric	Data Requirements	Success Criteria	Results*
Quantitative performance objectives				
1. Increased use of treatment (broadcast calls) vs. control (silent) restoration plots by focal species in year 2	a. Latency to colonization (if presently unoccupied) b. Species abundance c. Species productivity	Avian point counts	a. Colonization within first year of broadcasting calls on treatment plots b. >3 breeding pairs present on treatment plots (if presently unoccupied) c. >30% increase in species abundance following treatments on treatment plots (if presently occupied)	a and b. Northern bobwhite presence increased from two plots before treatment to five plots after treatments. There were two birds detected before treatment and 15 birds detected on treatment plots during/following treatments. c. Northern bobwhite abundances were 76% higher on treatment compared to control plots. Grasshopper sparrow abundances were 26% higher on treatment compared to control plots. * All other species had neutral responses.
2. Establishment of viable populations on treatment plots in years 2 and 3	a. Species abundance b. Species productivity c. Population stability	a. Avian point counts b. Nest survival and annual productivity	a. Productivity similar to published accounts b. Abundances are equivalent to or increase from year 2 to 3	a. Nest success data is limited but 40% of grasshopper nests and 36% of prairie warbler nests were successful. These are similar to published estimates (37 – 53%). b. Abundances did not increase between year 2 and 3 for any species.

Performance Objective	Metric	Data Requirements	Success Criteria	Results*
3. Improved cost effectiveness compared to traditional methods (translocation or restoration alone)	a. Equipment and labor costs b. Latency to colonization c. Population viability	a. Conspecific attraction costs b. Translocation costs c. Species demographic data d. Colonization times	a. 90% reduction in cost compared to translocation b. 30% increase in colonization time and/or abundance on treatment versus control (restoration alone)	a. Conspecific attraction costs at most 10% of a traditional translocation project. b. Northern bobwhite abundances were 76% higher on treatment compared to control plots. Grasshopper sparrow abundances were 26% higher on treatment compared to control plots.
*Due to the large number of species tested, some results are not displayed. See Section 5.6 (Sampling Results) for further details.				

Table 2. Performance objectives for frog species.

Performance Objective	Metric	Data Requirements	Success Criteria	Results*
Quantitative performance objectives				
1. Increased use of treatment (broadcast calls) vs. control (silent) restoration plots by focal species in year 2	a. Latency to colonization (if presently unoccupied) b. Species abundance c. Species productivity	a. Amphibian visual/aural surveys b. Egg mass surveys	a. Colonization within first year of broadcasting calls on treatment plots. b. 50% increase in treatment ponds with egg masses compared to control ponds.	a. Eastern grey tree frogs, wood frogs, and Cope's grey tree frogs colonized playback ponds. All other species were either undetected or did not colonize ponds during the demonstration. b. For wood frogs, only one egg mass was detected in a treatment pond (0 in control) and Cope's grey tree frog eggs were detected in 100% of ponds.

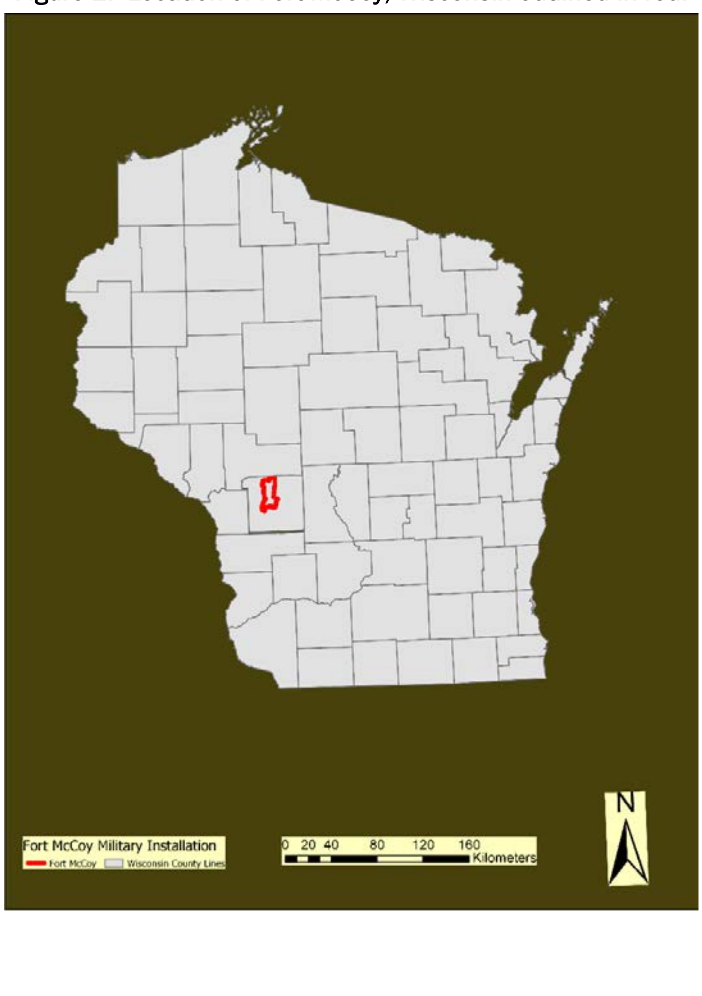
Performance Objective	Metric	Data Requirements	Success Criteria	Results*
2. Establishment of viable populations on treatment plots in years 2 and 3	a. Species abundance b. Species productivity c. Population stability	a. Amphibian visual/aural surveys b. Metamorph survival	a. Productivity on treatment plots exceeds replacement level. b. Abundances are equivalent to or increase from year 2 to 3.	a. A very large number of Cope's grey tree frogs egg masses (1530) were detected across all ponds at Fort Polk. The majority of treatment ponds (83%) had tadpoles detections. b. 100% of ponds were colonized by Cope's grey tree frogs at Fort Polk in year 2 and 96% colonized in year 3. Only American toads were tested in year 2 at Fort McCoy and they did not colonize any ponds.
3. Improved cost effectiveness compared to traditional methods (translocation or restoration alone)	a. Equipment and labor costs b. Latency to colonization c. Population viability	a. Conspecific attraction costs b. Translocation costs c. Species demographic data d. Colonization times	a. 90% reduction in cost compared to translocation b. 30% increase in colonization time and/or abundance on treatment versus control (restoration alone).	a. Conspecific attraction costs at most 10% of a traditional translocation project. b. More than 30% of treatment ponds were colonized than control ponds for wood frogs and eastern grey tree frogs.
*Due to the large number of species tested, some results are not displayed. See Section 5.6 (Sampling Results) for further details.				

4 Site Description

4.1 Fort McCoy, Wisconsin

Fort McCoy is an Army installation in Monroe County, Wisconsin (Figure 2). It is an approximately 24,281 ha property, 18,560 ha of which are used for training exercises. The habitat is primarily divided into wetland, dry upland, and dry-mesic upland communities. The dry and dry-mesic community are dominated by red oak (*Quercus rubra*), but red maple (*Acer rubrum*), basswood (*Tilia americana*), and white pine (*Pinus strobus*) are also present. Timber harvests are ongoing and approximately 600 acres of Jack pine (*Pinus banksiana*), red pine (*Pinus resinosa*), red oak, and quaking aspen (*Populus tremuloides*) are harvested each year. Red pine plantations have been planted since the 1930s for use for pulpwood and saw-timber production.

Figure 2. Location of Fort McCoy, Wisconsin outlined in red.



Fire, due in part by military training and other disturbances, has kept approximately 5,500 ha of savannah/oak barrens habitat on Fort McCoy. Some species associated with the savannah habitats include black oak (*Quercus velutina*), white oak (*Quercus alba*), bur oak (*Quercus macrocarpa*), northern pin oak (*Quercus ellipsoidalis*), Jack pine, white pine (*Pinus strobus*), red pine, red maple (*Acer rubrum*), black cherry (*Prunus serotine*), American hazelnut (*Corylus Americana*), blueberry (*Vaccinium* sp.), huckleberry (*Vaccinium membrancaceum*), big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and wild lupine (*Lupinus perennis*).

There are 240 ha of natural areas on Fort McCoy including the Fort McCoy Natural Barrens Area, which is an oak savannah habitat that hosts endangered and threatened species such as the Karner Blue Butterfly (*Lycaeides melissa samuelis*). A series of recently restored/modified shrubland and grassland habitats have been chosen as the demonstration sites. Determination of specific treatment/control plots within these general areas was determined based on abundance and distribution of target bird and frog species.

There are approximately 1,400 ha of grassland actively managed through prescribed burns and invasive plant control. Grassland areas are used for drop zones, landing zones, and other military exercises. All grasshopper sparrow demonstration sites were located within the two grassland drop zones and the Fort McCoy Natural Barrens Area, sized 200 ha, 56 ha, and 70 ha respectively, as they provided sufficient space to support multiple territories of the target species and multiple playback and control plots.

For golden-winged warblers (Figure 3), which use shrubland habitats, four plots (two treatment and two control) were placed just north of the Fort McCoy Natural Barrens Area in clear-cut timber harvests that were conducted in 1986, 1998, 1999, and 2004. The remaining eight plots (four treatment and four control) were placed in clear-cut timber harvests conducted in 1992, 1994, 2000, and 2004 throughout the remainder of the installation.

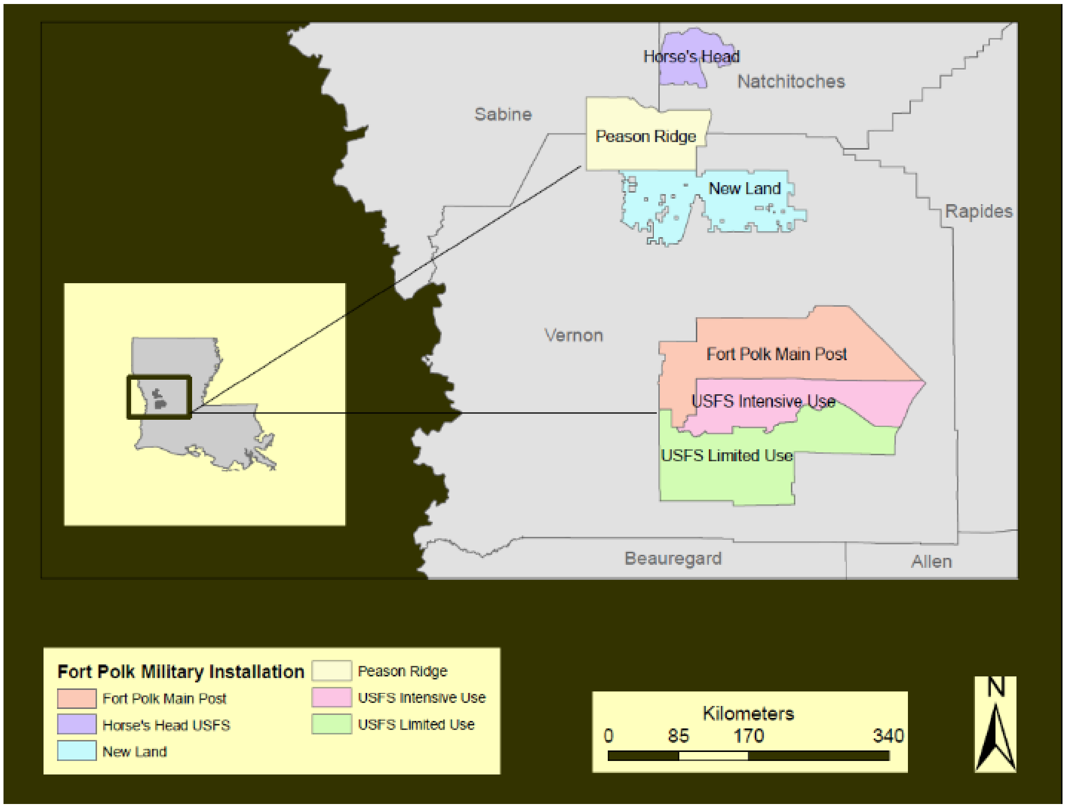
Figure 3. Golden-winged warbler (*Vermivora chrysoptera*) at Fort McCoy, Wisconsin.

Fort McCoy also has approximately 1,780 ha of wetland habitat. Wetland habitat types on Fort McCoy includes pond, stream, marsh, sphagnum bog, coastal-plain bog, sedge meadow, wet meadow, alder thicket, shrub carr, and swamp. Wetland vegetation is characterized by white pine (*Pinus strobus*), red maple (*Acer rubrum*), quaking aspen, white oak (*Quercus alba*), poison sumac (*Toxicodendron vernix*), speckled alder (*Alnus incana*), winterberry (*Ilex verticillata*), dewberry (*Rubus hispidus*), cinnamon fern (*Osmunda cinnamomea*), skunk cabbage (*Symplocarpus foetidus*), bunchberry (*Cornus canadensis*), bluejoint grass (*Calamagrostis canadensis*), sphagnum moss, meadowsweet (*Filipendula ulmaria*), cattails (*Typha* sp.), and dogwood (*Cornus* sp.). These wetland habitats were used for the amphibian component of the demonstration. The general wetland area chosen has a naturally occurring source pond, streams, and forest habitat while providing a large enough area to place artificial ponds for the demonstration.

4.2 Fort Polk, Louisiana

Fort Polk is an Army installation in west-central Louisiana. Within Fort Polk, the sites selected for the demonstration were on a newly purchased area known as The New Lands, located on either side of LA-117 and north of Leesville in Vernon Parish (Figure 4). The New Lands encompasses 7,316 ha and is comprised of two regions; Cold Springs, located to the west of LA-117, and Kurthwood to the east. Before U.S. Army ownership, land use consisted mostly of loblolly pine (*Pinus taeda*) plantations in short rotations. Minimal timber harvesting is ongoing, with military use progressing across clearings and open fields.

Figure 4. Area map of Fort Polk. The site selected for the demonstration, known as Cold Springs, is the western portion of the New Land area.



The New Lands was chosen as a demonstration site because it houses habitat appropriate for both avian and amphibian test species, is easily accessible, and currently receives little military training. It contains large areas of mostly flat ground (<5% grade) and many seasonally flooded pools in shrubland, open grassland, and various ages of pine plantation woodlands, which are used extensively by breeding amphibians. There is sufficient area of habitat among these wetlands that allowed placement of artificial ponds. Based on surveys conducted in summer 2016, we selected 24 locations for artificial ponds, 12 each within 500 m of a significant water source that holds large numbers of breeding amphibians, even fairly late into the summer. For birds, The New Lands contain several large areas of contiguous shrubland habitat, which supported multiple playback treatment and silent control plots. All of these shrubland plots are the product of previous pine harvest (i.e., clear-cuts) and while restoration efforts vary slightly among the plots, all are primarily dominated by deciduous shrubs.

Although much of the land is comprised of mixed-age pine stands, Cold Springs and Kurthwood contain a diverse variety of flora and fauna. The primary land cover of the area is loblolly pine woodland, but significant areas of open grassland, pine/oak shrubland, and mixed pine/hardwood bottomlands are also present. Other habitat types such as savannah, calcareous prairie, sandy upland woodland, baygall, beaver impoundment, and creek beds with neighboring oxbow ponds are present in relatively small amounts. The loblolly stands are dominated by loblolly pine with a variety of woody shrubs present in the understory. Depending on the openness of the canopy in these stands, an herbaceous layer can begin to develop; however, the herbaceous layer is typically limited to non-existent. The demonstration for amphibians occurred in this habitat type.

Several areas of mixed pine/oak scrub are present on sandy sites in the Cold Springs area. These shrublands are typically the result of recent clearcuts that were allowed to regenerate naturally instead of being replanted with pine. These areas are characterized by a dense understory dominated by young pine and oak species, as well as several types of vines. Common woody tree species present include loblolly pine, southern red oak (*Quercus falcata*), black jack oak (*Quercus marilandica*), and sand post oak or runner oak (*Quercus margaretta*). Vines commonly found at these sites include greenbrier (*Smilax* sp.), Virginia creeper (*Parthenocissus quinquefolia*), poison ivy (*Toxicodendron radicans*), poison oak (*Toxicodendron pubescens*), and brambles (*Rubus sp.*). Shrub species include yaupon (*Ilex vomitoria*), American beautyberry (*Callicarpa americana*), farklebery (*Vaccinium arboreum*), and Elliott's blueberry (*Vaccinium elliottii*). The demonstration for birds occurred in these shrubland habitats.

5 Test Design

This chapter provides an outline of the overall test design and results from our demonstration of conspecific attraction for bird and frog species.

5.1 Conceptual test design

Our technical approach included four primary tasks:

1. Establishment of treatment and control plots (birds) and ponds (amphibians)
2. Surveys to determine species distribution and abundance before, during, and after introduction of treatments (call boxes) at control and treatment plots
3. Execution of treatment (broadcast calling of target species) within treatment plots
4. Analyses of populations within treatment and control plots to determine long-term impacts of conspecific attraction.

5.2 Baseline characterization and preparation

The baseline condition for determining success of conspecific attraction as a management tool was based on species surveys conducted in year 1 of the demonstration (see section 5.4 below). These initial surveys allowed us to document any changes in abundance before and after broadcast calling on treatment (broadcast calls) sites compared to control (silent) sites (Figures 5 to 8). There is currently minimal information on species presence, distribution, and abundance on our demonstration sites. Installation natural resources personnel had conducted surveys for some of our focal species but the survey timing, methods and efforts vary substantially, prohibiting a rigorous evaluation of the technology before this demonstration.

5.3 Design and layout of technology and methodology components

Conspecific attraction is a relatively straightforward process that uses prerecorded vocalization of the target species, which are broadcast from a playback system within the focal area. A playback system consists of a game caller (call box) on a timer, powered by a battery. Vocalizations are broadcast throughout the focal species breeding season from the restored habitat, thereby encouraging individuals to settle and breed near the playback system.

5.4 Field testing

Demonstration sites within the installations were chosen based on focal species habitat requirements, species abundances, and installation habitat restoration activities (Figures 5 to 8). We focused on a range of species and habitats for which we could predict varying level of response to social cues. This variability allowed us to identify species and/or habitat traits that would improve the likelihood of success for conspecific attraction as a management tool. We also focused, as much as possible, on areas of recent restoration and on areas where habitat quality appears to be high (based on subject matter expert [SME] opinion). Selection preference was given to those species that were present on/near restoration sites and that occurred in relatively low abundances. Based on preliminary data from surveys and coordination with installation personnel, our list of focal species at Fort Polk included the prairie warbler, eastern towhee, northern bobwhite, blue grosbeak, brown thrasher, painted bunting, Cope's grey tree frog, and Eastern Narrow-mouthed Toad. All of these species had been detected on or near areas of habitat restoration within land recently acquired by Fort Polk.

At Fort McCoy, our list of focal species included the grasshopper sparrow, savannah sparrow, golden-winged warbler, upland sandpiper, and a suite of amphibian species including the American Toad, Eastern grey tree frog, and wood frog. Grasshopper sparrow demonstration sites included grassland restoration sites within the Badger Drop Zone where vegetation had been removed from over 80 ha in late 2015 for removal of ordinances. Golden-winged warbler and amphibian demonstration sites included several areas around the installation where focal species had been detected and installation personnel indicated an interest in increasing populations.

Figure 5. Bird callbox locations (red dots) and monitoring area (black circles) at Fort Polk, Louisiana.

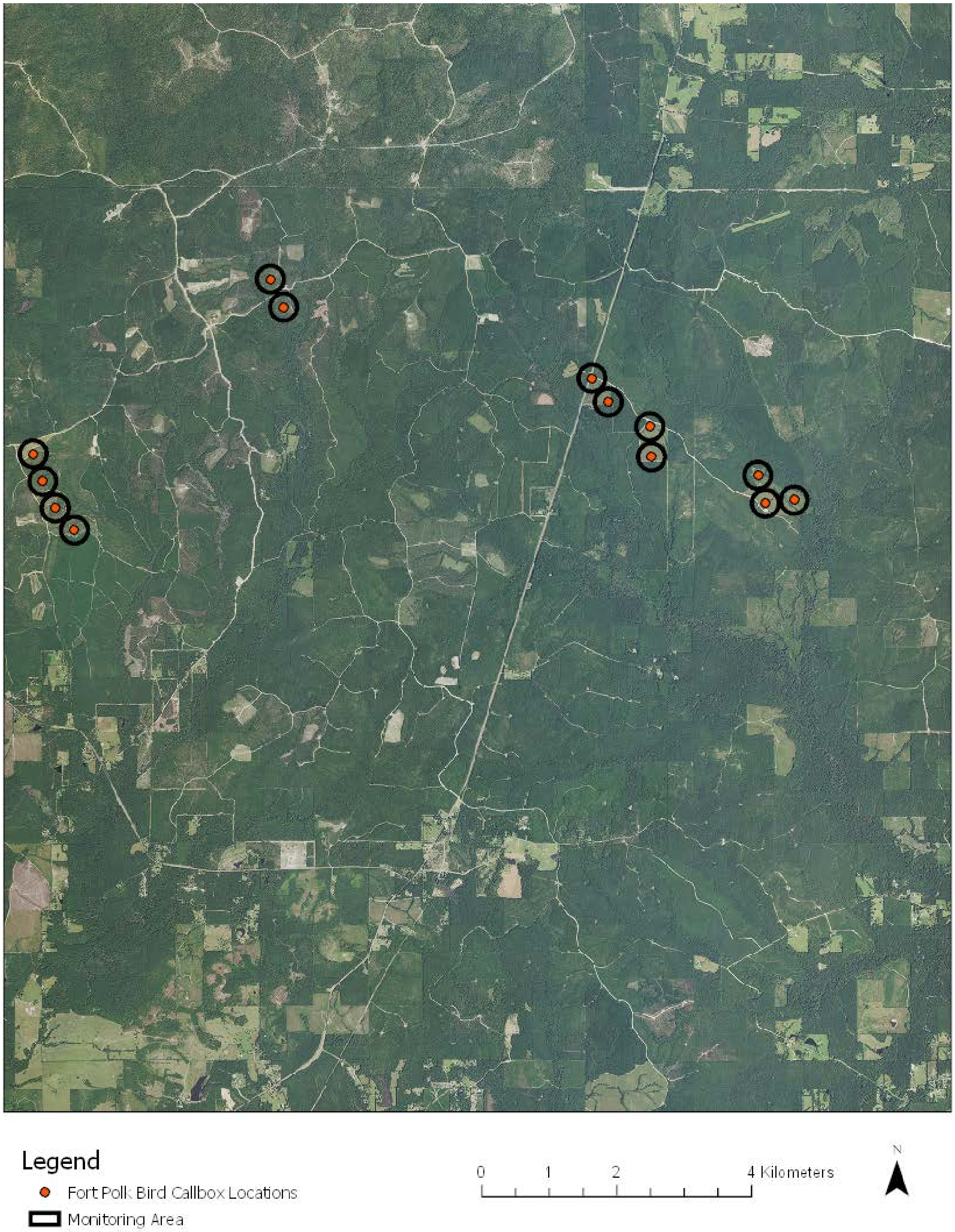


Figure 6. Artificial frog pond locations at Fort Polk, Louisiana.

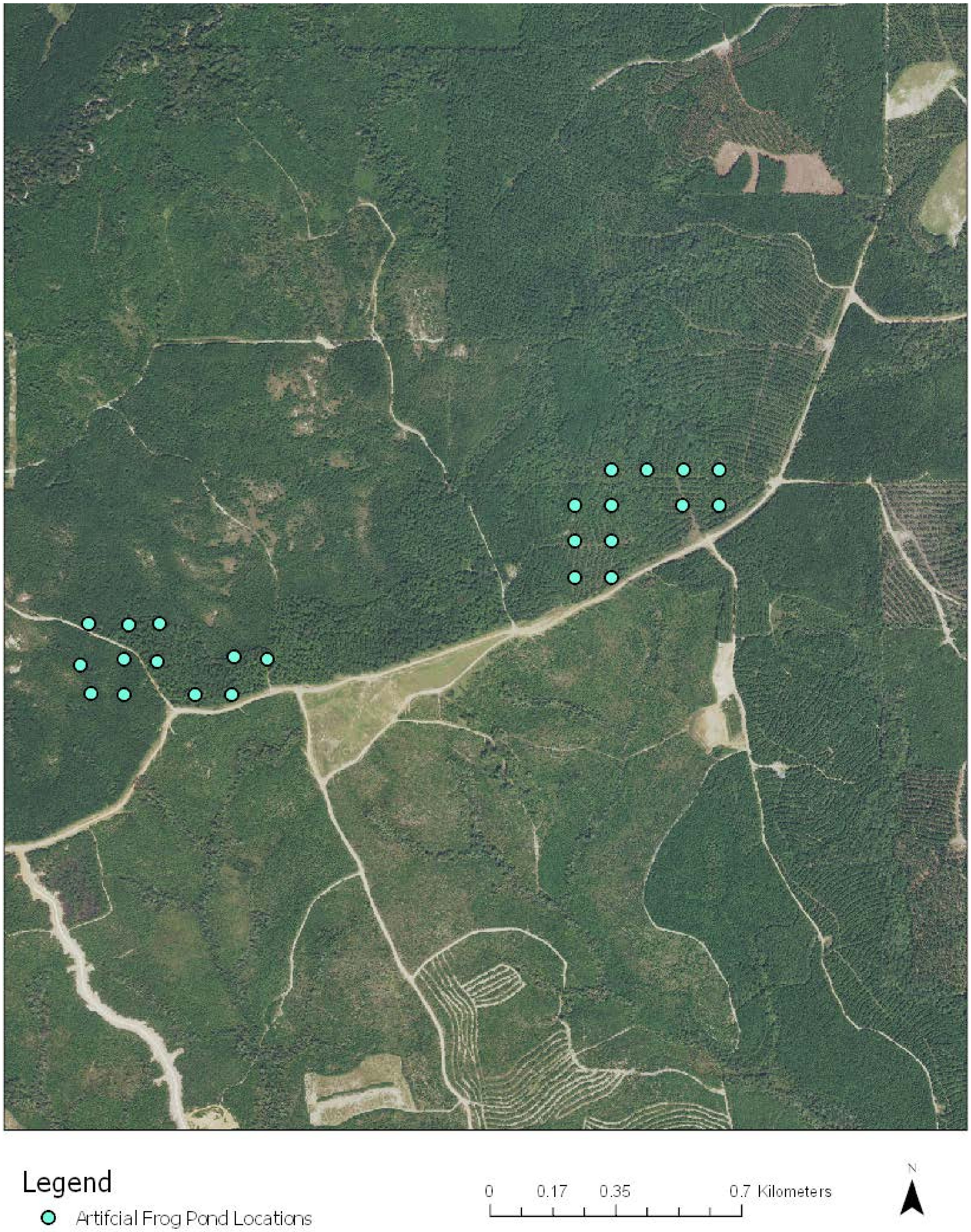


Figure 7. Callbox locations for golden-winged warblers (yellow dots) and grasshopper sparrows (green dots) and monitoring areas (black circles) at Fort McCoy, Wisconsin.

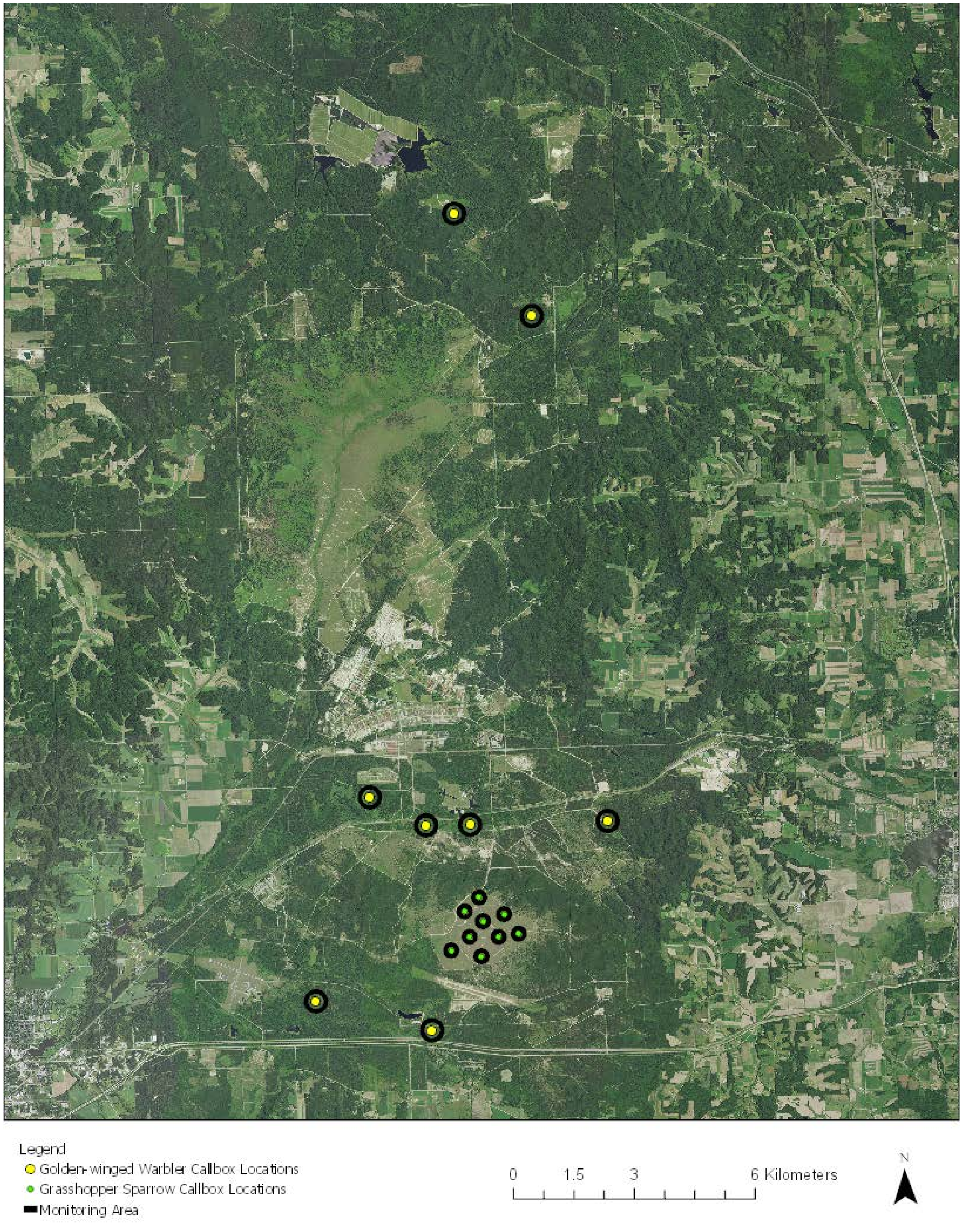
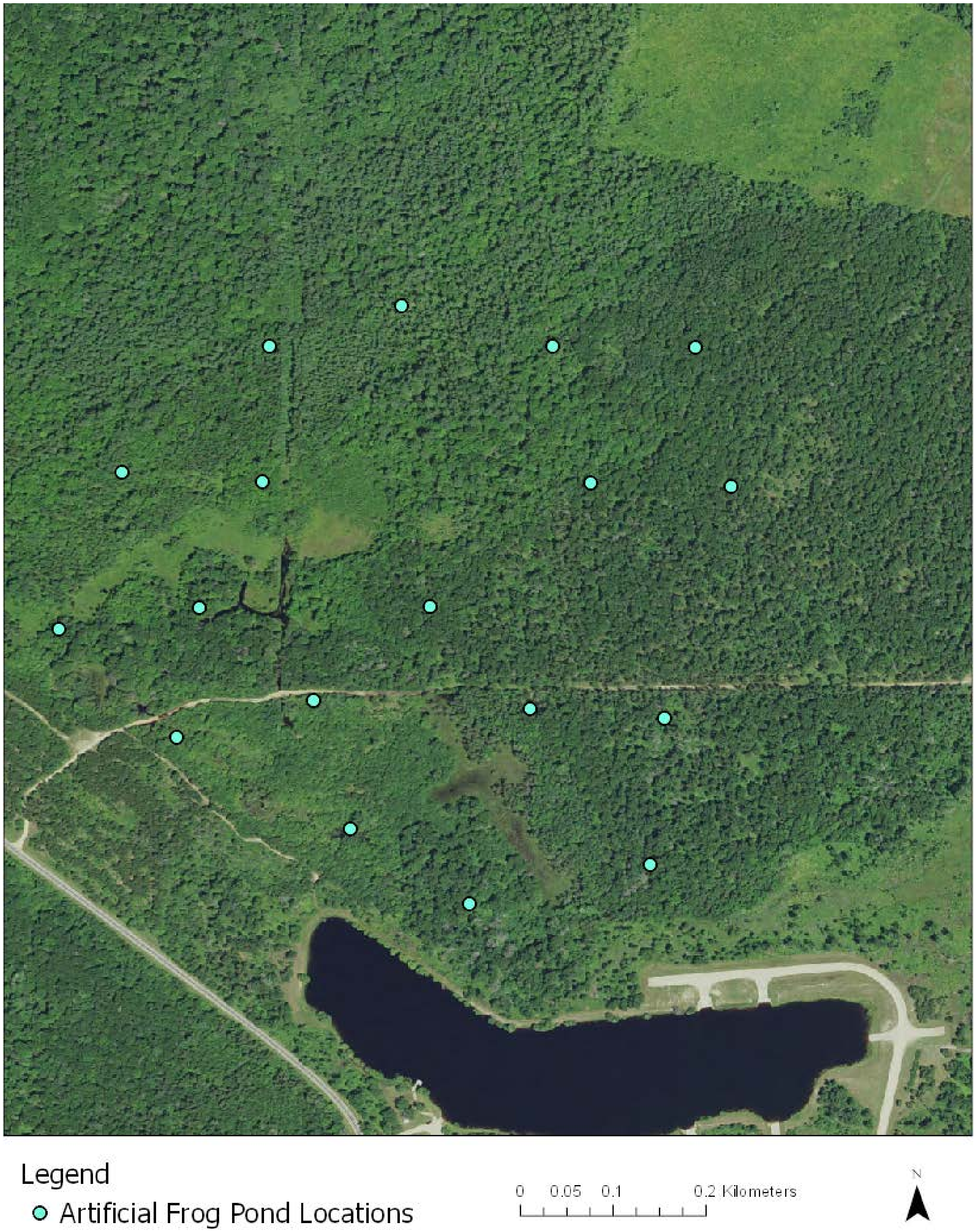


Figure 8. Artificial frog pond locations at Fort McCoy, Wisconsin.



Surveys were conducted for focal avian and amphibian species within treatment and control plots (Table 3). Surveys were conducted before, during, and after conspecific calls had been broadcast within treatment plots (Table 4). Abundance and distribution of avian species were determined using fixed distance point counts. These point count surveys were distributed across a variety of patches of early successional habitat. Point counts were conducted according to established protocols (Bibby et al. 2000) starting when focal species first began vocalizing and continued throughout the breeding season. Avian productivity within the study plots was determined by locating and monitoring nests (Martin and Geupel 1993). Birds were captured via mist net, aged as either hatch year or after hatch year via skull ossification or plumage, and then banded with unique color combinations.

Abundance and distribution of amphibian species were determined using timed visual surveys and nocturnal aural surveys for calling males. Amphibian productivity was monitored by recording number of egg masses per pond. Adults were marked via toe clipping and/or visible implant elastomer [VIE]) tags, depending on species.

Conspecific calls of focal bird and amphibian species were broadcast at treatment plots or, in the case of amphibians, treatment ponds. Paired control plots/ponds did not have any broadcast calls. Prerecorded vocalizations were broadcast from a portable game caller that was powered by a deep-cycle battery. Calls were broadcast at sound levels reflecting natural vocalizations and were broadcast throughout the beginning and peak of the focal species breeding period. Broadcast calls were initiated during the second year of the project.

Table 3. Description of sampling protocol, metric addressed, sampling method, sampling period, and sampling frequency.

Sample Description	Metric Addressed	Sampling Method	Sampling Period	Sampling Interval
Bird Surveys	Colonization time and abundance	Point counts and territory mapping	April – August	Weekly
Frog Surveys	Colonization time and abundance	Call surveys	March – July	Weekly
Bird Individual Identification (ID)	Bird productivity, age structure, and site fidelity	Mistnetting and color banding	April – August	Weekly
Nest Monitoring	Bird productivity	Monitor nests for fledge/fail	April – August	Every 2-4 days
Frog Eggmass/Tadpole Surveys	Frog productivity	Visual egg mass surveys and dip netting for tadpoles	April – August	Every 2-4 days

Table 4. Timeline for demonstration of conspecific attraction for birds and frogs at Fort Polk, Louisiana and Fort McCoy, Wisconsin.

Activity	Date Range	Description
Demonstration of Conspecific Attraction Experiments for Bird Species (Golden-winged Warblers and Grasshopper Sparrows) at Fort McCoy		
Site Selection and Preliminary Surveys	March – August 2016	• Preliminary survey data collected and study sites chosen with input from Fort McCoy Natural Resources Branch.
Callbox Experiment Implementation: Year 1	March – August 2017	• Callboxes were placed into the field in randomly designated “control” and “treatment plots” and broadcast bird vocalizations before migration. Point count surveys conducted weekly throughout the birds’ breeding season.
Callbox Experiment Implementation: Year 2	March – August 2018	• Control and Treatment Plots are switched between the 2017 and 2018 breeding seasons. Point count surveys conducted weekly throughout the birds’ breeding season.
Demonstration of Conspecific Attraction Experiments for American Toads at Fort McCoy		
Site Selection	May – August 2016	• Study site chosen and artificial ponds dug into the ground.
Callbox Experiment Implementation	April 2017	• Callboxes were placed into the field in randomly designated “control” and “treatment plots” and vocalizations broadcast before the American Toad breeding season. During the American Toad breeding season, ponds were surveyed daily (both during the day and at night) for colonization events and egg masses.
Demonstration of Conspecific Attraction Experiments for Wood Frogs at Fort McCoy		
Site Selection	May – August 2016	• Study site chosen and artificial ponds dug into the ground.
Callbox Experiment Implementation: Year 1	March-April 2018	• Callboxes were placed into the field in randomly designated “control” and “treatment plots” and vocalizations broadcast before the wood frog breeding season. During the wood frog breeding season, ponds were surveyed daily (both during the day and at night) for colonization events and egg masses.
Demonstration of Conspecific Attraction Experiments for Eastern Grey Tree Frogs at Fort McCoy		
Site Selection	May – August 2016	• Study site chosen and artificial ponds dug into the ground.
Callbox Experiment Implementation	April – June 2018	• Callboxes were placed into the field in randomly designated “control” and “treatment plots” and vocalizations broadcast before the eastern grey tree frog breeding season. During the breeding season, ponds were surveyed daily (both during the day and at night) for colonization events and egg masses.
Demonstration of Conspecific Attraction Experiments for Northern Bobwhite at Fort Polk		
Site Selection	March – August 2016	• Preliminary survey data collected and study sites chosen with input from Fort Polk Natural Resources Branch.

Activity	Date Range	Description
Callbox Experiment Implementation: Year 1	March – August 2017	• Callboxes were placed into the field in randomly designated “control” and “treatment plots” and broadcast bird vocalizations before migration. Point count surveys conducted weekly throughout the birds’ breeding season.
Callbox Experiment Implementation: Year 2	March – August 2018	• Control and Treatment Plots are switched between the 2017 and 2018 breeding seasons. Point count surveys conducted weekly throughout the birds’ breeding season.
Demonstration of Conspecific Attraction Experiments for Prairie Warbler, Brown Thrasher, Eastern Towhee, Blue Grosbeak, and Painted Bunting at Fort Polk		
Site Selection	March – August 2016	• Preliminary survey data collected and study sites chosen with input from Fort Polk Natural Resources Branch.
Callbox Experiment Implementation: Year 1	March – August 2017	• Callboxes were placed into the field in randomly designated “control” and “treatment plots” and broadcast bird vocalizations before migration. Point count surveys conducted weekly throughout the birds’ breeding season.
Callbox Experiment Implementation: Year 2	March – August 2018	• Surveys conducted in 2018 with no callboxes placed in order to determine whether conspecific attraction had lasting effects on populations of these species.
Demonstration of Conspecific Attraction Experiments for Eastern Narrow-mouthed Toads at Fort Polk		
Site Selection	March – August 2016	• Study site chosen and artificial ponds dug into the ground.
Callbox Experiment Implementation	March – April 2018	• Callboxes were placed into the field in randomly designated “control” and “treatment plots” and vocalizations broadcast before the Eastern Narrow-mouthed Toad breeding season. During the Eastern Narrow-mouthed Toad breeding season, ponds were surveyed daily (both during the day and at night) for colonization events and egg masses.
Demonstration of Conspecific Attraction Experiments for Cope’s Grey Treefrogs at Fort Polk		
Site Selection	March – August 2016	• Study site chosen and artificial ponds dug into the ground.
Callbox Experiment Implementation	March – April 2017	• Callboxes were placed into the field in randomly designated “control” and “treatment plots” and vocalizations broadcast before the Cope's Grey Treefrog breeding season. During the Cope's Grey Treefrog breeding season, ponds were surveyed daily (both during the day and at night) for colonization events and egg masses.

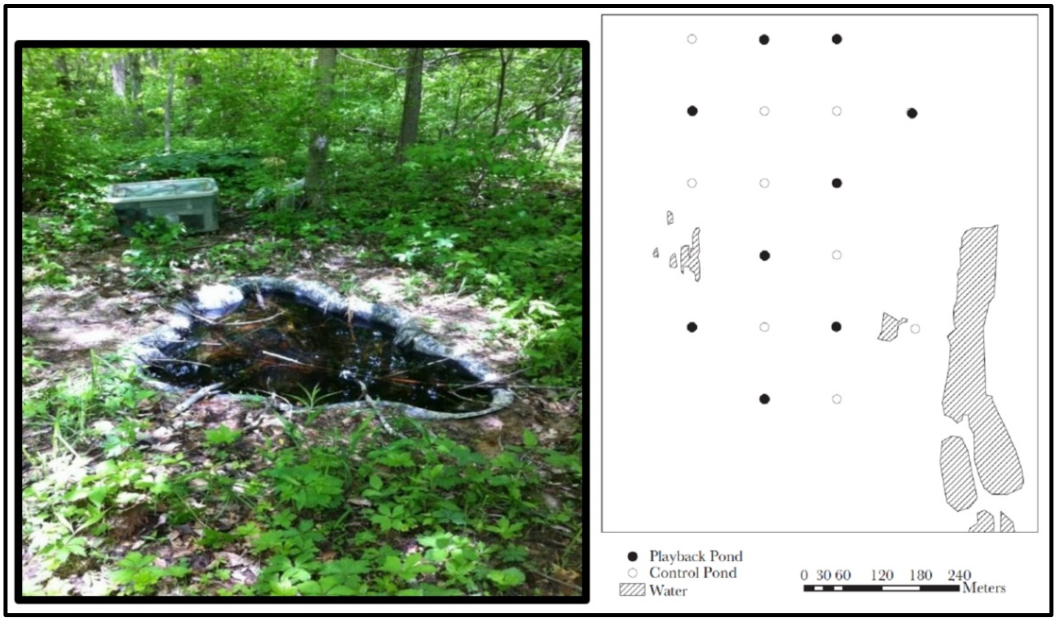
5.5 Sampling protocol

For avian species, we established a minimum of 12 demonstration plots per installation. Half of the plots were randomly assigned to a treatment group where conspecific calls were broadcast and half were silent controls. Plot size was based on the territory sizes of the focal species and the extent of appropriate habitat. For most bird species, the plots included areas large enough to accommodate three to eight breeding pairs and range from 3 to 10 ha. Plots were placed a minimum of 500 m apart to avoid overlapping of territories and noise contamination.

For amphibian species, we installed a minimum of 18 small artificial garden ponds (approximately 1.7 m x 1.2 m, 91-gal capacity) in a grid throughout the demonstration area on each installation (Figure 9). The demonstration area was positioned near (<500 m) already occurring water bodies. Ponds were dug into the ground so that the lip of the pond was flush with the ground surface. Ponds were placed a minimum of 150 m apart to avoid overlapping of territories and noise contamination. Ponds were filled with water from nearby water bodies, and leaf litter and branches were placed in the ponds to provide structural support for egg masses and to facilitate growth of algae as a food source for tadpoles. Many of the existing small ephemeral pools that our experimental ponds simulate have a similar substrate of leaf litter with little to no emergent vegetation. Ponds were refilled as necessary throughout the demonstration to maintain water levels.

Although future application of this technology would likely be in association with natural or created ponds or wetlands, the limited availability of newly created or uncolonized ponds would make a robust demonstration infeasible. However, we believed that a demonstration of the technology using artificial ponds would allow a controlled, replicated experiment and that the results would be applicable to naturally occurring breeding ponds. All of our target amphibian species (or closely related species) have been documented breeding in shallow ephemeral pools, including artificial pools (Buxton et al. 2015), thus the size and characteristics of our artificial ponds is unlikely to deter oviposition.

Figure 9. Example experimental pond and treatment/control pond arrangement for amphibian conspecific attraction (Buxton et al. 2015). Dark circles indicate treatment ponds (with conspecific calls) and open circles indicate silent control ponds.

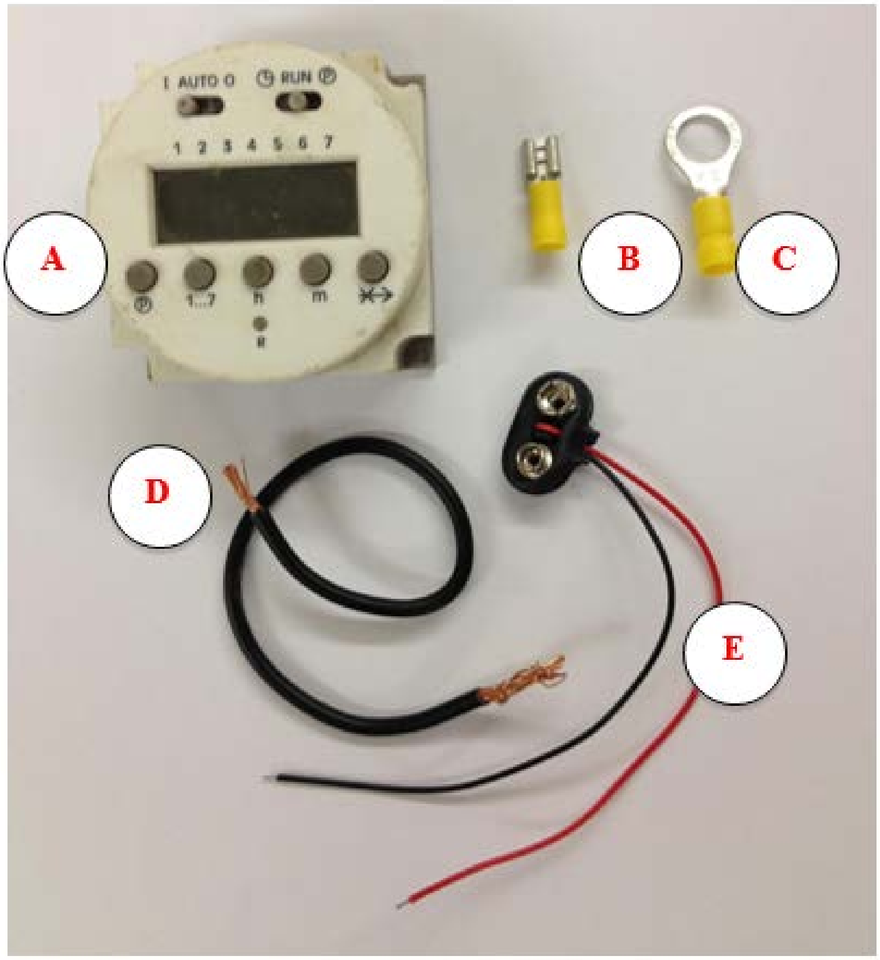


Broadcast call stations consisted of a commercially available call box, timer, and battery. For our demonstration, we used the FoxPro NX4 digital game caller[*] and Favolcano CN101 DC 12v digital programmable timer (Part No. FC-Q00050A1), however, other commercially available, programmable equipment would likely suffice. Because the game caller is designed to run on AA batteries (3-7 hours of play time), we rewired the power supply to attach to a deep-cycle battery. Needed accessory equipment included (1) three ¼-in. quick disconnect (female), (2) two ⅜-in. ring terminals, (3) 10-12 gauge thermoplastic high-heat resistant nylon-coated (THHN) stranded building wire, (4) one 9v battery connector (Figure 10), and (5) one Rubbermaid container.

Detailed instructions for design and setup of a playback call station are as follows. Cut the 10-12-gauge wire into three separate pieces (approximately 4 in. long). Strip the ends of one piece of wire and crimp one ring terminal to one end and one quick disconnect to the other end. Next, strip the ends of the two remaining pieces of wire. Twist two ends of the wire together and crimp a ring terminal to the end.

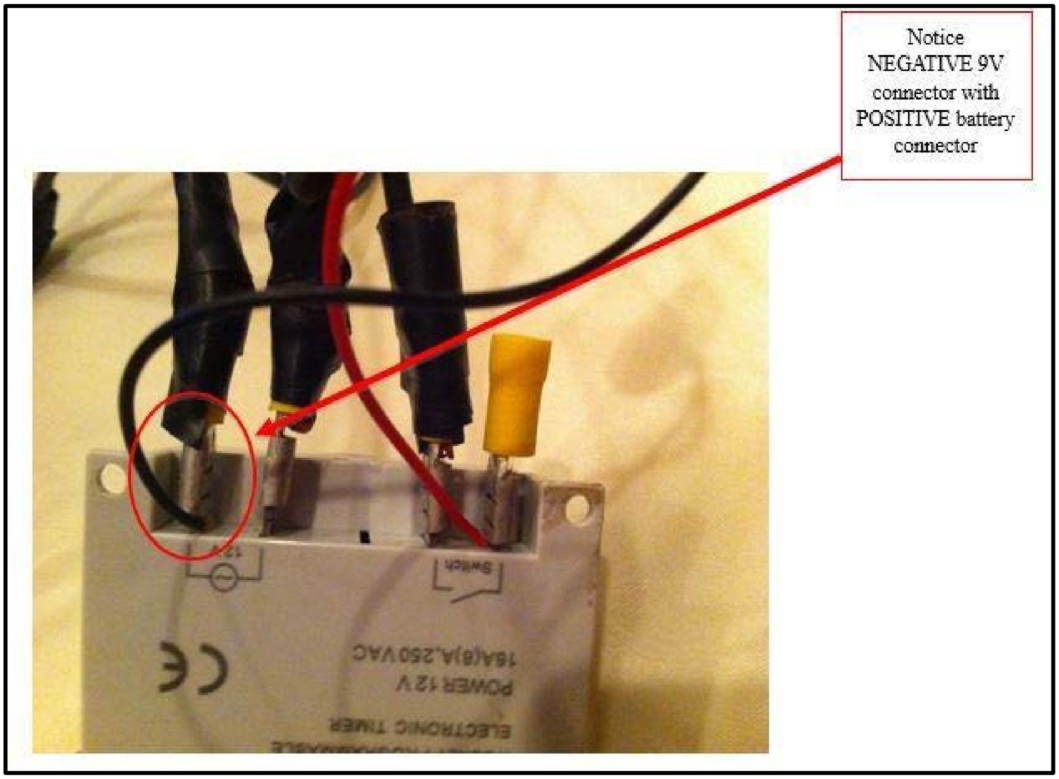
[*] FOXPRO Inc., Lewistown, PA, https://www.gofoxpro.com/products/digital-game-calls/nx4.

Figure 10. Digital timer and wires used for playback call stations. A) 12v digital programmable timer, B) 1/4 inch quick disconnect (female), C) 3/8-inch ring terminal, D) 10-12-gauge THHN stranded building wire, and E) 9v battery connector.



Then, take the two remaining quick disconnects and crimp them to the two loose ends of the now double stranded wire. The 'single' wire will be positive, the 'double' wire will be negative. Take the 9v battery connecter and strip the ends of the positive (red) and negative (black) wires. Attach them to the terminals on the programmable timer (negative to the 12v terminal at the end of the timer, positive to the switch at the other end of the timer). Take the 'single' positive wire and attach it to same terminal to which the negative end of the 9v battery connector is attached (see Figure 11). Take the 'double' negative wire and attach one end to the middle 12v terminal on the timer, and one end to middle of the switch terminal (see Figure 11). Then take a remaining quick disconnect and attach it to same switch terminal to which the positive 9v battery connector is attached (see Figure 11).

Figure 11. Photo example of timer setup for playback call station.



Attach the 9v battery connector to the FoxPro gamecaller. Custom-made audio tracks can be uploaded directly to the FoxPro. Attach the positive ring terminal to the positive terminal of the 12v battery and attach the negative ring terminal to the negative terminal of the 12v battery. Once the timer is programmed, the FoxPro will then play the audio tracks during the specified times.

All items were housed in a large plastic container to reduce risk of water or animal damage. The call box speaker was placed against a small window, cut into the side of container and covered with screening material, to allow clear sound transmission.

For birds, our playback methods mimicked those successfully used in Ward and Schlossberg (2004) and Hahn and Silverman (2006). Vocalizations were broadcast from an hour before sunrise until 10:30 a.m. at volumes reflecting natural levels (80–90 dB, as measured with a sound level meter). Songs were broadcast daily from the early settlement period through the breeding season (March–August). Broadcast tracks included ~70 minutes of bird songs (rotating through focal species) followed by 10 minutes of silence. Because each focal species had unique call types and combinations (e.g., golden-winged warbler type 1 and 2 songs), broadcast calls included numerous song types from each species. Exemplars used were from at least five unique individuals. Calls used for treatment were recorded in year 1 using a parabolic microphone (Wildtronics, LLC) and recorder. Abundance was estimated using point count data and territory monitoring. To ensure that habitat variables did not differ among treatment and control plots, we measured a variety of habitat features known to be important to avian breeding including canopy cover, shrub cover, and ground cover. We did not find any differences between treatment and control plots for any of these variables (MANOVA Wilk's Lambda, $F = 0.78$, $P = 0.67$). Avian abundance was compared among treatment and control plots, as well as year (if applicable) using generalized linear models in R 3.1.3 (R Core Team 2017). We monitored avian productivity by documenting the fates of nests (i.e., until eggs hatched or a nest failed due to predation, parental abandonment, or destruction by weather).

For frogs, our playback methods mimicked those successfully used in Buxton et al. (2015). Vocalizations were broadcast daily from an hour before sunset until midnight at volumes reflecting natural levels (measured using a sound level meter), with 15 minutes of silence after 60 minutes of calling to prevent habituation to playbacks. Vocalization tracks consisted of five different exemplars obtained from recordings downloaded from the Macauley Library. Exemplars contained calls of individuals and calls of a chorus but did not contain heterospecific calls. Each exemplar was clipped to 2 minutes and repeated six times on a 60-minute track. Abundance for amphibian species was estimated based on categorical frog call surveys and number of egg masses present in ponds. The proportion of colonized treatment and control ponds was compared using Fisher's exact tests. To evaluate productivity for frogs, we counted egg masses in ponds and compared the number of egg masses between treatment and control ponds using t-tests. Success metrics were evaluated with statistical significance determined at the $P \leq 0.05$ level. We measured canopy cover over the ponds, as an index of habitat structure, and we found no differences between treatment and control ponds ($t = -0.07$; $P = 0.95$). In 2017, we broadcast playback for Cope's grey tree frogs at Fort Polk and American toads at Fort McCoy. Because we did not detect any toads in 2017, we switched species in 2018 (the final year of the demonstration) to broadcast playback for wood frogs and eastern grey tree frogs at Fort McCoy. Although we were able to compare treatment and control plots for these two species, we were not able to determine abundances in the year following treatment.

Cost estimates for the demonstration were based on equipment, labor, installation, and maintenance costs (see chapter 7). All costs were combined into a cost per unit area. This cost unit was qualitatively compared to published accounts of translocation success/costs and to no active management (based on the data from our control plots). Unfortunately, a detailed cost-benefit analysis is not possible because the benefit of colonization to DoD managers is highly context dependent (e.g., costs may be significant if an installation has ESA requirements for which increased populations or reduced latency to colonization could reduce risk of training restrictions associated with endangered species). However, this costs comparison will allow land managers to assess the various strategies for their individual situations.

5.6 Sampling results

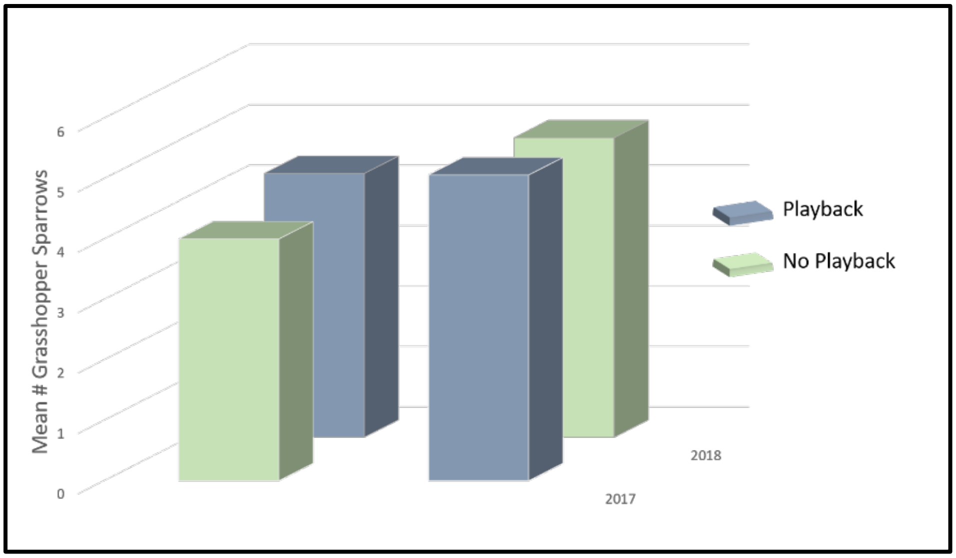
5.6.1 Bird species

5.6.1.1 Fort McCoy

5.6.1.1.1 Grasshopper sparrow

Our grasshopper sparrow demonstration sites consisted of nine plots; four control plots were surveyed in 2017 and five treatment plots were surveyed in 2017. We switched treatment and control plots in 2018. We conducted 119 point counts in 2017 (51 in control plots and 68 in treatment plots). This resulted in 548 grasshopper sparrow detections—204 birds in control plots and 344 in treatment plots. We conducted 120 point counts in 2018 (68 in controls and 52 in treatments). This resulted in 564 sparrow detections—337 birds in control plots and 227 in treatment plots. Playback treatment alone was not a significant predictor of abundance ($F = 1.80$, $P = 0.18$), but we found a significant interaction between year and treatment ($F = 4.92$, $P = 0.01$). Overall abundance did not change between years ($F = 0.87$, $P = 0.35$). Abundance increased on treatment plots in 2018 when no playback was conducted the year before, and abundance remained similar in plots with playback in 2017 to 2018 when no playback was conducted (Figure 12). Only five grasshopper nests were located, two of which were successful (40%). One successful nest was in a treatment plot, and the other was in a control area. The three failed nests were in control plots.

Figure 12. Grasshopper sparrow (*Ammodramus savannarum*) detections per point count in treatment (playback) and control (no playback) plots at Fort McCoy, Wisconsin.



5.6.1.1.2 Savannah sparrow

We conducted 119 point counts in 2017 (51 in control plots and 68 in treatment plots). This resulted in one savannah sparrow detection in a control plot. No birds were detected in treatment plots. We conducted 120 point counts in 2018 (68 in controls and 52 in treatments); no savannah sparrows were detected in 2018. We were unable to conduct statistical analyses for this species due to low statistical power.

5.6.1.1.3 Golden-winged warbler

We conducted 54 points counts in 2017 (27 in control plots and 27 in treatments plots) and detected 18 birds (one in treatment plots and 17 in control plots). In 2018, we conducted 24 point counts (12 in control plots and 12 in treatment plots) and detected five birds, all in treatment plots. Golden-winged warbler abundance was unaffected by playback treatment ($z = -1.01$, $P = 0.79$), year ($z = -1.05$, $P = 0.72$), or by the interaction of year and treatment ($z = 0.99$, $P = 0.36$).

5.6.1.1.4 Upland sandpiper

We conducted 119 point counts in 2017 (51 in control plots and 68 in treatment plots). This resulted in five detections (three in control plots and two in treatment plots). We conducted 120 point counts in 2018 (68 in controls and 52 in treatments). This resulted in seven total detections (three in control plots and four in treatment plots). We were unable to conduct statistical analyses for this species due to low statistical power.

5.6.1.2 *Fort Polk*

5.6.1.2.1 Prairie warbler

We conducted 155 point counts for prairie warblers in 2017 (75 in control plots and 80 in treatment plots). Sixty birds were detected in control plots, and 76 were detected in treatment plots. Playback thus had no effect on the number of prairie warbler detections compared to control plots ($z = 1.00$, $P = 0.32$).

A total of 46 prairie warbler nests were located and monitored. Twenty-one prairie warbler nests were found in treatment plots and 25 were found in control areas. Four nests (three in treatment areas and one in a control plot) had undetermined fates. Of the 42 nests with known fates, 15 (36%) were successful. Four of 18 (22%) nests on treatment plots were successful and 11 of 24 (46%) nests in control areas were successful.

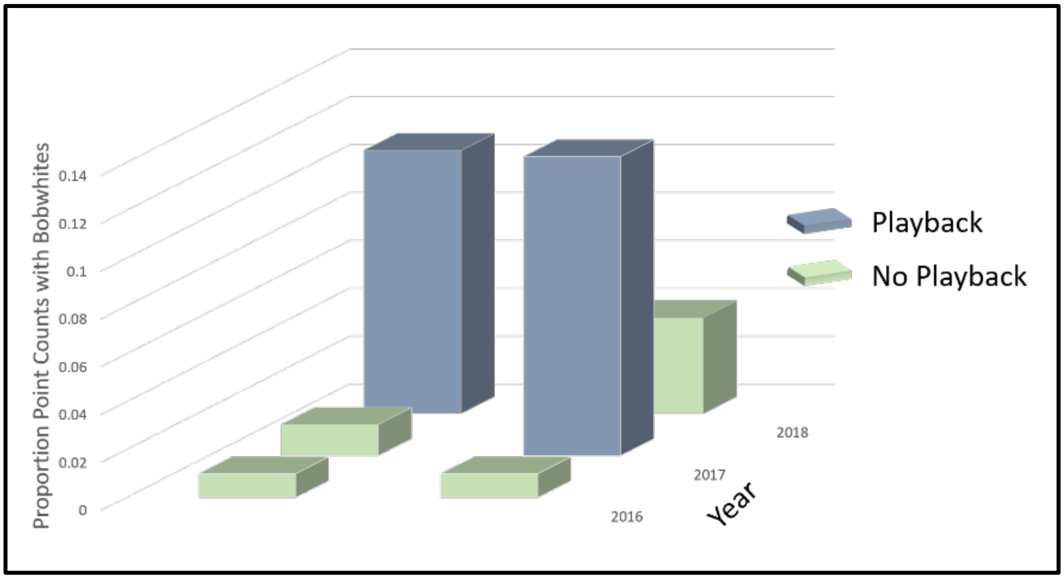
5.6.1.2.2 Eastern towhee

We conducted 155 point counts for eastern towhees in 2017 (75 in control plots and 80 in treatment plots). There were 47 towhee detections in control plots and 31 detections in treatment plots ($z = -2.08$, $P = 0.04$). However, there was no change in the number of birds on either the treatment or control plots from 2016 to 2017 (all $P > 0.90$), indicating that the count was not an effect of treatment but rather of the higher number of birds on the control plots initially.

5.6.1.2.3 Northern bobwhite

We conducted 201 point counts in 2016 at 35 sites. Before playback treatment, we detected bobwhites during two point counts at two sites during in 2016. In 2017, we conducted 155 point counts at 31 sites. In 2017, there were 15 total detections (14 in playback sites and one at control sites). In 2018, we conducted 190 point counts at the same sites. In 2018, when treatment and control sites were switched, there were four detections on control (treatment sites in 2017) and 10 on treatment sites. Playback was significantly positively associated with bobwhite detections ($F = 9.06$, $P < 0.01$; Figure 13), but there was no significant interaction between year and playback treatment ($F = 1.11$, $P = 0.29$).

Figure 13. Proportion of northern bobwhite (*Colinus virginianus*) counts in control (no playback) and treatment (with playback) plots from 2016–18.



5.6.1.2.4 Blue grosbeak

We conducted 345 point counts for blue grosbeaks in 2017 (166 in control plots and 179 in treatment plots). There were 29 birds detected in control plots and 33 in treatment plots. There was thus no effect of playback on abundance of blue grosbeaks ($z = 0.25$, $P = 0.75$).

5.6.1.2.5 Brown thrasher

We conducted 155 point counts for brown thrashers (75 in control plots and 80 in treatment plots). There were nine brown thrasher detections in control plots and six detections in treatment plots. There was no effect of playback on abundance of brown thrashers ($z = -0.89$, $P = 0.37$).

5.6.1.2.6 Painted bunting

No painted buntings were detected in any of the study plots (control or treatment).

5.6.2 Frog species

5.6.2.1 Fort McCoy

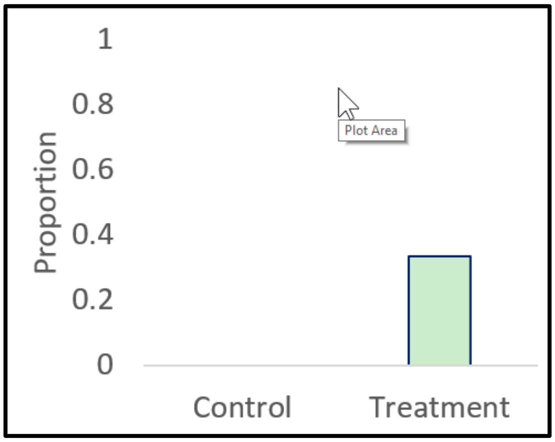
5.6.2.1.1 American Toad

No ponds (control or treatment) were colonized by American toads. We thus were unable to conduct a statistical analysis for this species.

5.6.2.1.2 Eastern grey tree frog

No artificial ponds without playback (controls) were colonized by eastern grey tree frogs, whereas over 30% of treatment ponds were colonized (Figure 14). We found some evidence that the proportion of grey tree frogs being attracted to treatment ponds was higher than control ponds, but the difference was not statistically significant ($\chi^2 = 2.57$; $P = 0.11$).

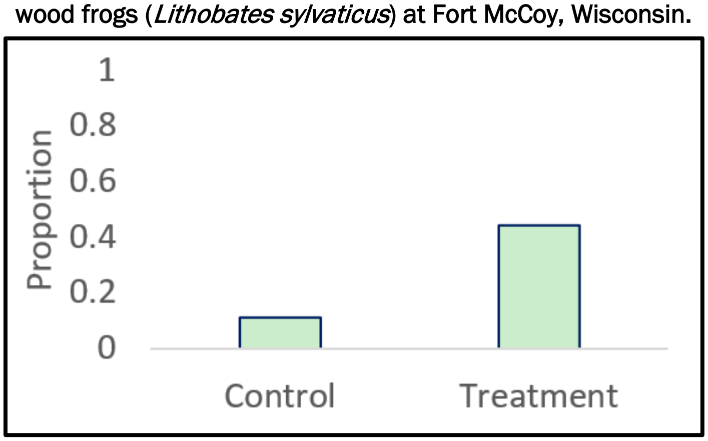
Figure 14. Proportion of treatment and control ponds colonized by eastern grey tree frogs (*Hyla versicolor*) at Fort McCoy, Wisconsin.



5.6.2.1.3 Wood frog

Approximately 10% of artificial ponds without playback were colonized by wood frogs, whereas more than 40% of treatment ponds were colonized (Figure 15). Similar to tree frogs, we found some evidence that the proportion of wood frogs being attracted to treatment ponds was higher than control ponds but the difference was not statistically significant ($\chi^2 = 2.49$; $P = 0.11$). Only one wood frog egg mass was detected and it was found in a treatment pond.

Figure 15. Proportion of treatment and control ponds colonized by wood frogs (*Lithobates sylvaticus*) at Fort McCoy, Wisconsin.



5.6.2.2 Fort Polk

5.6.2.2.1 Cope's grey tree frog

All ponds were colonized by Cope's grey tree frogs in the first year of playback. We thus did not conduct a statistical analysis for this species as the proportion of colonized ponds would not differ between treatment and control ponds. We found slightly more egg masses in treatment ponds compared to control ponds (mean = 72.14 ±12.54 SE and 52 ±13.72, respectively; $t = 1.08$; $P = 0.29$). Nearly all ponds (96%; 24/25) were again colonized in year 3 and more egg masses were found in treatment compared to control ponds (mean = 226.88 ±80 SE and 43.75 ±25.77; $t = 2.16$; 0.04).

5.6.2.2.2 Eastern narrow-mouthed toad

Despite conducting playback experiments, we detected no eastern narrow-mouthed toads at artificial ponds.

6 Performance Assessment

6.1 Bird species

6.1.1 P01: Increase use of treatment (broadcast calls) vs. control (silent) restoration plots by focal species in year 2

For avian species, we established a minimum of 12 demonstration plots per installation. Half of the plots were randomly assigned to a treatment group where conspecific calls were broadcast and half were silent controls. Plots were placed a minimum of 500 m apart to avoid overlapping of territories and noise contamination. Broadcast call stations consisted of a commercially available call box, timer, and battery. Vocalizations were broadcast from an hour before sunrise until 10:30 a.m. at volumes reflecting natural levels (80–90 dB, as measured with a sound level meter). Songs were broadcast daily from the early settlement period through the breeding season (March–August). Broadcast tracks included ~70 minutes of bird songs (rotating through focal species) followed by 10 minutes of silence. Because each focal species had unique call types and combinations (e.g., golden-winged warbler type 1 and 2 songs), broadcast calls included numerous song types from each species. Exemplars used were from at least five unique individuals. Calls used for treatment were recorded in year 1 using a parabolic microphone (Wildtronics, LLC) and recorder. Abundance of avian species was estimated using point count data and territory monitoring. Avian abundance was compared among treatment and control plots, as well as year (if applicable) using generalized linear models in R 3.1.3.

6.1.1.1 Fort McCoy

We conducted 119 point counts in 2017 (51 in control plots and 68 in treatment plots). This resulted in 548 grasshopper sparrow detections—204 birds in control plots and 344 in treatment plots. We conducted 120 point counts in 2018 (68 in controls and 52 in treatments). This resulted in 564 sparrow detections—337 birds in control plots and 227 in treatment plots. Playback treatment alone was not a significant predictor of abundance ($F = 1.80$, $P = 0.18$), but we found a significant interaction between year and treatment ($F = 4.92$, $P = 0.01$). Overall abundance did not change between years ($F = 0.87$, $P = 0.35$). Abundance increased on treatment plots in 2018 when no playback was conducted the year before, and abundance remained similar in plots with playback in 2017 to 2018, when no playback was conducted (Figure 12).

We conducted 119 point counts for savannah sparrows in 2017 (51 in control plots and 68 in treatment plots). This resulted in one detection in a control plot. No birds were detected in treatment plots. We conducted 120 point counts in 2018 (68 in controls and 52 in treatments); no savannah sparrows were detected in 2018. We were unable to conduct statistical analyses for this species due to low statistical power.

We conducted 54 points counts for golden-winged warblers in 2017 (27 in control plots and 27 in treatments plots) and detected 18 birds (one in treatment plots and 17 in control plots). In 2018, we conducted 24 point counts (12 in control plots and 12 in treatment plots) and detected five birds, all in treatment plots. Golden-winged warbler abundance was unaffected by playback treatment ($z = -1.01$, $P = 0.79$), year ($z = -1.05$, $P = 0.72$), or by the interaction of year and treatment ($z = 0.99$, $P = 0.36$).

We conducted 119 point counts for upland sandpipers in 2017 (51 in control plots and 68 in treatment plots). This resulted in five detections (three in control plots and two in treatment plots). We conducted 120 point counts in 2018 (68 in controls and 52 in treatments). This resulted in seven total detections (three in control plots and four in treatment plots). We were unable to conduct statistical analyses for this species due to low statistical power.

6.1.1.2 Fort Polk

We conducted 155 point counts for prairie warblers in 2017 (75 in control plots and 80 in treatment plots). Sixty birds were detected in control plots, and 76 were detected in treatment plots. Playback thus had no effect on the number of prairie warbler detections compared to control plots ($z = 1.00$, $P = 0.32$).

We conducted 155 point counts for eastern towhees in 2017 (75 in control plots and 80 in treatment plots). There were 47 towhee detections in control plots and 31 detections in treatment plots ($z = -2.08$, $P = 0.04$). However, there was no change in the number of birds on either the treatment or control plots from 2016 to 2017 (all $P > 0.90$), indicating that the count was not an effect of treatment but rather of the higher number of birds on the control plots initially.

We conducted 201 point counts for northern bobwhites in 2016 at 35 sites. Before playback treatment, we detected bobwhites during two point counts at two sites during in 2016. In 2017, we conducted 155 point counts at 31 sites. In 2017, there were 15 total detections (14 in playback sites and one at control sites). In 2018, we conducted 190 point counts at the same sites. In 2018, when treatment and control sites were switched, there were four detections on control (treatment sites in 2017) and 10 on treatment sites. Playback was significantly positively associated with bobwhite detections ($F = 9.06$, $P < 0.01$, see Figure 13), but there was no significant interaction between year and playback treatment ($F = 1.11$, $P = 0.29$).

We conducted 345 point counts for blue grosbeaks in 2017 (166 in control plots and 179 in treatment plots). There were 29 birds detected in control plots and 33 in treatment plots. There was thus no effect of playback on abundance of blue grosbeaks ($z = 0.25$, $P = 0.75$).

We conducted 155 point counts for brown thrashers (75 in control plots and 80 in treatment plots). There were nine brown thrasher detections in control plots and six detections in treatment plots. There was no effect of playback on abundance of brown thrashers ($z = -0.89$, $P = 0.37$).

6.1.2 PO2: Establish viable populations on treatment plots in years 2 and 3

We monitored avian productivity by documenting the fates of nests (i.e., until eggs hatched or a nest failed due to predation, parental abandonment, or destruction by weather). We obtained nest survival data only for grasshopper sparrows on Fort McCoy and prairie warblers on Fort Polk. Only five grasshopper nests were located, two of which were successful (40%). In comparison, Vos and Ribic (2013) found 45 of 85 (53%) nests survived. One successful nest was in a treatment plot, and the other was in a control area. The three failed nests were in control plots.

A total of 46 prairie warbler nests were located and monitored. Twenty-one prairie warbler nests were found in treatment plots and 25 were found in control areas. Four nests (three in treatment areas and one in a control plot) had undetermined fates. Of the 42 nests with known fates 15 (36%) were successful, which is comparable to other studies (e.g., 37%, Akresh 2012). Four of 18 (22%) nests on treatment plots were successful and 11 of 24 (46%) nests in control areas were successful.

6.1.3 P03: Improve cost effectiveness compared to traditional methods (translocation or restoration alone)

Cost estimates for the demonstration were based on equipment, labor, installation, and maintenance costs (see chapter 7). All costs were combined into a cost per unit area (i.e., per plot for a focal species). This cost unit was qualitatively compared to published accounts of translocation success/costs and to no active management (based on the data from our control plots). Conspecific attraction costs little more than $1,000 per plot. Comparable, albeit much more drastic and invasive, alternative management actions such as translocation cost between $10,000 to well over $1,000,000 annually, particularly for high-profile species (Fischer and Lindenmayer 2000). Thus, the annual costs of conspecific attraction are approximately 0.1% to 10% of the costs of a comparable translocation.

6.2 Frog species

6.2.1 P01: Increase use of treatment (broadcast calls) vs. control (silent) restoration plots by focal species in year 2

For amphibian species, we installed a minimum of 18 small artificial garden ponds (approximately 1.7 m x 1.2 m, 91-gal capacity) in a grid throughout the demonstration area on each installation (Figure 9). Ponds were placed a minimum of 150 m apart to avoid overlapping of territories and noise contamination. Ponds were filled with water from nearby water bodies and leaf litter and branches were placed in the ponds to provide structural support for egg masses and to facilitate growth of algae as a food source for tadpoles. Vocalizations were broadcast daily from an hour before sunset until midnight at volumes reflecting natural levels (measured using a sound level meter), with 15 minutes of silence after 60 minutes of calling to prevent habituation to playbacks. Vocalization tracks consisted of five different exemplars obtained from recordings downloaded from the Macauley Library. Exemplars contained calls of individuals and calls of a chorus but did not contain heterospecific calls. Each exemplar was clipped to 2 minutes and repeated six times on a 60-minute track. Abundance for amphibian species was estimated based on categorical frog call surveys. The proportion of colonized treatment and control ponds was compared using Fisher's exact tests.

6.2.1.1 Fort McCoy

No ponds (control or treatment) were colonized by American toads. We thus were unable to conduct a statistical analysis for this species. No artificial ponds without playback (controls) were colonized by eastern grey tree frogs, whereas over 30% of treatment ponds were colonized (Figure 14). We found some evidence that the proportion of grey tree frogs being attracted to treatment ponds was higher than control ponds, but the difference was not statistically significant ($\chi^2 = 2.57$; $P = 0.11$). Approximately 10% of artificial ponds without playback were colonized by wood frogs, whereas more than 40% of treatment ponds were colonized (Figure 15). Similar to tree frogs, we found some evidence that the proportion of wood frogs being attracted to treatment ponds was higher than control ponds but the difference was not statistically significant ($\chi^2 = 2.49$; $P = 0.11$).

6.2.1.2 Fort Polk

All ponds were colonized by Cope's grey tree frogs in the first year of playback. We thus did not conduct a statistical analysis for this species as the proportion of colonized ponds would not differ between treatment and control ponds. We found slightly more egg masses in treatment ponds compared to control ponds (mean = 72.14 ±12.54 SE and 52 ±13.72, respectively; $t = 1.08$; $P = 0.29$). Nearly all ponds (96%; 24/25) were again colonized in year 3 and more egg masses were found in treatment compared to control ponds (mean = 226.88 ±80 SE and 43.75 ±25.77; $t = 2.16$; 0.04). Despite conducting playback experiments, we detected no eastern narrow-mouthed toads at artificial ponds.

6.2.2 PO2: Establish viable populations on treatment plots in years 2 and 3

To evaluate productivity for frogs, we counted egg masses in ponds and compared the number of egg masses between treatment and control ponds using t-tests. We found slightly more egg masses in treatment ponds compared to control ponds (mean = 72.14 ±12.54 SE and 52 ±13.72, respectively; $t = 1.08$; $P = 0.29$) in 2017 and significantly more egg masses in treatment compared to control ponds in 2018. (mean = 226.88 ±80 SE and 43.75 ±25.77; $t = 2.16$; 0.04). This was not a function of habitat as canopy cover was similar among treatments (treatment pond mean canopy cover = 66% ±0.25; control pond mean = 65% ±0.27). Only one wood frog egg mass was detected in artificial ponds on Fort Polk and it was found in a treatment pond.

6.2.3 PO3: Improve cost effectiveness compared to traditional methods (translocation or restoration alone)

Cost estimates for the demonstration were based on equipment, labor, installation, and maintenance costs (see chapter 7). All costs were combined into a cost per unit area (i.e., per plot for a focal species). This cost unit was qualitatively compared to published accounts of translocation success/costs and to no active management (based on the data from our control plots). Conspecific attraction costs little more than $1,000 per plot. Comparable, albeit much more drastic and invasive, alternative management actions such as translocation cost between $10,000 to well over $1,000,000 annually, particularly for high-profile species (Fischer and Lindenmayer 2000). Thus, the annual costs of conspecific attraction are approximately 0.1% to 10% of the costs a comparable translocation.

7 Cost Assessment

7.1 Cost model

7.1.1 Equipment costs

We quantified all costs associated with the conspecific trials, which consisted of a call box (commercially available), battery, and timer. We also calculated the number of call box stations required for this particular project. Because application of conspecific attraction for amphibians in a management context would likely be associated with existing ponds/wetlands, costs associated with artificial ponds were not included in cost analyses. It is expected that broadcast calls are only necessary for a single breeding season to establish a viable population, but this will be species dependent.

7.1.2 Installation costs

Installation costs were noted, including labor/time associated with acquiring call recordings, programming call boxes, assembly of call box stations, and installation of stations. Materials included waterproof containers and desiccants to minimize risk of water damage to equipment. Installation costs were multiplied by number of callboxes required per unit area.

7.1.3 Maintenance costs

We tracked the frequency of required maintenance for the call box stations along with the required time and materials required during each maintenance action. This cost included charging and/or exchanging batteries. We checked call boxes 1–2 times per week and changed out batteries every 3 weeks.

It is expected that broadcasting calls over a single breeding season (3-4 months) will be sufficient to establish a viable population for most species. All equipment and materials associated with the cost model would be reasonably expected to last the duration of the trial and so total life-cycle costs will be equivalent to the single-year demonstration. The unit cost presented in the table is sufficient for one sampling plot (4–12 hectares) and can be simply multiplied by the number of units required for a given habitat.

Table 5 summarizes the cost model for conspecific attraction of bird and frog species.

Table 5. Cost model for conspecific attraction of bird and frog species.

Cost Element	Data Tracked	Formula	Total Cost
Material Costs	FoxPro game caller system	Quantity X unit cost	$249.49
	Battery	Quantity X unit cost	$100.00
	Timers	Quantity X unit cost	$10.00
	Rubbermaid Containers	Quantity X unit cost	$10.00
	Misc. Electrical components	Quantity X unit cost	$5.00
Installation Costs	Labor, time	Labor X Hours	$14.50*20 hrs
Maintenance	Labor, time, material	Labor rate X Hours + Material	$14.50*40 hrs
Total Cost Per Plot			$1,244.49

7.2 Cost drivers

Factors that may influence the cost of employing conspecific attraction as a management tool for species management would include (1) the necessity for additional surveys associated with the playback and (2) accessibility of focal sites. If surveys are not already being conducted as part of an overall management strategy, it may be required to conduct surveys to evaluate the effectiveness of playback to encourage colonization. For breeding bird and/or amphibian species, this may require surveys throughout the breeding season (typically 1-4 months). The accessibility of the focal sites could also affect cost due to transport, setup, and maintenance of the playback systems. Remote sites would require more effort (work-hours) to access sites, and if sites are too far from roads to reasonably transport the large deep-cycle batteries required for the playback systems, it may be more cost-effective to use solar panels, thereby increasing the cost by ~$200 per system.

7.3 Cost analysis and comparison

Cost estimates for the demonstration were based on equipment, labor, installation, and maintenance costs. All costs were combined into a cost per unit area (i.e., per plot for a focal species). This cost unit was qualitatively compared to published accounts of translocation success/costs and to no active management (based on the data from our control plots). Conspecific attraction costs little more than $1,000 per plot. Comparable, albeit much more drastic and invasive, alternative management actions such as translocation cost between $10,000 to well over $1,000,000 annually, particularly for high-profile species (Fischer and Lindenmayer 2000). Thus, the annual costs of conspecific attraction are approximately 0.1% to 10% of the costs of a comparable translocation.

8 Implementation Issues

As a wildlife management tool, conspecific attraction was relatively straightforward to employ. All required equipment is commercially available and the calls can either be recorded on site or acquired through publicly available sources (e.g., Macaulay library*). Required maintenance was minimal and was limited primarily to battery replacement (every 3 weeks). Total costs were little more than $1,000 per demonstration plot, far below the costs associated with alternative management techniques such as translocation (Fischer and Lindenmayer 2000).

The primarily implementation issue encountered was the variation in effectiveness across the numerous species tested. We demonstrated clear success in attracting some bird and frog species into our target areas. In particular, northern bobwhite detections increased dramatically on our treatment plots and remained relatively high following cessation of calls. Similarly, the number of ponds colonized by wood frogs was much higher for ponds with calls (40% of ponds) compared to silent controls (10% of ponds). We also found trends of higher use of treatment plots for grasshopper sparrows and eastern grey tree frogs. Species that are highly social and at moderate abundances appear to more receptive to the playbacks.

However, other species did not show responses to playback, particularly those that were very rare near our sites. We did not find enough nests to conduct a robust analysis of productivity but we found that overall nest survival was similar to previously published accounts. We did find that prairie warbler nest survival was lower on treatment plots, but since we did not see a response to playback, it is unlikely that reproductive success was linked to treatments. More work is needed to evaluate any possible effects of playback on productivity. For frogs, some species were very abundant and thus colonized all available ponds, regardless of whether playback was conducted. Conversely, some species such as American toads may have shown no response because they generally rely on permanent water bodies for breeding and thus may have limited behavioral plasticity for selecting alternate breeding sites (Buxton et al. 2015).

In an attempt to understand the disparity in responses, we compiled results from all published work examining conspecific attraction for habitat

* Macauley Library, Cornell Lab of Ornithology, Ithaca, NY, https://www.macaulaylibrary.org/how-to/use-media/.

selection.* We conducted a review of the literature and found 149 studies investigating conspecific attraction across eight taxa (Figure 16). We found that conspecific attraction is widespread, with between 50% and 80% of studies documenting positive associations, depending on taxa (Figure 17).

Figure 16. Timeline of conspecific attraction studies by taxonomic group from 1960-2017.

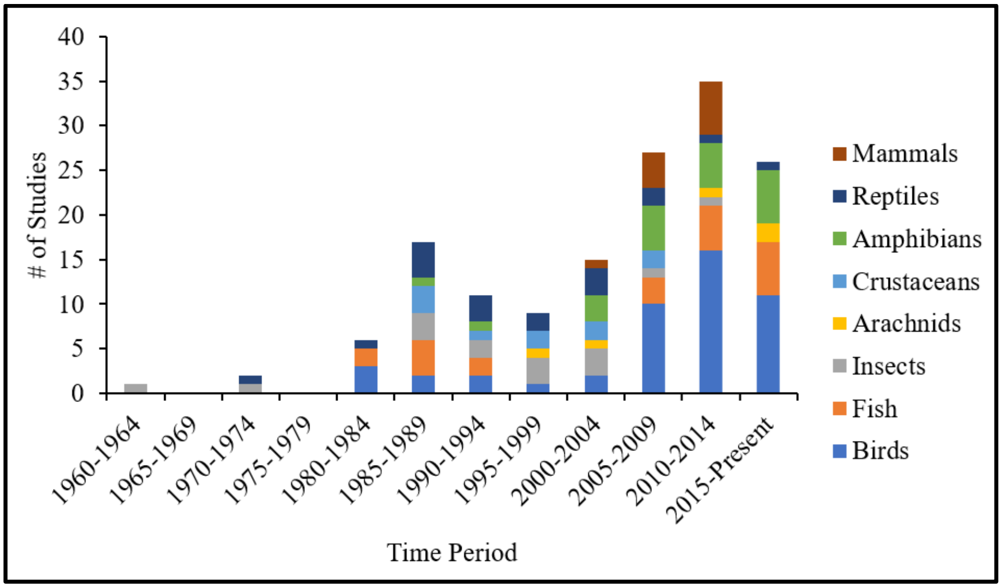
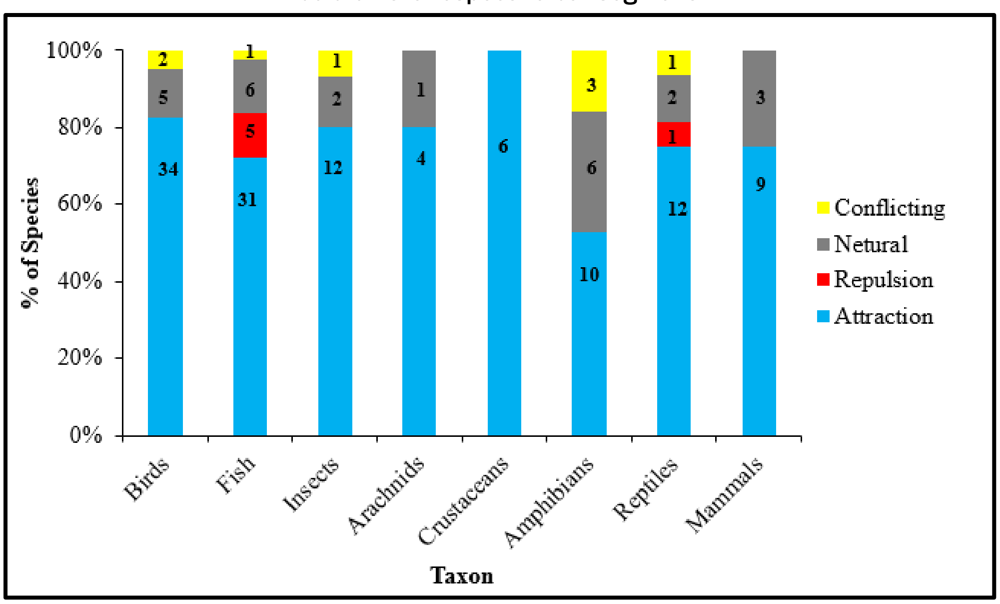


Figure 17. Percentage of species showing attraction, repulsion, or no response (neutral) to conspecific cues grouped by taxa. "Conflicting" indicates that a species showed a differential response to conspecific cues in two or more studies. Sample size for each category is listed in bold on the respective bar segment.



* V. Buxton, J. Kelly, J. Sperry, and M. Ward. 2019. *A Review of Conspecific Attraction for Habitat Selection across Taxa—What Are We Missing?* In review.

The ubiquity of published accounts of conspecific attraction would indicate that this could be a viable management tool across a wide variety of taxa. Our results affirm this result although we found the effectiveness was much more variable (25% of bird species and 50% of amphibian species). As discussed in this review, this likely reflects a publication bias with studies demonstrating a response more likely to be published.

Although responses varied among species, our work demonstrated the utility of this method for species management on military lands. Given how little effort and resources are required for deployment, playback appears to be a viable tool for encouraging colonization or increasing abundances of focal species into restored habitats. Because responses can be variable, we recommend using this method for targeting multiple species simultaneously (e.g., rotating playback of multiple species) with the acknowledgment that it is unlikely to be effective for all species. Conversely, if restoration is aimed at particular species (e.g., Threatened and Endangered Species [TES]), we would recommend attempting this non-invasive method before attempting techniques such as translocation. A large number of species have been included in studies examining conspecific attraction* and so a literature search on effectiveness of this technique for particular species may yield information on how responsive specific species may be and, therefore, how effective playback may be in eliciting species-specific responses.

* V. Buxton, J. Kelly, J. Sperry, and M. Ward. 2019. *A Review of Conspecific Attraction for Habitat Selection across Taxa—What Are We Missing?* In review.

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Acronyms and Abbreviations

Term	Definition
DoD	U.S. Department of Defense
DPW	Directorate of Public Works
ESA	U.S. Endangered Species Act
ID	Identification
SE	Southeast
SME	Subject Matter Expert
TES	Threatened and Endangered Species
THHN	Thermoplastic High-Heat resistant Nylon-coated
VIE	Visible Implant Elastomer

Appendix A: Points of Contact

Point of Contact (Name)	Organization (Name, Address)	Phone & Email	Role in Project
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