Florida Field Naturalist

PUBLISHED BY THE FLORIDA ORNITHOLOGICAL SOCIETY

VOL. 43, NO. 4 NOVEMBER 2015 PAGES 139-201

Florida Field Naturalist 43(4):139–147, 2015.

ACCURACY ASSESSMENT OF A JAY WATCH POST-REPRODUCTIVE SURVEY OF FLORIDA SCRUB-JAYS (*Aphelocoma coerulescens*)

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Abstract.—We assessed the accuracy of the Jay Watch survey methodology in conjunction with ongoing Florida Scrub-Jay (*Aphelocoma coerulescens*) research in the Ocala National Forest during 2012 and 2013. We compared the numbers of family groups, adults, and fledglings estimated during Jay Watch post-reproductive surveys with the same parameters obtained through demographic monitoring on the same study sites. We found close agreement between estimates derived from short-term Jay Watch surveys (conducted by teams of volunteers and trained staff) and the same parameters obtained through intensive demographic monitoring by a full-time field biologist. Intraclass correlation coefficients between data sources were high (0.83–0.95). We found some discrepancies in fledgling numbers between Jay Watch and demographic monitoring, but such discrepancies were uncommon and most likely to occur in densely vegetated forest stands that were populated by multiple family groups that each had fledglings. Some of our Jay Watch participants were skilled biologists with prior experience with Florida Scrub-Jays, which may have increased the accuracy of our results.

Volunteers have become increasingly important in collecting survey and monitoring data on biological organisms in a wide range

of ecological projects. Citizen-science projects enable scientists to address research questions across broad spatial and temporal scales with large data sets while providing opportunities for volunteers to increase their understanding of and appreciation for the natural environment. Because birdwatching is popular among the general public, bird-monitoring projects have been among the most successful in integrating citizen scientists (e.g., Sullivan et al. 2009). Studies have examined various characteristics of citizen-science projects that affect data quality (Lewandowski and Specht 2015), but relatively few have compared the accuracy of data collected by volunteers with that of data collected by biologists who use more intensive survey methods at the same locations.

"Jay Watch" was created in 2002 by the Lake Wales Ridge Ecosystem Working Group with the primary goal of using volunteers to conduct annual assessments of Florida Scrub-Jay (*Aphelocoma coerulescens*) populations throughout the region (TNC 2010). The Florida Scrub-Jay, the only bird species endemic to Florida, is listed as threatened by the Florida Fish and Wildlife Conservation Commission (FWC) and the U.S. Fish and Wildlife Service (USFWS 1987). The species is non-migratory, largely sedentary, and lives in extended family groups that cooperatively defend the territory and care for young (Woolfenden and Fitzpatrick 1984). Jay Watch was initially coordinated by The Nature Conservancy (TNC) with direction from Archbold Biological Station. Since 2012, the program has been coordinated by Audubon of Florida with assistance from various partners including FWC. Each year, the Jay Watch program coordinator works with professional biologists to train volunteers in using playback surveys to monitor scrub-jay populations during the post-reproductive period (June–July). Although the program is now widely used (68 sites were monitored in 2014; M. Korosy, unpublished data), there have been limited efforts to rigorously assess the accuracy of these data on a site-by-site basis (TNC 2008).

We conducted an accuracy assessment of Jay Watch survey methodology in conjunction with ongoing Florida Scrub-Jay research at the Ocala National Forest (ONF). Our primary objective in this study was to assess whether we could use the Jay Watch protocol effectively in our study population to increase the number of sites that we monitor while maintaining data quality. Our secondary objective was to use our findings to make general recommendations about the Jay Watch protocol and its use elsewhere. Specifically, we compared the numbers of family groups, adults, and fledglings estimated using Jay Watch surveys with the same parameters obtained through more intensive demographic monitoring on the same study sites.

METHODS

Study site.—ONF supports the largest remaining Florida Scrub-Jay population (Stith et al. 1996) and is one of three areas critical to the recovery of the species (USFWS 1987). Located in Marion, Lake, and Putnam counties, ONF encompasses approximately 91,000 ha (225,000 acres) of scrub and sand pine (*Pinus clausa*) habitat, which are managed for multiple objectives including forest products, wildlife habitat, and recreation (USFS 1999). The ONF landscape is unique in that suitable habitat for Florida Scrub-Jays occurs in hundreds of small clear-cut patches within an extensive matrix of forest habitat unsuitable for scrub-jays. Most stands are roller chopped and reseeded with sand pine after they have been clear-cut. Ongoing research at ONF seeks to identify how forest management and landscape configuration influence scrub-jay population density and annual productivity. Forest stands used in this assessment ranged from 12 to 62 ha in size and 1 to 10 years postharvest.

Field methods for demographic monitoring.—Within selected focal stands, we color-banded scrub-jays and visited their territories regularly to assess family group composition and breeding status (e.g., Woolfenden and Fitzpatrick 1984). Our goal was to band at least one member of each family group. We trap tamed scrub-jays with walk-in, single-cell Potter traps and drop traps constructed of welded wire and baited with peanuts. Each banded individual received a U.S. Geological Survey aluminum band and a unique combination of three plastic color bands. During April–June of 2012 and 2013, a full-time trained biologist (hereafter "lead biologist") conducted regular monitoring and territory mapping on the sites without the use of playback recordings. The lead biologist visited each focal stand regularly (typically at 4- to 5-day intervals, sometimes more frequently) to assess the status of each family group and maintain an ongoing roster of its members. Breeding status was determined in the field through vocalizations (the female-specific "hiccup" call) and behavior (Woolfenden and Fitzpatrick 1984, 1996), and special care was taken to note the location of territorial encounters between neighboring groups (Fitzpatrick et al. 1991, Bibby et al. 1992). Observations were recorded in the field on aerial photos ranging in scale from 1:2,400 to 1:13,000.

Field methods for Jay Watch surveys.—Jay Watch uses territory mapping methods that emphasize the importance of obtaining simultaneous registrations of birds from neighboring territories (Fitzpatrick et al. 1991). Playbacks elicit territorial vocalizations and encounters between scrub-jays during the post-reproductive period (late June–early July), when juveniles can be easily distinguished from adults by plumage and behavior. We established survey points 150 m apart (sometimes closer or farther apart depending on the configuration of the stand) for the Jay Watch monitoring protocol. Teams of paired observers played recordings of Florida Scrub-Jay territorial calls (most of which we had recorded locally at ONF) at each survey point to elicit responses from resident scrub-jays. Each survey point was visited ≥3 times on non-consecutive mornings. Territorial interactions and other clues (e.g., group composition, direction of travel, presence of color bands) were used to map approximate territory boundaries and to enumerate group members. Use of paired observers maximized the likelihood of maintaining visual contact with observed scrub-jay families and helped avoid double counting. Maps and data sheets were interpreted afterward by analysts using consistent rules to determine the number of family groups, adults, and fledglings.

We trained most participants 4-6 weeks prior to the surveys. As is usually done with Jay Watch elsewhere (C. Millett and M. Korosy, personal communication), we paired more experienced participants with less experienced participants during surveys. Unlike most other Jay Watch surveys, our more experienced participants sometimes included trained wildlife biologists. For example, the lead biologist often participated in Jay Watch surveys. Other less skilled participants included citizen volunteers and students as well as staff employed by FWC, USFWS, and the U.S. Forest Service who had little experience with scrub-jay behavior.

Accuracy assessment and analyses.—We compared the numbers of family groups, adults, and fledglings determined by demographic monitoring with estimates derived by three (2012) or two (2013) analysts who interpreted Jay Watch survey maps and data sheets. Analysts completed this exercise independently without conferring with one another, using only information available from the Jay Watch survey. The lead field biologist who conducted demographic monitoring did not serve as an analyst. If scrub-jay territories extensively overlapped two neighboring stands, we assigned 0.5 group (and half of its members) to each stand for analyses.

When sample sizes allowed, we used Wilcoxon signed-rank tests to test for differences between Jay Watch results for each analyst against demographic monitoring results. Chi-square tests of independence were not appropriate, given that these were repeated or paired measures. We also used Winer's (1971) intraclass correlation coefficient (ICC) to assess the reliability of repeated measurements by different analysts. High ICC values indicate that the error of measurement associated with each analyst is constant. In addition, we compared results stand by stand qualitatively.

Given the vocal and conspicuous nature of this species, we were not concerned with inaccurate species identification or with measuring detectability of individuals at a given point. Playbacks of scrub-jays are known to increase detection rates to near 1.0 (Breininger et al. 2006; T. Castellon and K. Sieving, unpublished data).

Results

In 2012, demographic monitoring on 12 focal stands identified 35 family groups comprising 79 adults and 16 fledglings. Jay Watch survey data yielded almost identical results, particularly when interpreted by analyst #1 and analyst #2 (Table 1). Statistical comparisons between demographic data and Jay Watch either were not possible because of the large number of ties (i.e., demographic and Jay Watch data did

Table 1. Comparing the accuracy of Jay Watch post-reproductive survey analyses with intensive monitoring data from a full-time field biologist, ONF, 2012 (Grp = number of family groups, Ad = number of adults, Juv = number of juveniles).

2012		Intensive monitoring			Analyst 1			Analyst 2			Analyst 3		
Stand #	Acres	Grp	Ad	Juv	Grp	Ad	Juv	Grp	Ad	Juv	Grp	Ad	Juv
1621	44.6	**3**	8	0	**4**	11	0	**3**	11	0	**3**	8	0
2506	40.9	**2**	6	0	**2**	6	0	**2**	6	0	**2**	6	0
2532	53.0	**3**	6	1	**3**	6	1	**3**	6	1	**2**	4	1
2503/2624	152.9	**5**	10	0	**5**	10	0	**5**	10	0	**4**	8	0
4632	48.4	**2**	4	1	**2**	4	1	**2**	4	1	**2**	4	1
4720	28.6	**2**	4	0	**1**	2	0	**1**	2	0	**1**	2	0
4727	38.3	**1**	2	1	**1**	2	1	**2**	3	1	**1**	2	1
4729	31.2	**2**	6	4	**2**	5	5	**2**	6	6	**2**	6	7
4736	35.0	**3**	6	0	**3**	5	0	**3**	5	0	**2**	5	0
4745	65.1	**4**	10	2	**4**	10	2	**4**	9	2	**4**	9	2
21424	80.1	**5**	11	4	**5**	10	4	**6**	12	4	**4**	9	4
21440	47.1	**3**	6	3	**3**	6	3	**3**	6	4	**3**	6	4
Total	**665.3**	**35**	**79**	**16**	**35**	**77**	**17**	**36**	**80**	**19**	**30**	**69**	**20**

not differ at most stands) or were not significant ($P > 0.05$). Analyst #3 sometimes undercounted the number of family groups present or overcounted the number of fledglings present, but the differences were small. The intraclass correlation coefficient for analyst performance was high, ranging from 0.89 (family groups) to 0.95 (fledglings).

In 2013, demographic monitoring on 10 focal stands identified 35.5 family groups comprising 83.5 adults and 37.5 fledglings. (We included 0.5 group at stand 4736 because that group's territory straddled the border between that stand and an adjacent stand not included in this assessment; see Methods.) Jay Watch survey data yielded very similar results (Table 2). Statistical comparisons between demographic and Jay Watch data were not significant ($P > 0.05$). Analysts performed similarly, with the intraclass correlation coefficient ranging from 0.83 (family groups) to 0.92 (adults).

Stands with discrepancies in the number of family groups tended to be those with several family groups and no banded birds (e.g., in 2012 only 2 of 11 adult scrub-jays were banded in stand 21424; Table 1). Discrepancies in the number of fledglings were uncommon (79% of comparisons at the stand level were the same; Fig. 1). When discrepancies occurred, they were almost always in stands that were both densely vegetated and populated by neighboring family groups that had fledglings.

DISCUSSION

We found close agreement between population estimates derived from short-term Jay Watch playback surveys (by teams of volunteers and trained staff) and the same parameters obtained from demographic

Table 2. Comparing the accuracy of Jay Watch post-reproductive survey analyses with intensive monitoring data from a full-time field biologist, ONF, 2013 (Grp = number of family groups, Ad = number of adults, Juv = number of juveniles).

2013		Intensive monitoring			Analyst 2			Analyst 3		
Stand #	Acres	Grp	Ad	Juv	Grp	Ad	Juv	Grp	Ad	Juv
4632	48.43	**2**	4	2	**1**	3	1	**2**	5	2
4727	38.3	**2**	5	3	**2**	5	3	**1**	3	3
4736	35	**3.5**	7.5	3.5	**4**	9	5	**2**	5	4
4745	65.13	**5**	10	7	**4**	10	7	**4**	10	5
21424	80.06	**4**	9	7	**4**	11	7	**4**	11	7
21440	47.08	**3**	8	3	**3**	9	3	**4**	10	4
27312	60.44	**4**	12	1	**5**	14	1	**4**	13	2
27314	62.45	**2**	4	3	**2**	4	3	**3**	6	3
27316	55.69	**4**	9	4	**4**	9	4	**3**	8	4
27406	128.16	**6**	15	4	**6**	16	4	**6**	15	5
Total	**620.74**	**35.5**	**83.5**	**37.5**	**35**	**90**	**38**	**33**	**86**	**39**

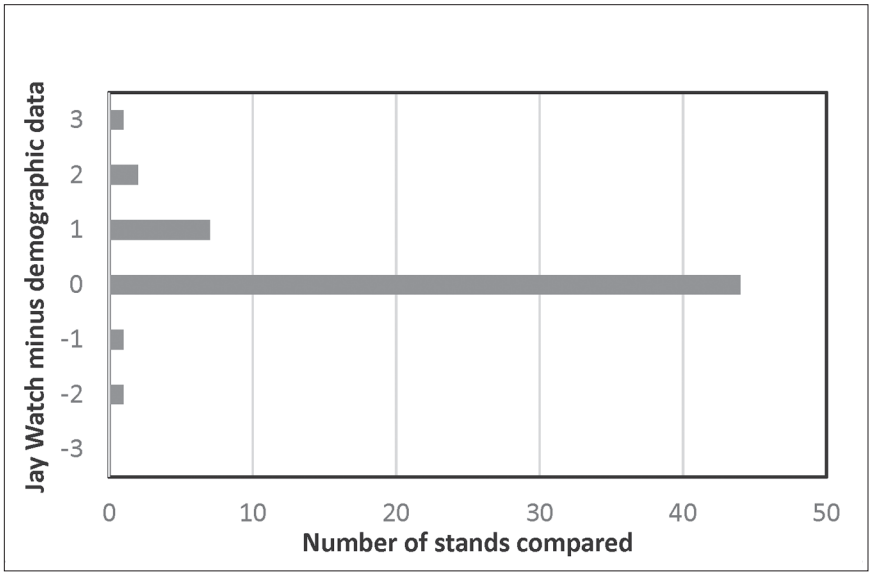

Figure 1. Difference in fledgling counts between Jay Watch estimates and demographic monitoring data, 2012-2013. Comparisons were made at the stand level.

monitoring data (by a full-time lead biologist). This finding strengthens our ability to draw conclusions from short-term post-reproductive surveys at ONF, and consequently allows us to monitor a larger study area each year without sacrificing accuracy.

We conducted this assessment in conditions representative of sites monitored by Jay Watch across Florida, so our results may have applicability to the use of Jay Watch elsewhere. For example, we surveyed small populations (1-10 family groups per stand) in small habitat patches (forest stands were <60 ha), and most scrub-jay populations monitored by Jay Watch elsewhere are small (78% are ≤10 family groups; M. Korosy, unpublished data). Sites in our assessment also represented a range of vegetative conditions, with average height of scrub oaks ranging from 1–3 m.

Some caveats should be noted. The average skill level of field staff in our Jay Watch surveys was very high, which may have increased our accuracy. In-depth field training for participants is critically important for any program that uses volunteers (e.g., Koss et al. 2009, Lewandowski and Specht 2015), and some programs choose to use only professionals for certain tasks at some stages of the data collection or verification process (e.g., Anderson et al. 2001). We took such an approach by usually allocating the most difficult tasks (i.e., note taking) to those with the highest skill levels.

An assessment of Jay Watch data at a few sites on the Lake Wales Ridge found that the accuracy of fledgling numbers varied although differences were not statistically significant (TNC 2008; R. Bowman, unpublished data). We found some discrepancies in fledgling numbers between Jay Watch and demographic monitoring, but they were infrequent and more likely to be overestimates than underestimates (Fig. 1). In our experience, the behavior of juveniles can potentially lead to overcounting, especially in high-density populations such as those in our study area (4–5 family groups per 41 ha [100 acres], K. Miller, unpublished data). Juvenile Florida Scrub-Jays often wander into neighboring territories, where they mix with, and are tolerated by, offspring from other groups (Woolfenden and Fitzpatrick 1996; K. Miller, personal observation). Our study suggests that analysts should pay careful attention to this possibility in densely populated study sites, especially where vegetation height reduces visibility.

In addition, many of the scrub-jays on our stands were color banded, which facilitated accurate data collection. Jay Watch monitoring programs in high-density scrub-jay populations without any color banded individuals may not be as successful.

The labor -intensive nature of collecting Florida Scrub-Jay data across large spatial and temporal extents would seem to make the regional assessment of population status and trend an ideal candidate for citizen science. On the other hand, research indicates that projects that use quantitative measurements are better suited for citizen science than projects that ask volunteers to collect more qualitative data (Galloway et al. 2006). Assessing the meaning of interactions among multiple birds observed at a playback station involves a combination of quantitative skills (e.g., how many adults and juveniles are seen?) and qualitative judgments that are learned only through experience (e.g., is this a territorial encounter?). The Jay Watch program provides annual training for all volunteers to improve their ability to make such assessments (TNC 2010). Given the complexity of data collected by Jay Watch, we recommend pairing volunteers with trained biologists (or with highly experienced volunteers) to produce the most accurate results. Any training should include a special emphasis on taking careful and unambiguous notes in the field to make it easier for analysts to summarize the data later.

Although it is possible that Jay Watch monitoring programs that rely exclusively on volunteer citizen scientists may not yield the same accuracy as our study, we did not evaluate that directly in our assessment. We recommend repeating this type of assessment at other Jay Watch locations that use only less-experienced volunteers.

Acknowledgments

We acknowledge The Nature Conservancy and Audubon of Florida for their investment in citizen science. We thank our dedicated field assistants K. Cattrano, M. Mietzelfeld, and A. Sirman for conducting our demographic monitoring, and we thank J. Rodriguez and C. Sunquist for helping to recruit and train volunteers for our Jay Watch surveys. E. Leone calculated the intraclass correlation coefficients. R. Bowman, M. Korosy, and K. Sieving provided access to unpublished data. A. Cox, B. Crowder, M. Korosy, C. Millett, and an anonymous reviewer reviewed earlier drafts of the manuscript. Funding for our project was provided by FWC's Nongame Wildlife Trust Fund, FWC's allotment of Section 6 funding from the U.S. Fish and Wildlife Service, and in-kind support from various project partners. We dedicate this paper to Glen Woolfenden in honor of his life-long commitment to the meticulous field study of Florida birds in their natural environment.

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