Preliminary report on the 2006 census of Ipswich sparrows

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Summary

The breeding population of the Ipswich sparrow (*Passerculus sandwichensis princeps*), Sable Island's endemic passerine, was censussed in spring 2006 using two methods: one used from 1968-1995 that had yielded a population of up to 3400 birds, and another developed in 1998 (slightly modified here) that had yielded nearly 6000 birds. In this 2006 census, the methods yielded 6700 and 6800 sparrows, respectively, well within the margin of error of the 1998 census. These results suggest that the difference between pre-1998 and 1998 censusses represents a real increase in the sparrow population, and not just a difference in censussing technique. The Discussion evaluates the methods based on such features as how well they cover different habitats, how well they detect birds, and practicality.

Introduction

The Ipswich sparrow (*Passerculus sandwichensis princeps*) is one of Sable Island's best known residents. It breeds almost exclusively on the island and winters along the Atlantic seaboard, where it is highly sought after by birders. Public interest in the bird, together with its current listing by COSEWIC as "Special Concern", make estimating its current population size of particular interest.

Yearly censusses of the population were conducted from 1967 to 1975 as part of intensive, long term studies of the bird, and estimated its population at 2100 to 3300 individuals. Counts using the same methods in 1978 and 1995 yielded the record lowest and highest numbers of birds, respectively: 1250 and 3400 individuals. In 1998, however, a more statistically sophisticated census estimated nearly double the record high, at about 6000 birds.

The difference in the results of the two census methods raise several questions. Does the difference reflect a real increase in the sparrow's numbers, or just a change in methods? If the latter, which census method gives a more accurate estimate of the sparrow's population size, and thus should be used in future years?

The present study was undertaken to answer these questions. In 2006, a field team censussed Ipswich sparrows on Sable Island using both census methods, including some modifications to the more recent methods to explore how they might be refined.

Methods

Censusses between 1967 and 1995 employed exhaustive searches of representative areas of the island, a method hereafter called "area searches". The 1998 census counted birds flushed by counters walking abreast along several straight lines transecting the island, a method hereafter called "strip transects". Both area searches and strip transects were conducted from June 16-20, all days with low wind and good visibility, between 0730 and 1730.

The strip transect design used here largely followed the methods of Smith et al. 2003 (for the differences and their rationale, see the Appendix). Using a handheld GPS for guidance, three censussers went to each integer easting (i.e., every kilometre) along the north beach, and walked south to the south beach, with one censusser directly on the line and one 10 m on each side of him. Each observer picked a distant landmark to guide him or her in a straight line, with the center observer additionally guiding himself and the group with the GPS. In all, 33 transects were walked.

The middle observer kept the transect on course and recorded the data. Every 50 m he wrote down the habitat underfoot (open sand, sandwort, sparse marram, fescue, marram-pea, or heath). The outer observers shouted when they saw a bird, specifying whether it was within the transect or within a band extending 10, 20, or 30 meters beyond the transect.

Area searches duplicated the methods of McLaren 1968 (see also Stobo and McLaren 1975). McLaren's plots were first located by comparing recent aerial photos with maps and descriptions used during previous surveys (McLaren unpub. data) and the maps published in Stobo and Mclaren (1975). The field crew then tried to locate the plot on site and censussed it using previous methods (McLaren 1968, Stobo and McLaren 1975). Specifically, they spread out at one of the narrow ends of the plot and walked its length, zig-zagging to ensure that all birds in the area would be flushed, trying to come within 10 m of every point in the plot. Birds were counted only once when they flew out the edge of the plot or over the counters.

Out of 16 census plots, two could not be found on site, a third appeared so changed in topography and habitat that it was skipped, and a fourth was deemed too large to survey with only three censussers. Thus 12 of the 16 plots were included in the final sample.

In both types of census, particular care was taken to avoid double-counting birds or counting other passerine species that occur at that time of year on the island. The latter can include "typical" Savannah Sparrows and migrants such as warblers and other species of sparrows, but constitute fewer than one percent of the passerines encountered.

Data from strip transects were analyzed following the methods of Smith et al. (2003), i.e. by breaking them down into the strata that Smith et al. (2003) defined based on habitat differences. After confirming that habitat coverage was similar to Smith et al. (2003) and that the number of birds increased with transect length (as required by the ratio estimate of density used by Smith et al. 2003), the number of birds in each stratum and in total were estimated using the equations and the stratum areas given in Smith et al. (2003). Estimation of sampling variance and quantitative evaluation of detectability functions is still in progress.

Data from area searches were analysed as in Stobo and McLaren (1975), and assumed that the representativeness of the area plots and total vegetated area of the island have not changed substantially (as suggested by Freedman 1996).

Results

Strip transects

The proportions of habitat types sampled across the island were quite similar to those sampled by Smith et al. (2003; Table 1). Also, as in Smith et al. (2003), the number of sparrows detected increased with transect length (Fig. 1), justifying the use of a ratio estimator of density (i.e., the number of birds divided by the area censussed).

The densities of sparrows within each stratum agrees well with the 1998 data (Table 2). The densities yield an estimate of 6671.27 Ipswich sparrows on Sable Island, within 1.3 standard errors of, and thus not statistically significantly different from, the 1998 estimate of 5962$\pm$546.8 individuals (Smith et al. 2003).

Detectability functions varied across habitats. Sample sizes were too small in marram-pea and sparse grass habitats to discern clear patterns (Fig. 2). In heath, however, detectability declined quite steeply from the center of the transect, whereas in fescue the decline was more gradual (Fig. 2).

Area searches

All plots, as defined in the field, were on average about half the size reported by Stobo and McLaren

(1975; 24.1 ha in total versus 48.3), but this represents the censussers' conservative approach to identifying the plots, rather than actual habitat change. The habitat within all but two plots was strikingly similar between the two surveys. One exception (area 14) had changed from nearly all (95%) heath to all fescue; the other exception (area 11) had changed from an equal mix of four habitats to nearly all (90%) fescue, although its identification was somewhat in doubt. Given that the plots were identified partly based on vegetation, little can be concluded from these patterns.

In the surveyed plots, sparrow density was 2.59 times higher in 2006 than in 1972 (6.67 birds/ha versus 2.58 birds/ha), yielding an estimate of 6788.89 sparrows on the island.

Discussion

Coverage of habitats

In their thorough discussion of their own and previous censusses, Smith et al. (2003) identify representative coverage of habitats as one of the most important requirements for an accurate census. Random selection of transects can yield a biassed sample of actual habitats, and thus a biassed sample of sparrow numbers. By using regularly spaced transects, the present census attempted to provide a more representative coverage of habitats, without resorting to hand-picking patches of habitat as was done in earlier area searches, with all the hidden biases such an approach might introduce.

Nonetheless, habitat coverage should be refined still further. In particular, the field crew had difficulty identifying the habitats, so it would be useful to compare their fine-scale habitat identification with the fine-scale habitat maps made for the Sable Island Preservation Trust by the Centre of Geographic Sciences. Results may suggest how finely field crews can reliably identify habitats, and over how fine a spatial scale.

Detectability within and beyond the strip

The detectability functions reveal strong and interesting differences in detectability between habitats. The function for heath appears to match the normal distribution that is typical of most surveys, including surveys of other populations of Savannah Sparrows (e.g. Diefenbach et al. 2003). The function for fescue, however, is flatter, suggesting either that birds flushed more readily (i.e., requiring just one approaching observer rather than all three) or that observers were more likely to categorize a bird’s position as falling just outside the transect. The skew across sides of the transect (e.g., for heath in Fig. 2, the +10 m total is nearly double the -10 m total) supports the latter explanation, in that it also suggests an observer bias in how birds at the edge of transects were counted. This possibility is being explored in further analyses, although a definitive test will require more field trials.

Either bias would raise the disturbing possibility that densities might be underestimated in fescue relative to heath. Depending on which habitat yielded the more accurate values, this bias might either over- or under-estimate the population size, although the agreement between the strip transect and area searches (see below) are somewhat reassuring.

Comparison of strip transect and area searches

With a few exceptions, the early census plots were surprisingly easy for the 2006 field crew to locate and had changed surprisingly little, considering that they had not been censussed in three decades (apart from one census in 1995) and that none of the field crew had visited them before. Nonetheless, implementation of the area searches revealed all the problems that method is subject to and which led Smith et al. (2003) to propose strip transects in the first place: several plots were hard to relocate, had changed in the intervening period, may or may not have been representative of the island as a whole, and/or were hard to cover adequately with the available personnel.

Nonetheless, given enough personnel relative to the area being covered, area searches provide a more

accurate estimate of the number of birds in a given area than transects through that area (Roberts and Schnell 2006). This is because area searches are more likely to flush all the birds, and the area being covered is well defined and thus not subject to such biasses in defining "out" versus "in" birds as may have occurred in the present study. With today's GPS technology, it might be possible to define plots on the island in ways that are less subject to shifting topography and habitat. Within the plots, birds might be more accurately counted, and habitat could be more accurately delineated, than along transects, so area searches may still be the best method. Nonetheless, the availability of sufficient personnel would be a continuing challenge.

Estimate of population size

Both methods agreed on the number of sparrows on Sable Island; 6671 birds in the strip transect count versus 6789 birds in the area searches. Refined estimates of the precision of the strip transects have yet to be made, although based on preliminary calculations, it seems likely that the precision is similar to that reported by Smith et al. (2003), i.e. a standard error of 500-600 birds. Certainly the estimate is statistically indistinguishable from the 1998 estimate, i.e. nearly double pre-1998 estimates.

The match between the methods in the present study is interesting, because it suggests that the increase in numbers from pre-1998 area searches to more recent strip transects reflects a real increase in numbers, rather than just a change in methods. This result is somewhat corroborated by increases in Christmas Bird Count totals over the same period; CBC totals were at least 15% higher in 1999 and 50% higher in 2005 than in 1972, the highest CBC total recorded while area searches were ongoing (McLaren and Horn unpub. data).

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Table 1. Percent vegetation in each stratum defined by Smith et al. (2003).

	Stratum						
Vegetation type	B1	B2	B3	B4	B5	B6	B7
Sandwort	0.00	0.00	0.00	0.00	0.00	0.00	0.30
Sparse marram	0.05	0.46	0.30	0.16	0.25	0.38	0.23
Fescue	0.45	0.24	0.30	0.47	0.11	0.17	0.20
Marram-pea	0.20	0.11	0.08	0.18	0.18	0.13	0.27
Heath	0.30	0.20	0.32	0.20	0.46	0.33	0.00

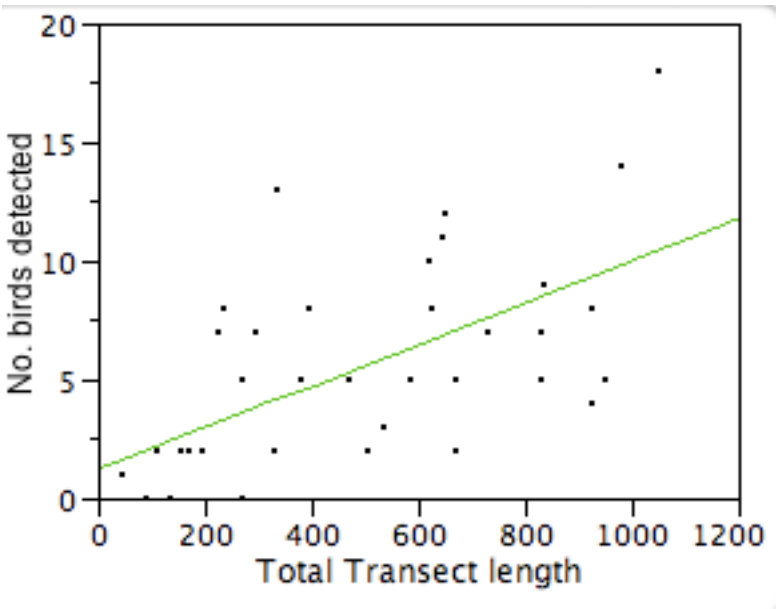
Table 2. Density of sparrows in each stratum.

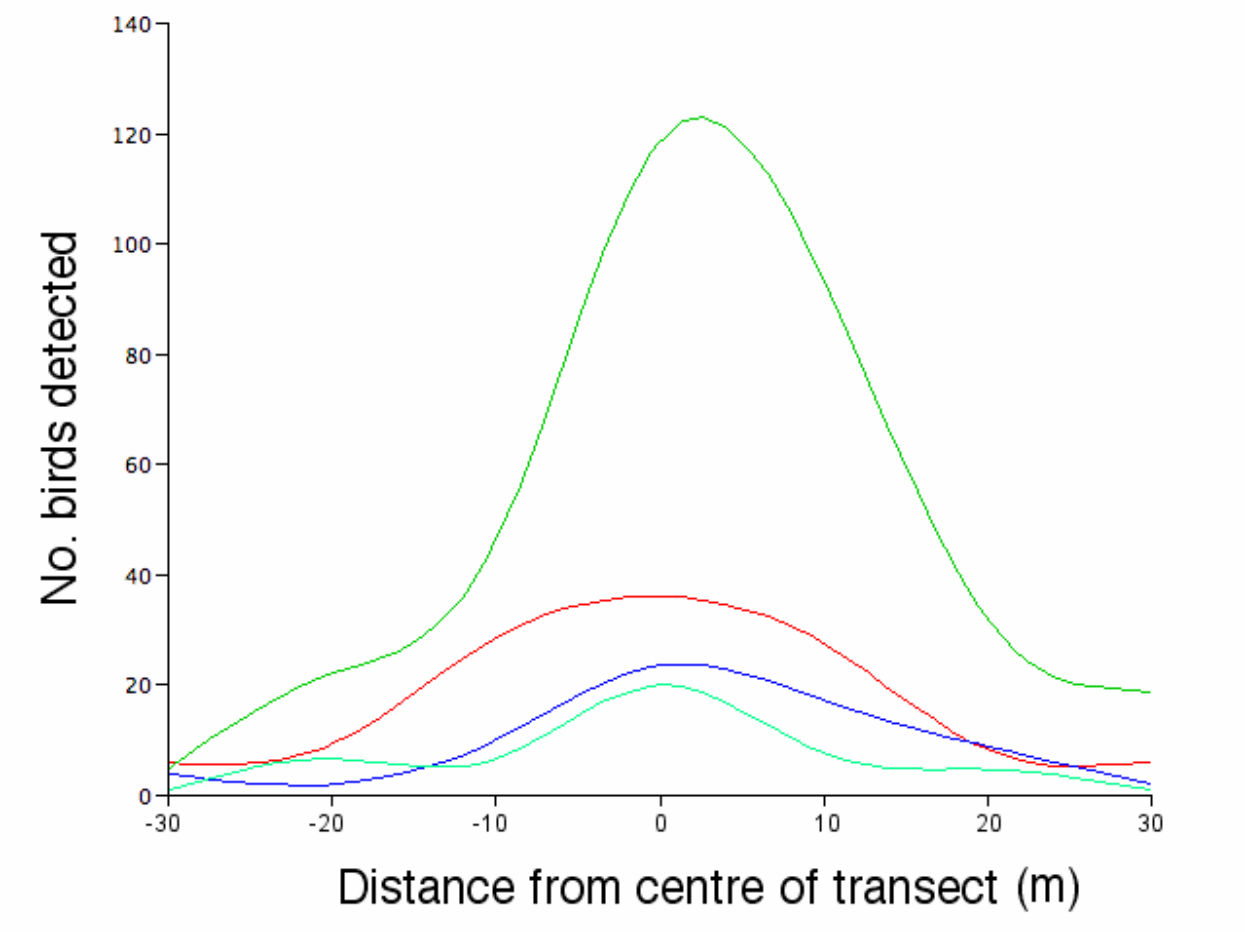
Stratum	Density (/1000m^2)	Number, 2006	Number, 1998
B1	0.439	635.01	555.17
B2	0.332	979.32	1054.59
B3	0.565	1688.21	1400.47
B4	0.536	1072.04	1474.75
B5	0.079	1448.44	1125.40
B6	0.113	562.85	251.51
B7	0.332	285.40	100.30
Total		6671.27	5962.19

Figure legends

Figure 1. Relationship between number of birds detected and transect length, with least squares fit (linear and quadratic fits were virtually indistinguishable).

Figure 2. Detectability functions (total number of birds seen in each transect band) in heath (green), fescue (red), marram-beach pea (blue), and sparse grass (grey). Each curve is a cubic spline that intersects the raw data points.


20
15
10
5
0
No. birds detected
0
200
400
600
800
1000
1200
Total Transect length


140
120
100
80
60
40
20
0
No. birds detected
-30
-20
-10
0
10
20
30
Distance from centre of transect (m)

APPENDIX. Rationale for modifying Smith et al.'s (2003) strip transect method

Area searches were done by picking up to 16 patches of habitat across the island and flushing sparrows from them every year. Advantages of the method include:

- it is repeatable across years;
- clearly delimited areas are thoroughly searched;
- the habitat is clearly defined.

Strip transects were done by three counters walking in parallel on randomly selected north-south lines (i.e. transects) across the island, counting all sparrows that flushed up between them. Transects were randomly selected, within each of seven sections of the island that differ in habitat and topography. The advantages of the method include:

- it provides an estimate of sampling variance, because there are multiple transects and they are randomly selected;
- it is broken down by habitat, so that sparrow density can be estimated for each habitat, which leads to a more precise estimate of the total population;
- since the whole island is sampled, rather than pre-defined plots, year-to-year changes should reflect changes across the island rather than merely changes within particular plots.

In comparing the two methods, we explored whether a hybrid method could be devised that had the advantages of both methods (items 1-4 below) and improved upon them (item 5), i.e. a census that:

1. is repeatable from year to year;
2. is independent of local changes in topography/habitat;
3. estimates sampling variance;
4. is representative of habitat and numbers across the island;
5. estimates detection error.

For "1", transects should be at readily identifiable points, and for "2" those points should be independent of habitat/topography. North-south transects starting at integer eastings accomplish both. Regularly spaced transects will also be more representative and less biassed (i.e., closer to the true mean) than random samples (Gregory et al. 2004), thus fulfilling "4". They yield biassed estimates of sampling variance, but at least they allow its estimation, thus fulfilling "3". Also, the bias is toward overestimating sampling variance, and thus yields a conservative estimate of sampling precision. For "5", the transects should be carried out using at least some version of distance sampling. All previous counts were versions of strip transects -- i.e., counting every bird within the band encompassed by the observers. This method assumes that 100% of birds within the transect are detected, but the assumption hasn't been tested.