Response of Wintering Birds to Simulated Birder Playback and Pishing

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Abstract: Researchers have used playback as an effective survey tool for ornithological research and monitoring, but amateur use is controversial because of potential negative effects on birds. Despite limited peer-reviewed research on this technique, conservation organizations worldwide have limited or banned the use of playback. Some birders use "pishing" (vocal imitation of avian alarm calls) as an alternative to playback. We investigated the effects of simulated birder playback and pishing on the behavior of wintering birds in northern Louisiana. Four experimental treatments were performed at each of six sites: baseline (no birder), control (birder present—no sound), pishing (birder pished five times), and playback (birder played three pre-recorded bird songs). Our order of presentation of each experimental treatment was varied at each site to control for habituation of birds. From hunting blinds, we recorded the behavior of birds during a 45-min observation period split into three 15-min periods: pre-, during-, and post-exposure to experimental treatment. The total number of bird behaviors we recorded differed by site and order of experimental presentation. Some sites had more bird activity than others and the total number of recorded behaviors tended to increase with an increase in the order of presentation. Experimental treatment best explained variance in the repeated factor. Pishing and playback increased vocalization behaviors and decreased foraging and movement behaviors. Pishing also reduced self-maintenance behaviors whereas birder presence reduced vocal activity of birds. Potentially, all of the behavioral changes noted in birds could have negative impacts on wintering birds. Nonetheless, additional work is needed to determine if birds compensated after disturbance ended or if these brief behavioral changes can influence subsequent survival and reproduction. We suggest that resource managers should be judicious with the use of pishing and playback activities at sites during the winter, particularly if birds of conservation concern are present.

Key words: avian behavior, birdwatcher activity, management decisions, stress, winter ecology

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Ornithologists have used pre-recorded calls and songs, or playback, as well as "pishing" (vocal mimicry of avian alarm calls; Langham et al. 2006) as effective survey tools for decades (Zimmerling and Ankney 2000, Gregory et al. 2004). Playback and pishing make birds more visible (Zimmerling and Ankney 2000, Gregory et al. 2004, Zimmerling 2005), can be used to generate more accurate survey counts (Zimmerling and Ankney 2000, Gregory et al. 2004, Zimmerling 2005, Wilkins and Husak 2006), and increase the number of birds captured with mist-netting (Wojczulanis-Jakubas et al. 2016). However, amateur use of these techniques, particularly playback, by birdwatchers has generated concern because of the potential for negative effects on native birds (Millard et al. 2011, Sibley 2011). Birdwatching has increased in popularity in recent years; approximately one-fifth of the U.S. general population participates in this activity contributing more than $82 billion per year to the national economy (Carver 2009). Birdwatchers also obtain data to help direct conservation, i.e., Christmas Bird Count, the North American Breeding Bird Survey, and eBird (Sullivan et al. 2009). The increased popularity of birding (Carver 2009) has raised concern for the potential negative effects that increased foot traffic (McClung et al. 2004, Müllner et al. 2004, Millard et al. 2011) and easily available technology (mobile devices with playback available) can have on native birds (Millard et al. 2011, Sibley 2011). Despite limited research, land managers have begun to restrict the use of playback in their management areas (Sibley 2011, Harris and Haskell 2013) due to potentially negative effects on birds.

Many studies have investigated the effects of playback on birds when used in research. Typically, playback use in research is structured by explicit protocols and is only used in the particular time frame of interest, for example, during the pre-breeding (Fletcher 2007, Virzi et al. 2012, DeJong et al. 2015) or breeding seasons (Verner and Milligan 1971, Mennill et al. 2002, Mota and Depraz 2004, Zanette et al. 2011, Deviche et al. 2014). However, few studies have been conducted during the winter or non-breeding season in temperate biomes (but see: Wilkins and Husak 2006). Based on the results of experimental studies, use of playback by birders could have negligible (e.g., altered habitat selection), positive (e.g., recruitment to new or abandoned sites and accelerated reproductive development), or negative (e.g., reduced paternity, parental investment, foraging activity, and reproductive success and increased energy expenditure) effects on birds (Verner and Milligan

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1971, Kroodsma 1976, Hinde and Steel 1978, Mennill et al. 2002, Mota and Depraz 2004, Ward and Schlossberg 2004, Langham et al. 2006, Wilkins and Husak 2006, Fletcher 2007, Hahn and Silverman 2007, Zanette et al. 2011, Harris and Haskell 2013, Hua et al. 2014, DeJong et al. 2015).

Although the effects of playback are well-documented in research contexts, amateur playback use is likely different from researcher use. At popular birdwatching sites, playback can be used for extended periods each day (Harris and Haskell 2013) and throughout the year (E. Jakub, Conservación Panamá, Inc., personal communication). Other birding sites may be frequented only at particular times of year, such as during migration, and the overall popularity of a site depends greatly on human population density (Munson et al. 2010). A survey of members of LABIRD, an email bulletin board (LABIRD-L@listserv.lsu.edu) dedicated to disseminating information about birds of Louisiana, revealed that >70% of respondents used playback while birding, and of those that use playback, most use it in all seasons except the breeding season (T. J. Maness, Louisiana Tech University, unpublished data). To date, we know of only one study that has investigated the simulated effects of birdwatcher playback on bird behavior (Harris and Haskell 2013). Harris and Haskell (2013) found that plain-tailed wrens (*Thryothorus euophrys*) and rufous antpittas (*Grallaria rufula*) in Ecuador increased their vocal responses to a single bout of birder playback. With repeated exposure, the wrens habituated suggesting that long-term exposure to birdwatcher playback may cause birds to treat playback as they would a regular neighbor (Harris and Haskell 2013).

Our study was designed to determine if simulated birder use of playback or pishing altered the behavior of temperate wintering birds during and after a single bout of experimental exposure to the treatment. To our knowledge, this is the first research that has experimentally examined the effects of simulated birder playback and pishing on wintering birds. Directed research using playback in winter are rare, yet birders responding to our LABIRD survey indicated that they were most likely to use playback during the winter (T. J. Maness, unpublished data). Winter can be stressful to birds because of the potential for reduced food resources and the need to maintain body temperature when ambient temperature is low (Schwabl et al. 1985, Lima 1986).

Study Area

We had six experimental sites at two different levels of exposure to human visitation; three sites were located in an urban area within the city limits of Ruston, Louisiana, and three sites were located within Jackson Bienville Wildlife Management Area (WMA) located in Jackson and Bienville parishes, LA. The urban sites were (from most to least foot traffic) in a city park (Site 1; Garland Gregory Hide-A-Way Park; 32°32′6.90″N, 92°39′37.76″W), a city cemetery (Site 2; Greenwood Cemetery; 32°31′54.23″N, 92°38′44.66″W), and a powerline right-of-way next to an apartment complex parking lot (Site 3; Campus Evolution Villages Ruston, 32°32′09.98″N, 92°39′44.47″W). The sites in the WMA, in Jackson Parish, generally are only visited by hunters during hunting seasons, so foot traffic is presumed low, and we observed no visitors during the observation period. Sites were near trails that did not allow motorized vehicles (WMA 1: 32°22′53.31″N, 92°43′57.95″W; WMA 2: 32°23′23.41″N, 92°43′47.49″W; WMA 3: 32°23′59.17″N, 92°43′34.07″W). All sites contained open areas, stretches of shrub-scrub, and stands of pine (*Pinus* spp.) and hardwood trees within the observation area (except the cemetery, which was an open, grassy area with scattered trees and shrubs). The city park also had a pond within observation area. Birds at these sites are unlikely to have been exposed to birder playback previously because few birders report sightings in Lincoln or Jackson parishes and no eBird reports were made from these sites the year prior to, or the year of, this study (eBird 2017). Checklists of birds are available for Jefferson and Lincoln Parishes from the Louisiana Parish Checklist Project (Seidler 2017)

Methods

We conducted experimental observations from 10 to 18 February 2014. Observations occurred during the afternoon from 1300 h to 1500 h. Each observation period lasted 45 min and was split into three sections: pre-exposure (15 min before experimental exposure), during-exposure (15 min of experimental exposure), and post-exposure (15 min after experimental exposure). We had four experimental treatments: (1) no birder, (2) birder, (3) pishing, and (4) playback exposure. Each site was visited for four consecutive days (Table 1). Only one treatment was performed at each site per day and the order of experimental treatment exposure varied

Table 1. The area (urban = within city of Ruston, Louisiana; WMA = Jackson Bienville Wildlife Management Area in Jackson Parish, Louisiana), site, experimental treatment (see methods), and order of experimental presentation. Treatments were conducted from 10 to 18 February 2014 and behaviors of birds were recorded by observers in hunting blinds. The number in parentheses following the experimental treatment type indicates the total number of bird behaviors recorded in 30-s intervals over a 45-min observation period by observers during that treatment period.

		Treatment and order of presentation			
Area	Site	Day 1	Day 2	Day 3	Day 4
Urban	Site 1	No Birder (16)	Pishing (371)	Playback (250)	Birder (945)
Urban	Site 2	No Birder (130)	Birder (160)	Pishing (368)	Playback (303)
Urban	Site 3	Pishing (375)	No Birder (157)	Birder (123)	Playback (175)
WMA	WMA 1	Playback (104)	Birder (383)	Pishing (152)	No Birder (252)
WMA	WMA 2	Birder (24)	Playback (156)	No Birder (146)	Pishing (150)
WMA	WMA 3	Playback (150)	No Birder (304)	Birder (108)	Pishing (278)

at each location (Table 1) to ensure that habituation did not take place (Verner and Milligan 1971, Harris and Haskell 2013).

Each treatment scenario (except no birder treatment) included three participants: one simulated birder and two observers in observation blinds. Blinds were set up 15 min before the experiment began to allow birds to become accustomed to the blind. One observer watched bird activity through the screened windows in the blind while the second observer recorded the behaviors observed by the first observer (see behaviors below) on a tally sheet. We recorded temperature (using a weather app on mobile device and categorized as 1 = ≤5˚C, 2 = 6 –14˚C, 3 = ≥15˚C), wind speed (negligible, light, or gusts) and weather conditions (sunny or cloudy) at the beginning of the observation period. For consistency, the same birder was used in all treatments and the birder wore the same clothes each visit. To allow the birder time to travel between sites in a single day, start times (1300 h, 1345 h, and 1415 h) and days (10 or 11 February at the urban sites and 15 February at the WMA sites) were staggered. The start time was consistent within each site; for example, if the observation began at 1300 h on day 1, then observations on all other days at that site began at 1300 h. The two observers in blinds were consistent within a site, in that the same two people were present on all days that site was visited, but the observers varied among sites.

When a treatment required a birder to be present, the birder entered the area at the end of the pre-treatment period and stood 6–7 m from the blind, within view of the observers. The birder stayed within a ~2 m^2 area for the whole exposure period. When not pishing or using playback, the birder searched for birds by eye, using binoculars when a bird was spotted. For the no birder treatment, no birder entered the area. In the birder treatment, the birder entered the area after the 15-min pre-exposure period with the playback equipment turned on (see below), but no sound was played. The birder left the area at the end of the 15-min exposure period. For the (3) pishing treatment, the birder entered the area after the 15-min pre-exposure period and stood in place for 2 min. The birder then rapidly repeated a pish five times, waited 1 min, then repeated the same pishing phrase again. In all, there were five pishing bouts (25 repetitions of pish in total) which took ~4 min to complete. The birder searched for birds for the remaining 9 min of the exposure period, and then left the area. For the playback exposure, the birder entered the viewing area at the end of the pre-exposure period and stood in place for 2 min while searching for birds. The birder then used playback (birdJam iPod speaker system; MightyJams LLC, medium/high loudness setting) of northern cardinal (*Cardinalis cardinalis*) song (northern cardinal C1 typical song, 13 s duration, iBird App, Mitch Waite Group, Sausalito, California) and eastern screech-owl (*Megascops asio*) call (eastern screech-owl 2 whinny call, 15 s duration, iBird App, Mitch Waite Group, Sausalito, California). The cardinal playback was played once, the birder then scanned the area for birds for 10 s, and repeated the cardinal playback once more. After 30s the owl call was played once (15 s). In total, playback was used three times during the exposure period: two cardinal playbacks and one owl playback. The birder then spent the rest of the exposure period observing birds. We selected the cardinal song because these birds are abundant in the observation areas in winter. The LABIRD survey also indicated that birdwatchers in the area mostly use species-specific playback song to make a target bird visible and that they will play the song once or twice before leaving the area (T. J. Maness, unpublished data). The owl call was used because birders in the area often use it to make more birds visible, after species-specific song playback fails to do so (T. J. Maness, personal observation).

During each 45-min testing period, four different behavioral categories were noted by the two observers for all observed birds in the area. These included: (1) self-maintenance (preening or resting), (2) vocalization, (3) foraging (scratching ground litter, gleaning, or hawking), and (4) movement (not associated with foraging: flying, hopping, or running). The behaviors were noted instantaneously at 30-s intervals during the entire observation period. Birds could be in multiple behavioral categories if they performed different behaviors at the same time (e.g., flying and vocalizing) and an individual's behavior could be noted in multiple 30-s intervals. Given that the observers were novices (undergraduate Animal Behavior students at Louisiana Tech University) and the fact that several different species could be present at the sites, the behavior of all birds in the observation areas were pooled for analysis.

All procedures and protocols were approved by the Human Use Committee (#HUC 1163) and Institutional Animal Care and Use Committee (#2013-10A) at Louisiana Tech University.

Statistical Analysis

We tallied the total number of behaviors observed per behavioral category during the pre-, during-, and post-exposure periods separately for each observation period to reduce variability among sites due to differences in numbers of birds present or weather conditions. We used repeated measures analysis of variance (ANOVA) to assess differences within and between subject differences. Our outcome variable was the number of behaviors observed pre-, during-, and after-exposure (the repeated factor). Possible explanatory variables were: area, site, temperature, wind speed, weather conditions, order of presentation, and treatment. Our between-subject tests assessed the main effects of an explanatory variable on the outcome variable and the within-subject tests assessed differences in the total number of observed behaviors between observation periods due to an explanatory variable or its interaction with

the repeated factor. Because repeated measures analyses compare the mean difference between repeated measures to the null expectation (mean difference = 0; Zar 1999), we presented percent difference from the baseline state (pre-exposure) when a mean difference was different from the null expectation. A positive difference indicates an increase in the behavior, whereas a negative difference indicates a decrease in the behavior. Due to the small sample size, we examined the ability of single explanatory variables to explain variance in the outcome variable and selected the best model with Akaike's Information Criterion corrected for small sample sizes (AICc; Burnham and Anderson 2002). All statistical tests were performed with Statistica v.13 (Dell Inc., Tulsa, Oklahoma).

Results

Weather during the entire observation period was consistent; all days were partly cloudy to sunny and winds were negligible to light (less than 5 mph). Accordingly, we did not consider the potential explanatory variables "weather conditions" and "wind speed" in the list of candidate models, because they did not vary among the observation days. Temperature varied from 0˚C (12 February) to 24˚C (16 February), but for most (six of nine observation days) days, temperature was above 10˚C. Although we did not consider the behavior of different species separately in analyses, the birder noted the species present at the sites. Birds seen/heard at all sites, but not necessarily on all observation days, were: northern cardinal, red-bellied woodpecker (*Melanerpes carolinus*), Carolina chickadee (*Poecile carolinensis*), tufted titmouse (*Baeolophus bicolor*), Carolina wren (*Thryothorus ludovicianus*), American crow (*Corvus brachyrhynchos*), blue jay (*Cyanocitta cristata*), pine (*Setophaga pinus*) and yellow-rumped (*Setophaga coronate*) warblers, and white-throated sparrow (*Zonotrichia albicollis*). Birds that were unique to particular sites were: domestic mallard (*Anas platyrhynchos*, Site 1: city park), red-shouldered hawk (*Buteo lineatus*, Site 3; powerline right-of-way), red-cockaded woodpecker (*Leuconotopicus borealis*, all WMA sites—the area is managed for this species), eastern phoebe (*Sayornis phoebe*, WMA 1 and 2), northern mockingbird (*Mimus polyglottos*, all urban sites), brown thrasher (*Toxostoma rufum*, Site 3: powerline right-of-way), American robin (*Turdus migratorius*, Site 2: city cemetery and WMA 2), eastern towhee (*Pipilo erythrophthalmus*, Site 3: powerline right-of-way), dark-eyed junco (*Junco hyemalis*, Sites 1 and 2: city park and cemetery), and chipping sparrow (*Spizella passerine*, Sites 1 and 2: city park and cemetery). The total number of behaviors noted by observers at a site during an observation session ranged from 16 to 945 (Table 1; $\overline{X} = 232.5 \pm 37.9$ SE), but the total number was consistent on a given day at a site (e.g., consistently low or high pre-, during- and post-exposure). No site had consistently low activity across all observation days, for example, the city park (Site 1) had the lowest and highest total number of behaviors (Table 1). Vocalizations were the most commonly noted behavior (72.3%; 95% CI = 71.2–73.5), and self-maintenance was the least noted behavior (6.2%; 95% CI = 5.6–6.8).

Some behavioral categories were not observed during a session at a site, so we added one to all cells before performing the analyses to avoid empty cells in the design matrix of the repeated measures analysis. Two different models best explained between-subject variability and they included the main effects of "site" and "order of presentation." Both of these models were approximately eight times stronger than the next best model, each explaining about 20% of the variance in the data (Table 2; Burnham et al. 2011). The total number of observed behaviors varied between sites in that fewer behaviors were noted in WMA2 than were in the city park or cemetery (Figure 1). The total number of observed behaviors differed by order of presentation in that more behaviors were noted during the second and last presentations than were noted in the first presentation (Figure 2).

The model that best explained variability in activity between exposure periods (pre-, during-, and post-) included treatment as an explanatory variable (Table 3). The top model was 8.2 times stronger than the next best model and explained 21% of the variance in the repeated factor (Table 3; Burnham et al. 2011). Therefore, we only used the effect of treatment to examine how activity varied by treatment type. All behavioral categories (self-maintenance, vocalization, foraging, and movement) varied within subject by treatment (Table 4). Behavior of birds did not change under the no birder treatment conditions. In the birder treatment, the number of

Table 2. Models testing main effects of explanatory variables on the total number of bird behaviors recorded in 30ps intervals over a 45-min period (15 min pre-, 15 min during-, and 15 min post-exposure) by observers in blinds using a repeated measures ANOVA analysis. Treatments were conducted from 10 to 18 February 2014. Models are: Treatment = experimental manipulation (no birder, birder, pishing, or playback conditions), Area = urban (within Ruston, Louisiana) or Wildlife Management Area (Jackson Bienville WMA, Jackson, Louisiana) sites, Site = six different experimental locations (three in each Area: city park, cemetery, power line right-of-way, WMA1, WMA2, and WMA3), Temperature = categorized temperature at the start of the observation period (1 = ≤ 5°C, 2 = 6 –14°C, 3 = ≥15°C), and Order = sequence of experimental exposure (first – fourth). Models are ranked using Akaike's Information Criterion corrected for small sample sizes (Burnham and Anderson 2002); K indicates the number of variables included in the model (all models include intercept and error terms).

Model	AICc	DAICc	Model likelihood	AICc weight	K	Evidence ratio	Effect size
Site	255.81	0.00	1.000	0.467	3	1.00	0.21
Order	256.10	0.30	0.862	0.402	3	1.16	0.20
Treatment	260.11	4.30	0.116	0.054	3	8.59	0.09
Area	260.74	4.94	0.085	0.040	3	11.79	0.07
β (Null)	260.88	5.07	0.079	0.037	2	12.62	0.07
Temperature	260.93	5.13	0.077	0.036	3	12.97	0.07

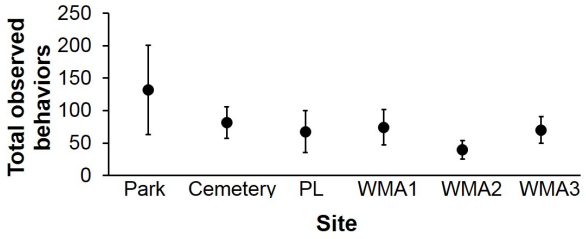

Figure 1. The total number of bird behaviors recorded in 30-s intervals over a 45-min period by observers in hunting blinds at different sites. Treatments were conducted from 10 to 18 February 2014. The sites are: park = Garland Gregory Hide-A-Way Park in Ruston, Louisiana; cemetery = Greenwood Cemetery in Ruston, Louisiana; PL = power line right-of-way in Ruston, Louisiana; WMA1-3 = three different sites in Jackson Bienville Wildlife Management Area in Jackson Parish, Louisiana. Error bars indicate 95% confidence limits.

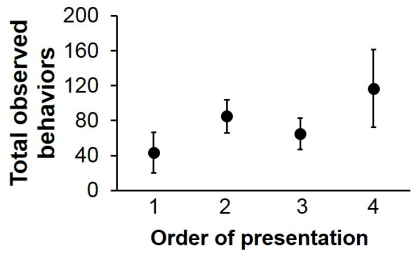

Figure 2. The total number of bird behaviors recorded in 30-s intervals over a 45-min period by observers in hunting blinds depending on order of presentation of four different experimental treatments (no birder, birder, pishing, and playback). Treatments were conducted from 10 to 18 February 2014. The order of presentation of experimental treatments was varied at six different study sites in Ruston, Louisiana, and Jackson Bienville Wildlife Management Area in Jackson Parish, Louisiana, to control for habituation of birds in the observation areas. Error bars indicate 95% confidence limits.

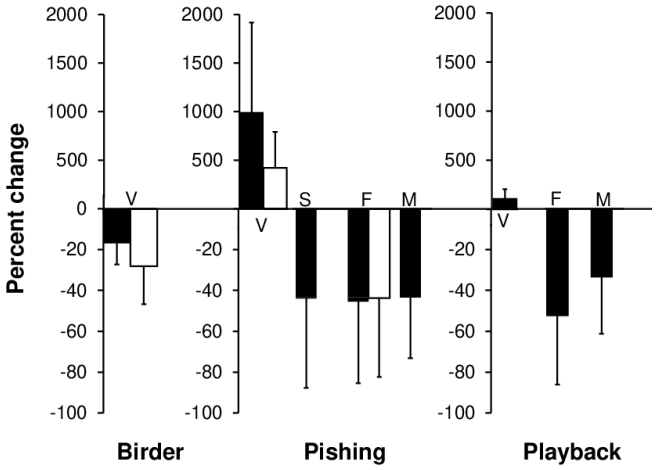

Figure 3. Percent change in the number of bird behaviors recorded during- (solid bars) and post-exposure (open bars) by observers in hunting blinds compared to the total number of bird behaviors recorded during the pre-exposure period based on type of experimental treatment (no birder, birder, pishing, and playback). Treatments were conducted from 10 to 18 February 2014. Each exposure period was 15 min long and behaviors were instantaneously recorded by observers every 30 min. Four different categories of behaviors (V = vocalizations, S = self-maintenance, F = foraging, and M = movement not associated with foraging) were tallied separately during each exposure period. Data are only presented when repeated measures ANOVA analysis revealed that the mean difference in behaviors recorded during- and post-exposure from the pre-exposure was different from the null expectation (mean difference = 0). Positive numbers indicate an increase in the behavior, negative numbers indicate a decrease in the behavior. Error bars are 95% confidence limits

Table 3. Models testing effects of explanatory variables on the total number of bird behaviors recorded pre-, during-, and post-exposure by observers in blinds using a repeated measures ANOVA analysis. Treatments were conducted from 10 to 18 February 2014. Models are: Treatment = experimental manipulation (no birder, birder, pishing, or playback conditions), Area = urban (within Ruston, Louisiana) or Wildlife Management Area (Jackson Bienville WMA, Jackson, Louisiana) sites, Site = six different experimental locations (three in each Area: city park, cemetery, power line right-of-way, WMA1, WMA2, and WMA3), Temperature = categorized temperature at the start of the observation period (1 = ≤ 5°C, 2 = 6 –14°C, 3 = ≥15°C), and Order = sequence of experimental exposure (first – fourth). Models are ranked using Akaike's Information Criterion corrected for small sample sizes (Burnham and Anderson 2002); K indicates the number of variables included in the model (all models include intercept, the repeated factor, and error terms).

Model	AICc	DAICc	Model likelihood	AICc weight	K	Evidence ratio	Effect size
Treatment	209.7	0.00	1.000	0.726	4	1.00	0.21
Site	214.0	4.22	0.122	0.088	4	8.23	
Temperature	214.6	4.90	0.086	0.063	4	11.59	
Order	214.9	5.16	0.076	0.055	4	13.22	
β (Null)	215.2	5.41	0.067	0.048	3	14.97	
Area	216.9	7.18	0.028	0.020	4	36.30	

Table 4. Models testing effect of experimental treatment (no birder, birder, pishing, and playback) on the total number of categorized bird behaviors (maintenance, vocalization, foraging, and movement) recorded pre-, during-, and post-exposure by observers in hunting blinds using a repeated measures ANOVA. Treatments were conducted from 10 to 18 February 2014. Models were ranked with Akaike's Information Criterion corrected for small sample sizes (Burnham and Anderson 2002), K is the number of variables included in the model (all models include the intercept, the repeated factor, and error terms).

Behavior	Model	AICc	Model likelihood	AICc weight	K	Evidence Ratio	Effect Size
Maintenance	Treatment	–136.6	1.000	0.821	4	1.00	0.19
	β (Null)	–133.5	0.218	0.179	3	4.59	
Vocalization	Treatment	–110.4	1.000	1.000	4	1.00	0.24
	β (Null)	–103.1	0.026	0.026	3	37.88	
Foraging	Treatment	–153.4	1.000	1.000	4	1.00	0.24
	β (Null)	–146.6	0.034	0.034	3	29.25	
Movement	Treatment	–160.8	1.000	1.000	4	1.00	0.20
	β (Null)	–155.1	0.059	0.059	3	16.93	

vocalization behaviors decreased during exposure to the birder and this difference continued after the birder left the area (Figure 3). Pishing altered all behaviors: the number of vocalization behaviors increased during and after exposure, self-maintenance behaviors decreased during exposure, foraging behaviors decreased during and after exposure, and movement behaviors decreased during exposure (Figure 3). Playback treatment altered vocalization, foraging, and movement behaviors during exposure only. Vocalizations increased, while foraging and movement behaviors decreased (Figure 3).

Discussion

In our study, the total number of bird behaviors observed differed between sites and by the order of presentation (Figures 1 and 2). Differences in the number of observed behaviors among sites are to be expected, since some habitats may be preferred over others (Hutto 1985, Sherry and Holmes 1996) and behavior of some species may be easier to observe than others, such as a mallard on a pond versus a songbird in vegetation. Sites accounted for little variance in the repeated factor (Table 3), so behavior did not change from one exposure period to another due to site differences. Order of presentation possibly could have influenced bird behavior in that the birds at the sites may have become accustomed to the hunting blind over time or the observation ability of the student observers may have improved over time. In either case, certain behaviors did not become more prevalent or more readily observable in particular exposure periods because order of presentation did not explain much variance in the repeated factor (Table 3).

Birder presence, pishing, and playback exposure all altered the behavior of birds with pishing affecting bird behavior the most in that all behavioral categories changed (Figure 3). Birder presence had the opposite effect on the vocalization behavior of the birds than did pishing and playback exposure (Figure 3). Birder presence reduced bird vocalizations for at least 30 min but ended to increase after the birder left the area (Figure 3). Reduced vocalization behavior may indicate increased fear of predation (De Haas et al. 2012). Many animals exhibit reduced motor activity or freezing behavior, including reduced vocalizations, when attempting to hide from potential predators (Eilam 2005). However, movement and foraging of birds did not change across exposure periods, so the reduction in vocal activity during- and post-exposure to a silent birder may be related to induced antipredator vigilance (Beauchamp 2015) of some birds in the observation area.

Pishing and playback treatments altered bird behavior in similar ways; both increased vocalization behavior and decreased foraging and movement behaviors (Figure 3). Pishing also reduced self-maintenance behaviors, tending to induce more dramatic and prolonged changes in vocalization behavior than did playback, and reduced foraging for a longer period than did playback (Figure 3). Pishing is thought to increase the detectability of birds by inducing a generalized mobbing response in the birds that hear it (Zimmerling and Ankney 2000, Langham et al. 2006). Because pishing induces a generalized response in bird communities (Langham et al. 2006), more species are likely to respond to pishing (Zimmerling and Ankney 2000, Zimmerling 2005, Langham et al. 2006) than would respond to a species-specific song. Although we did not consider the response of different species during the observation periods, the behavioral response to playback may have been driven primarily by cardinals, whereas the response to pishing is likely to have been driven by the response of multiple species. This may explain why pishing altered more behaviors and some behavioral categories for a longer period of time than did playback. Additional research that follows the responses of different species to pishing and playback is needed to assess this possibility. Playback of predator calls could induce a mobbing response in some species (Lynch 1995, Wilkins and Husak 2006); however, we used eastern screech-owl song during playback exposure only once and after we played northern cardinal songs. Birds may have a stronger response to repeated predator song playback, and this also warrants further investigation.

Potentially, the behavioral changes observed in all simulated birder exposures could reduce the probability of overwinter survival, with the greatest potential for negative impacts found in the pishing treatment and the least in the birder treatment. Altered vocal activity may indicate increased stress (Harris and Haskell 2013), aggression (Amy et al. 2010, Jacobs et al. 2014), or fear (De Haas et al. 2012) and could increase energy mobilization through activation of the hypothalamic-pituitary-adrenal axis (i.e., stress response; Wingfield et al. 1998). Additionally, vocal activity can attract and expose individuals to predators (Millard et al. 2011). Reduced foraging activity implies that birds spent less time gathering food at a time of increased energy use from increased vocal activity (Oberweger and Goller 2001) and potential stress responses. Reduced self-maintenance behaviors, such as preening, may increase damage inflicted by ectoparasites (Clayton et al. 2010). However, birds may have compensated by increasing foraging and self-maintenance behaviors after we concluded observations. As such, brief changes in behavior (15–30 min) may not have a significant impact on survival or subsequent fitness, unless birds were already under duress. Longer post-treatment observation periods are needed to determine how long the treatment altered the birds' behavior and if birds eventually compensate by increasing foraging or self-maintenance behaviors. Birds also would need to be tracked to determine if survival or fitness was compromised in comparison to untreated birds.

The use of playback by amateur birders often is regulated in refuges and management areas because of the potential for negative effects for altering bird behavior (Sibley 2011, Harris and Haskell 2013). To our knowledge, pishing is not included with restrictions on playback use. The question of whether such brief changes in behavior, in the absence of other stressors, lead to long-lasting negative effects on birds remains an open question. Any potential negative impacts to birds are likely to be localized to popular sites that are frequented by birders. Sites that are further from vis-

itor centers or guided walks/drives are less likely to be impacted. Resource managers need to find a balance between the value of allowing visitors to appreciate wildlife, data obtained about bird presence and distribution by citizen scientists, and the potential negative impacts of disturbance. We suggest that resource managers discourage pishing and playback activities at sites during the winter, particularly if birds of conservation concern are present.

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