Importance of Volunteer Training and Identification Ability on Results of Great Lakes Marsh Monitoring Program Bird Surveys

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Abstract Citizen scientists are increasingly called upon to help monitor wildlife populations such as marsh birds. Volunteer participation in monitoring can be beneficial by contributing important information for managers, often at such a large scale that the data would otherwise be unobtainable. Such programs have also been the subject of scrutiny, with concerns arising mainly from questions of data quality. The specific objectives of this study are 1) to assess the effectiveness of training to improve volunteers' ability to identify marsh birds and 2) to determine how such an ability may affect the results of bird surveys conducted through Bird Studies Canada's Great Lakes Marsh Monitoring Program. In self-administered tests, training materials improved volunteers' accuracy by 11–25% on visual and aural identification. In the field, total bird abundance and species richness were unaffected by test scores, but species composition differed based on ability. Volunteers with poorer identification skills detected more obligate marsh bird species and this affected the Index of Biotic Integrity (IBI) scores calculated at one of the sites. However, when the IBI scores were pooled for all volunteers, the data accurately reflected the degree of disturbance at each site. Our results confirm that training contributes to the ability of MMP volunteers to monitor the health of Great Lakes wetlands and that useful information on MMP surveys can be collected by volunteers with different levels of skill in identification; however, IBIs based on results collected by a single volunteer with unknown ability should be carefully scrutinized.

Introduction

Ecological monitoring is important for tracking changes in wildlife populations and ecosystem health due to development, environmental pollution, climate change, and other stressors. Citizen-science environmental monitoring programs are cost effective, covers a large geographic area, have high data comparability over years (often the same observer collects the data), and provide opportunities for citizens to act as environmental stewards and become engaged in managing their local environment (Savan et al. 2003; Droege 2007). Volunteer environmental monitoring programs also have challenges, some of which include maintaining volunteer interest and ensuring data quality (Whitelaw et al. 2003).

Citizen-science programs differ greatly in their training and data-quality control measures. For instance, only 39% of citizen-science programs (50 of 128) focusing on invasive species had any form of data quality control that included aspects such as training, validation of species identification/location or quality assurance of data (Crall et al. 2010). With regards to volunteer macroinvertebrate monitoring organizations, 57% (72 of 126) had some sort of internal quality assurance plan and 50% (64 of 128) had their samples validated by professionals (Frost-Nerbonne and Nelson 2008). Avian volunteer programs are one of the most popular types of citizen monitoring programs with some providing training kits to participants (Bonney et al. 2009; MMP Handbook 2009), and few insisting on volunteer testing after providing training tools and prior to sampling (e.g., Cohn 2008; Mountain BirdWatch, Vermont Centre for Ecostudies). This apparent lack of standardization of data quality among citizen-science programs may be an impediment to using volunteer data in scientific publications.

Previous studies on the accuracy of volunteer-based surveys have shown mixed results. Citizens produced results similar to professionals for stream water quality and benthic invertebrate surveys, indicating that volunteer data are sufficient for providing early warning of poor conditions (Fore et al. 2001; Mayfield et al. 2001). In some anuran surveys, volunteers provided reliable species identification and abundance estimation irrespective of their experience (Genet and Sargent 2003), while in others, results were dependent on volunteer experience (Shirose et al. 1997). Similarly for birds, citizens with advanced identification ability counted more bird species and individuals in some programs (Faanes and Bystrak 1981; Sauer et al. 1994; Kendall et al. 1996), but not in others (McLaren and Cadman 1999). The ability of volunteers to assess habitat for Bird Studies Canada's Great Lakes Marsh Monitoring Program (MMP) is comparable to more-detailed surveys by professionals (Crewe and Timmermans 2003). What is not known, however, is the extent to which volunteers' identification ability may influence survey results or whether or not training materials can improve the quality of citizen-collected data during bird surveys. In this study, we will 1) assess the effectiveness of training materials for improving identification ability of volunteers and 2) determine how volunteer identification ability affects the results of MMP bird surveys.

Materials and Methods

Volunteers were recruited from high schools, universities, local bird study groups, and an MMP training workshop in the vicinity of Hamilton, Ontario. We used deception methodology to keep volunteers unaware of the specific question we were attempting to answer, although we did make them aware that we were interested in studying the outcomes of MMP surveys. The methodology was approved by the McMaster University Research Ethics Board and has received ethics clearance (MREB 2011-038).

Self-administered Tests

We used two standard self-administered tests to assess the effectiveness of training materials and volunteers' ability to identify marsh birds, one taken before using training materials (pretest) and the other taken after using training materials but prior to conducting field surveys (posttest). Training materials consisted of the MMP Participant's Handbook for Surveying Marsh Birds (MMP 2009) and the MMP Training CD (2008 edition), the same materials used by regular volunteer participants in the program. Each test consisted of 19 individual calls of different species and color images of 33 marsh birds. Table 1 shows a list of species included and whether the volunteers were tested on visual identification, aural identification or both. We included only males for visual identification and only territorial calls for aural identification.

After taking the pretest, volunteers were asked to use the training resources to practice as much as they would if they were going to participate in the MMP as a regular volunteer. Both pretests and posttests were mailed to volunteers; however, the posttest was sealed in an envelope and was not to be opened and taken until after the training materials had been used but prior to field surveys. Posttests contained the same species found in the pretests, except that the order was randomized, and new photos were used. Volunteers were asked to take the posttest after all training had been completed and as close as possible to the field surveys.

Field Surveys

Surveys were conducted in Ontario, Canada at an environmentally degraded wetland of poor quality — Grindstone Creek Marsh (8 June 2011) — and a less-degraded wetland of good quality — Big Creek Marsh in the Long Point marsh complex (4 June 2011; Fig. 1). Chow-Fraser (2006) assessed the wetland quality of 110 wetlands throughout the Great Lakes and identified Grindstone Creek as being “highly degraded” and Big Creek Marsh as being “moderately degraded” on the basis of human-induced water quality degradation. Volunteers conducted field surveys as a group at three points in one or both wetlands, following standard MMP bird survey protocol. Participants did not discuss the results of their surveys. After all the counts were completed, we collected the data and the volunteers completed a basic questionnaire including questions on past birding experience, age, visual and aural impairment, and total time spent training.

Statistical Analyses

To measure total abundance, we averaged the number of birds from all species combined across the three surveys. Species richness was the cumulative number of species detected across the three surveys. Simple linear regression was used to determine any influence of age of volunteer or years of bird-watching experience on overall test scores. We used the Index of Marsh Bird Community Integrity (IMBCI; DeLuca et al. 2004) and the MMP Index of Biotic Integrity (IBI; Crewe and Timmermans 2005) as measures of wetland quality. Both indices relate the amount of surrounding anthropogenic land use to wetland bird richness or abundance, with higher scores indicating higher environmental quality.

We used a repeated measures analysis of variance to examine how test number (repeated measure: first or second) and test type (aural or visual) affected volunteer test scores (% of species correctly identified). We also used a repeated measures analysis of variance to examine how test number and species grouping (focal or non-focal; Table 1) affected volunteer test scores.

We used simple linear regression to determine the effect of avian identification ability (% of species correctly identified on tests) on total abundance, abundance of each species, species richness, IMBCI, and the MMP IBI at the better quality site (Big Creek) and poorer quality site (Grindstone Creek) separately. We used an independent t-test to compare IMBCI and MMP IBI values between sites. STATISTICA™ (StatSoft 2001) was used for all analyses and statistically significant differences were considered at $p \leq 0.05$.

Results

Volunteer Demographics

Of 31 packages mailed to volunteers, 12 returned the self-administered tests (39%) and 11 (36%) participated in the field surveys. Volunteers were 34.3 ± 18.5 (mean ± SD) years of age (range: 19 – 71) and reported training for 5.7 ± 5.3 hours (range 1 – 18).

Self-administered Tests

There was no significant effect of age ($R^2 = 0.114$, $F_{1,10} = 1.289$, $p = 0.283$) or number of years of bird-watching experience ($R^2 = 0.355$, $F_{1,5} = 2.755$, $p = 0.158$) on overall test scores. There was a significant improvement in test scores between the pretest and posttest ($F_{1,22} = 12.6$, $p < 0.01$; Fig. 2). Scores on aural and visual tests were statistically the same ($F_{1,22} = 2.20$, $p = 0.152$; Fig. 2).

In general, focal species were identified poorly compared to non-focal species on both aural and visual identification in the pretest (Fig. 3). Improvements were greater for the visual identification of focal species than for non-focal species as indicated by a significant interaction effect ($F_{1, 31} = 7.446$, $p = 0.01$; Fig. 3b). There were similar improvements with training for the aural identification of both focal and non-focal species ($F_{1, 17} = 0.048$, $p = 0.829$; Fig. 3a).

Field Surveys

Nine volunteers surveyed at the poorer quality wetland (Grindstone Creek), six at the better quality wetland (Big Creek), and four at both locations. There was no significant effect of identification ability on total bird abundance (Good quality: $R^2 = 0.34$, $F_{1,5} = 2.515$, $p = 0.174$; Poor quality: $R^2 = 0.004$, $F_{1,8} = 0.03$, $p = 0.868$; Fig. 4a) or species richness (Good quality: $R^2 = 0.09$, $F_{1,5} = 0.475$, $p = 0.522$; Poor quality: $R^2 = 0.03$, $F_{1,8} = 0.224$, $p = 0.649$; Fig. 4b). There was also no significant effect (all $p > 0.05$) of identification ability on abundance of Common Moorhen (*Gallinula chloropus*), Pied-billed Grebe (*Podilymbus podiceps*), Red-winged Blackbird (*Agelaius phoeniceus*), Marsh Wren (*Cistothorus palustris*), Tree Swallow (*Tachycineta bicolor*), Barn Swallow (*Hirundo rustica*), Black Tern (*Chlidonias niger*), Swamp Sparrow (*Melospiza georgiana*), Song Sparrow (*M. melodia*), or Common Yellowthroat (*Geothlypis trichas*) at the good quality wetland nor Red-winged Blackbird, Song Sparrow, Common Yellowthroat, Yellow Warbler (*Dendroica petechia*), Mallard (*Anas platyrhynchos*), Green Heron (*Butorides virescens*), or Great-crested Flycatcher (*Myiarchus crinitus*) at the poor quality wetland. It is worthwhile to note that even though no statistically significant differences were apparent, volunteers with advanced identification ability tended to count more individuals for every species we analyzed.

We found no significant effect of avian identification ability on the IMBCI ($R^2 = 0.25$, $F_{1,5} = 1.70$, $p = 0.249$; Fig. 4c) or the MMP IBI ($R^2 = 0.05$, $F_{1,5} = 0.26$, $p = 0.630$; Fig. 3d) at Big Creek. By contrast, there was a significant effect of ability on the IMBCI ($R^2 = 0.49$, $F_{1,8} = 7.69$, $p = 0.024$; Fig. 4c) and the MMP IBI ($R^2 = 0.47$, $F_{1,8} = 7.17$, $p = 0.028$; Fig. 4d) at Grindstone Creek, with more experienced volunteers unexpectedly producing lower scores. However, when data from all volunteers were pooled, there was a significant difference in the IMBCI and MMP IBI scores between locations (IMBCI: $t_{13} = 4.61$ $p < 0.001$; MMP IBI: $t_{13} = 6.02$, $p < 0.0001$; Fig. 5), with lower mean scores for the poorer quality wetland and higher for the better quality wetland.

Discussion

We found improvements in aural and visual identification ability between the pretest and the posttest, a finding that is consistent with other literature (e.g., Kepler and Scott 1981). Aural identifications improved to a greater degree (25%) compared with visual identifications (11%) and this is an encouraging result since identification by sound is more important in bird surveys (Faanes and Bystrak 1981). Aural identification is also especially important in marshes because secretive marsh birds are more likely to be detected aurally than visually (Gibbs and Melvin 1993).

Contrary to the literature (e.g., Faanes and Bystrak 1981; Sauer et al. 1994, Kendall et al. 1996) neither total species richness nor total abundance on MMP bird surveys in this study were dependent on a volunteer's ability to identify marsh birds correctly. Our results are more consistent with those of McLaren and Cadman (1999), who did not find a significant difference in individual species abundances between novice and advanced observers; however, they found that novices tended to report fewer individuals, whereas we were unable to discern this difference, probably because of our small sample size. Repeating our study with larger sample sizes may confirm this finding.

The significant effect of volunteer ability on the results of both indices of biotic integrity at Grindstone Creek, the poorer quality wetland, was contrary to our expectations. Higher scores are the result of higher counts of marsh-obligate species, which tend to be secretive and more difficult to detect, and the literature suggests that advanced observers can identify more of these species and enumerate more individuals than novices. We therefore expected that higher IMBCI and MMP IBI scores would have been associated with the more skilled birders. In Grindstone Creek, however, it was the novice volunteers who detected more marsh obligate species than did the advanced observers and since we know that this wetland is degraded, we suspect that the less-skilled participants had misidentified the marsh-obligates.

These results show that there is higher variability in the data obtained by less experienced volunteers relative to more experienced volunteers, which is in accordance with the literature (McLaren and Cadman 1999; Danielson et al. 2005; Cohn 2008). New birders may be affected by bias (expecting marsh-obligate presence), conflicts of interest (recording data geared towards an organization's/previous volunteer's experience), and lack of measurement experience (i.e., call variability, proximity, abundance) (Faanes and Bystrak 1981, Danielson et al. 2005).

When both IMBCI and MMP IBI scores were pooled by location, the better quality wetland had significantly higher scores than did the poorer quality. This is consistent with the previous assessments of Grindstone Creek and Big Creek Marsh (Chow-Fraser 2006; Smith and Chow-Fraser 2010a; Smith and Chow-Fraser 2010b). It is also worth noting that the rankings of the quality for these wetlands were the same for the two indices, suggesting that even though different criteria are involved, these indices provide comparable results for identifying wetland integrity.

There is a consensus that studies should be conducted, whenever feasible, to determine discrepancies in data between professionals and non-professionals (Danielson et al. 2005; Crall et al. 2010), which will then provide best advice for designing protocols with maximum output. The evidence from this small pilot study indicates that less experienced volunteers may misidentify marsh obligate species in small, degraded wetlands. This needs to be verified by conducting a larger-scale study, the results of which will then provide useful advice to a valuable program such as the MMP. We acknowledge that data provided by citizen scientists can provide information regarding trends and this needs to be researched further with more intensive studies (Bonney et al. 2009). In this case, a more intensive study may show that the MMP would benefit from an iterative sampling design, where volunteers with differing skill levels are assigned tasks based on their ability (Crall et al. 2010), thereby still contributing valuable data to a continuous large-scale monitoring program.

Since differences in volunteers' ability to correctly identify marsh birds led to discrepancies in IBI's, the MMP should consider incorporating standardized tests in order to ensure volunteers are at a standard and comparable skill level (McLaren and Cadman 1999). This method has been applied by DeLaney et al. (2008), whose aim was to determine the ability of volunteers to identify two intertidal crab species; they found differences in accuracy based on education (which included age) and difficulty level. Similarly, Mountain BirdWatch (Vermont Centre for Ecostudies) requires volunteers to take an online test after training, and assigns monitoring tasks based on experience, whereby those participants with high ability are asked to count all bird species encountered, and those with lower ability are asked to focus on only five bird species on their transect (Cohn 2008).

We recommend that volunteer programs should incorporate both visual and aural training materials when possible. Similarly, it may be useful to include additional aural recordings that emulate real-time field surveys with numerous bird species calling simultaneously, to better prepare volunteers for a more representative field experience. Both auditory and visual tests should be applied until new volunteers achieve a satisfactory passing grade. Another aspect to consider is quality control; if organizations plan to use volunteer data to evaluate long-term trends, some level of data checking should be implemented to ensure that potential misidentifications are excluded (Danielson et al. 2005; Bonney et al. 2009; Crall et al. 2010).

Our study has shown that volunteers can improve their ability to identify birds by both sight and sound by training for both focal and non-focal marsh bird species. Volunteers had similar abundance and species richness estimates regardless of avian identification ability; however, when community-based monitoring programs seek to calculate indices, it may be worthwhile to account for variability in index scores. Some future directions for this research include repeating this study on a larger scale to increase volunteer sample sizes, and to develop new training software for volunteers and to test its effectiveness.

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Table 1 Species included in self-administered tests for volunteers

Grouping	Common name	Latin name	Visual	Aural
Focal species	American Bittern	*Botaurus lentiginosus*	x	x
	Black Rail	*Laterallus jamaicensis*	x	x
	Common Moorhen	*Gallinula chloropus*	x	x
	American Coot	*Fulica americana*	x	x
	King Rail	*Rallus elegans*	x	x
	Least Bittern	*Ixobruchus exilis*	x	x
	Pied-billed Grebe	*Podilymbus podiceps*	x	x
	Sora	*Porzana Carolina*	x	x
	Virginia Rail	*Rallus limicola*	x	x
	Yellow Rail	*Coturnicops noveboracensis*	x	x
Other marsh obligate species	Black Tern	*Chlidonias niger*	x	x
	Swamp Sparrow	*Melospiza georgiana*	x	x
	Marsh Wren	*Cistothorus palustris*	x	x
	Wilson's Snipe	*Gallinago delicata*	x	x
Other species	American Goldfinch	*Carduelis tristis*		x
	Bank Swallow	*Riparia riparia*	x	
	Barn Swallow	*Hirundo rustica*	x	
	Cliff Swallow	*Petrochelidon pyrrhonota*	x	
	Purple Martin	*Progne subis*	x	
	Tree Swallow	*Tachycineta bicolor*	x	
	Belted Kingfisher	*Ceryle alcyon*	x	
	Black-crowned Night-Heron	*Nycticorax nycticorax*	x	
	Canada Goose	*Branta canadensis*	x	
	Common Grackle	*Quiscalus quiscula*	x	
	Common Yellowthroat	*Geothlypis trichas*		x
	Great-blue Heron	*Ardea herodias*	x	
	Mallard	*Anas platyrhynchos*	x	
	Mute Swan	*Cygnus olor*	x	
	Osprey	*Pandion haliaetus*	x	
	Red-winged Blackbird	*Agelaius phoeniceus*		x
	Ring-billed Gull	*Larus delawarensis*	x	
	Song Sparrow	*Melospiza melodia*		x
	Yellow Warbler	*Dendroica petechia*		x

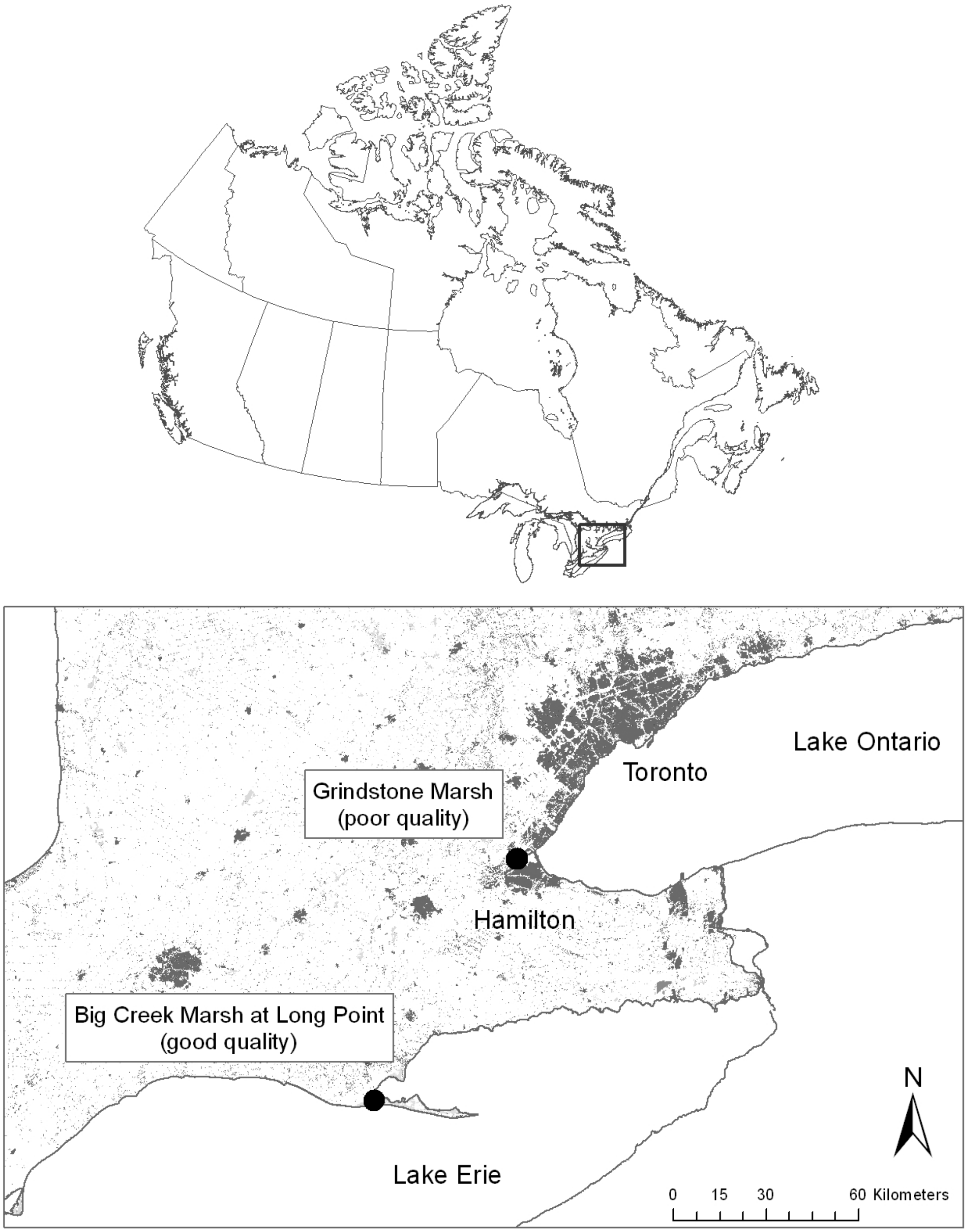
Fig. 1 Study sites used for field surveys. Grindstone Marsh represented a poor quality marsh and Big Creek Marsh represented a good quality marsh. Dark-shaded land areas show more intense levels of urbanization

Fig. 2 Effect of training, shown as first and second aural and visual tests, on the proportion of correct identifications. Error bars are ± 1 SE

Fig. 3 Effect of training, shown as first and second (a) aural and (b) visual tests, on the proportion of correct identifications for focal and non-focal species. Error bars are ± 1 SE

Fig. 4 Effect of avian identification ability on (a) average bird abundance, (b) species richness, (c) IMBCI, and (d) MMP IBI from volunteer field surveys at a poor quality wetland (Grindstone Marsh; closed circles and solid line) and a good quality wetland (Big Creek Marsh at Long Point; open circles and dashed line)

Fig. 5 Average IMBCI and MMP IBI scores based on data from all volunteers at a poor quality and good quality marsh



Lake Ontario
Toronto
Grindstone Marsh
(poor quality)
Hamilton
Big Creek Marsh at Long Point
(good quality)
Lake Erie
N
0 15 30 60 Kilometers

Fig. 1.

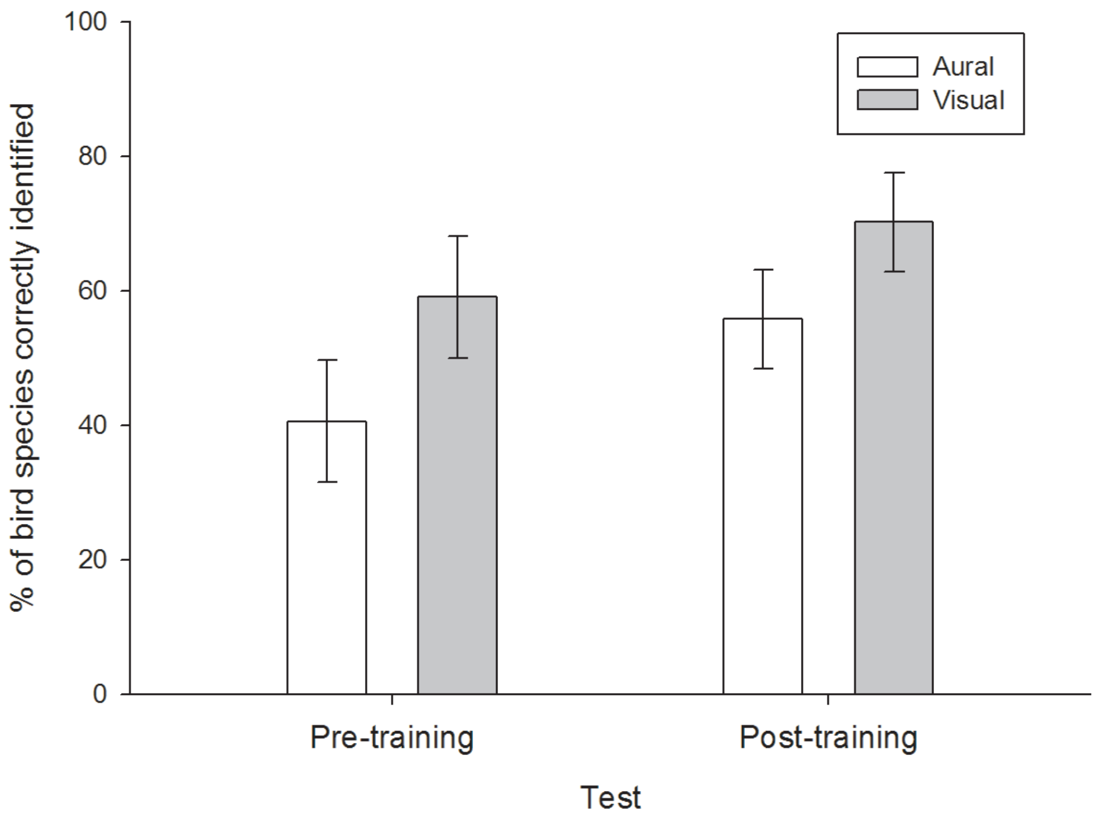
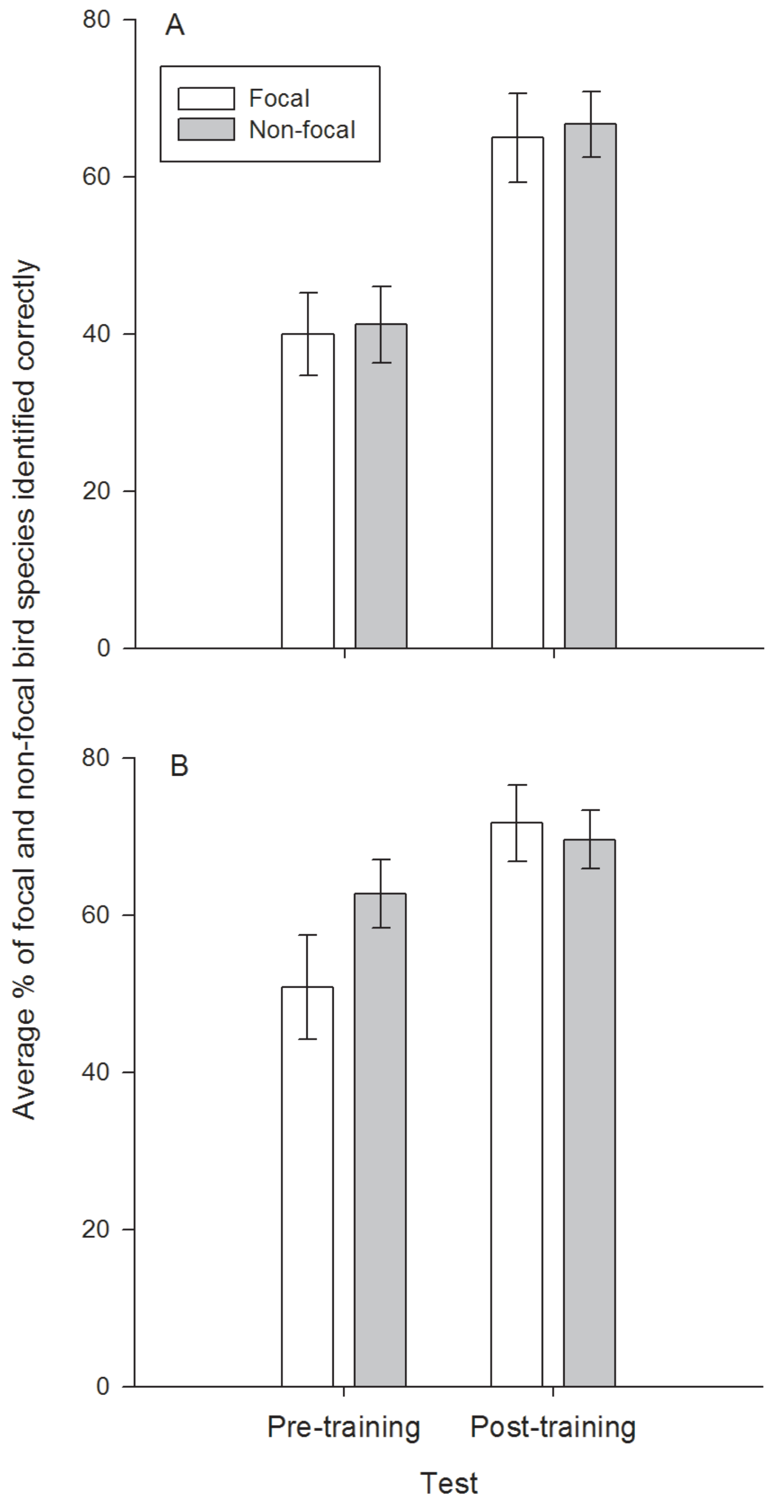
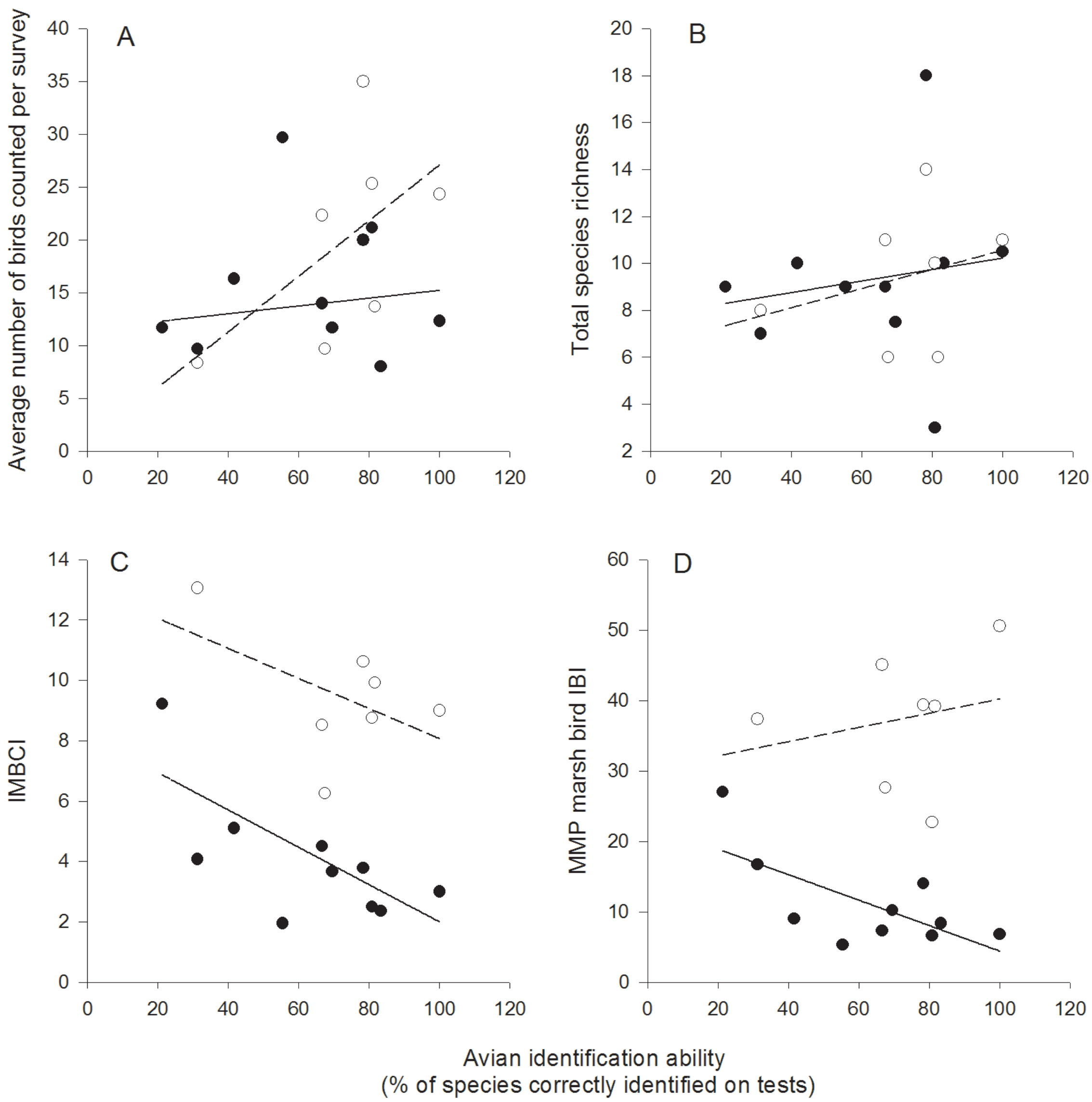

100
80
60
40
20
0
% of bird species correctly identified
Aural
Visual
Pre-training
Post-training
Test

Fig. 2.



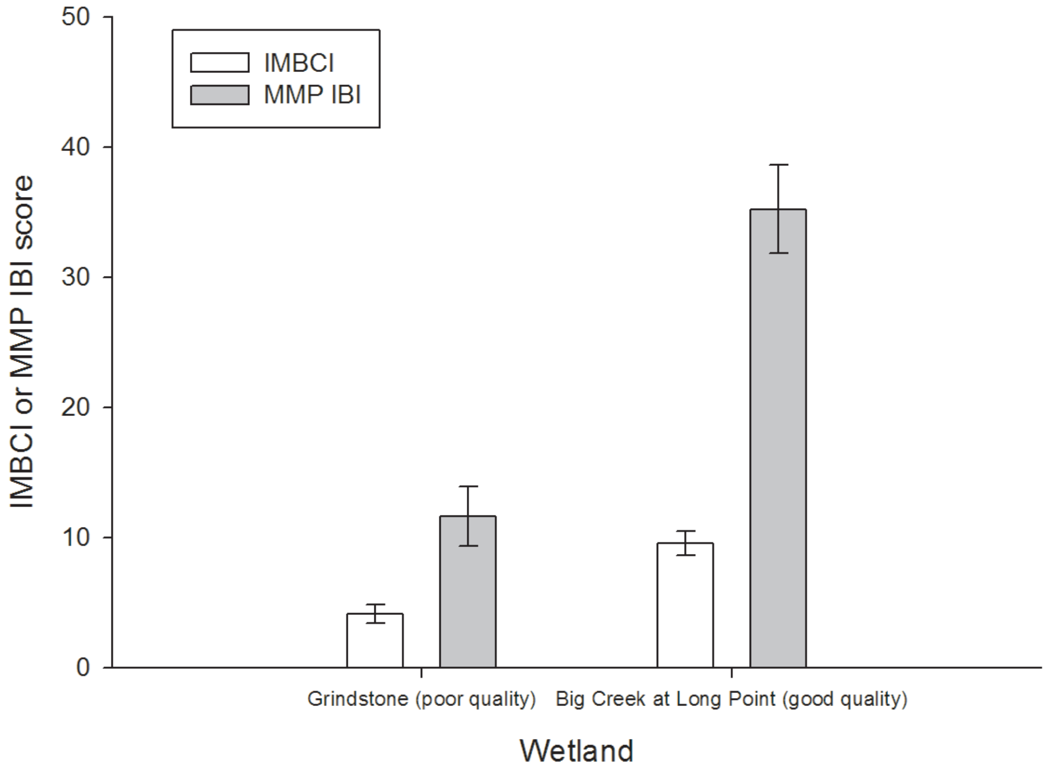
A
Focal
Non-focal
B
80
60
40
20
0
Average % of focal and non-focal bird species identified correctly
Pre-training
Post-training
Test

Fig. 3.



A
Average number of birds counted per survey
B
Total species richness
C
IMBCI
D
MMP marsh bird IBI
Avian identification ability
(% of species correctly identified on tests)

Fig. 4.



50
40
30
20
10
0
IMBCI
MMP IBI
IMBCI or MMP IBI score
Grindstone (poor quality)
Big Creek at Long Point (good quality)
Wetland

Fig. 5.