
Supplementary Address Bands Increase Recovery Rates

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INTRODUCTION

Fish and Wildlife Service bands larger than size 1A bear an inscription of a return address and a serial number on the outside of each band. For example, on sizes 2 and 3 bands the inscription is AVISE BIRD BAND WRITE WASH DC USA. Larger sizes bear an expanded version of this message that directs the finder to contact the Fish and Wildlife Service rather than "Bird Band." Sizes 0, 1, 1B and 1A carry only the serial number on the outer surface of the band and an abbreviated message AVISE BIRD BAND WASH DC USA is printed on the inside surface. Do finders of birds banded with these four small bands open the band and see the printed message on the inside and if so, do they understand what it means? Recovery rates of small birds are notoriously low. Could the obscurity of the return address on band sizes 0 through 1A be partially responsible for a low reporting rate?

Little information is available on the effect of a return address on recovery rates. As far as we are aware, all other national banding schemes include some form of return address message, as well as a serial number, on the outside surface of bands of all sizes. From 1969 to 1973 the Ringing and Migration Committee of the British Trust for Ornithology (BTO) conducted an experiment in which two different return addresses were compared (Sales 1973). The species involved were European Starling (*Sturnus vulgaris*) and Sandwich Tern (*Sterna sandvicensis*) and bands were inscribed

with either INFORM BTO TRING ENGLAND or INFORM BRIT. MUSEUM LONDON SW7. The address used on the band had a highly significant effect on the reporting rate of starlings found dead in the British Isles, with 83% more birds reported if they wore bands with the British Museum address. For starlings and terns reported outside the British Isles, there was a smaller but non-significant tendency for "British Museum" bands to be reported more often (Sales 1973). If the wording of the address itself can have an impact on reporting rates, it seems likely that the lack of any address at all on the outside of the band would have a severe adverse effect on reporting rates.

Recovery rates calculated for birds banded with sizes 0 through 1A bands at Long Point Bird Observatory in 1960-1964 indicated a marked discontinuity between the reporting rates of sizes 1A and 2 bands and it was suggested that the readily visible address on the outside of the size 2 band might be at least partially responsible (Hussell 1967). Hussell recommended that the U.S. and Canadian banding offices should investigate whether the lack of a return address on the outside of the band had a serious adverse effect on recovery rates of birds banded with the smaller-sized bands and, if so, take steps to correct the situation; but nothing was done.

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Personnel of the Long Point Bird Observatory (LPBO) have been concerned about the problem of low recovery rates for many years. In 1983, David Shepherd pointed out that we could overcome the address problem by placing a second "supplementary address band" (bearing an address on the outer surface) on each bird and he proceeded to design and find a suitable supplier for the bands. Since 1984 nearly all birds banded with sizes 0 through 1A bands at Long Point Bird Observatory have also received a supplementary address band on the other leg. Here we report recovery rates of birds banded with supplementary address bands and compare them with those for birds banded only with the regular Fish and Wildlife Service bands.

We use the word "recovery" to refer to any banded bird whose band number is reported to the banding laboratory.

METHODS

From 1960-1990, 370,998 birds of 247 species were banded by LPBO. This study, however, was limited to cuckoos, woodpeckers, goatsuckers, swifts and passerines banded with band sizes 0, 1, 1B, 1A, 2 and 3 on the Long Point peninsula on the north shore of Lake Erie (42° 30' N, 80° 10' W) in Ontario, Canada, from 1975 to 1990. Birds included in the sample were captured in mist-nets, Heligoland traps or other baited traps, or by hand when they were attracted to the Long Point lighthouse during nocturnal migration. Species compositions of these bandings were reasonably consistent from year to year. Nearly all of the birds were transients migrating to summer or winter ranges far from Long Point, but recaptures indicated that a small number of individuals of a few species were local summer or winter residents. In order to limit the sample primarily to migrants, we did not include several thousand nestling and adult Tree Swallows (*Tachycineta bicolor*) banded at nest boxes near the eastern tip of the peninsula.

From 1975 to June 1984, only regular Fish and Wildlife Service bands were used. Starting in July 1984, nearly all birds that were banded with sizes 0, 1, 1B or 1A bands on one leg were also fitted with an aluminum alloy supplementary address band on the other leg (Figure 1). The supplemen-

tary bands were manufactured by Lambournes (B'ham) Ltd. (Shallowford Court, Off High Street, Henley-in-Arden, Solihull, West Midlands, England B95 5BY) who are suppliers of bands to the British Trust for Ornithology. Inside diameters of size A, B, C and D, supplementaries were 2.0, 2.3, 2.8 and 3.3 mm versus 2.11, 2.38, 2.78 and 3.18 mm, for sizes 0, 1, 1B and 1A, respectively. The four sizes of supplementary and regular bands were roughly equivalent, so usually a bird that took a size 0, 1, 1B or 1A band received, respectively, a size A, B, C or D supplementary. During the years when supplementary bands were used, some birds were released without supplementary bands when the supply of the appropriate size was depleted.

Figure 1. Eastern Bluebird (*Sialia sialis*) banded with a regular size 1B band on its right leg and a size C supplementary address band on its left leg.



From 1984 to 1987, supplementary bands of sizes A and B were inscribed with the message BIRD BAND WASH DC USA and sizes C and D with INFORM BIRD BAND WASH DC USA. Starting in mid-1987, the message was changed to INFORM NAT MUS OTTAWA CANADA on supplementary sizes A and B, and to INFORM NAT MUSEUM OTTAWA CANADA on sizes C and D. Reports of banded birds received at the National Museum of Canada were forwarded to the Bird Banding Office of the Canadian Wildlife Service (CWS).

To calculate recovery rates, we extracted banding totals from LPBO records, obtained a listing from the CWS banding office of all recoveries reported to them to August 1992 and compiled additional recoveries reported by the US banding laboratory to LPBO to 31 December 1992. Recoveries with

"how obtained" codes 10, 16, 33, 44, 51, 53, 89 or 99 were excluded. Of these, codes 33 (caught at nest), 44 (caught due to control operations) and 89 (trapped and released in another 10' block) and 99 (trapped and released in the same 10' block) occurred among the LPBO recoveries. Thus, our recovery rates are for birds reported by the public and not by people likely to be familiar with band reporting procedures. We also excluded recoveries of four European Starlings, four Common Grackles (*Quiscalus quiscula*) and one Brown-headed Cowbird (*Molothrus ater*) shot by two persons near the banding location on Long Point in 1989-1991. The first recovery reported by each of these persons was included in our sample, but later recoveries by the same persons were rejected as atypical and not independent.

We compared recovery rates of regular bands of size 0, 1, 1B and 1A in 1975-1984, when supplementaries were not used, with recovery rates of the same band sizes used in conjunction with supplementary bands in 1984-1990. To determine whether there was a change in recovery rate between the two time periods that was unrelated to the use of supplementary bands, we compared the recovery rates of band sizes 2 and 3 used in 1975-1984 with those for the same band sizes used in 1985-1990. We calculated recovery rates and numbers of birds banded per recovery based on all birds recovered to date. To provide a direct comparison of changes in recovery rates, however, it was necessary to choose a uniform recovery interval, because not all recoveries will have been reported by 31 December 1992. For this purpose, we chose to calculate recovery rates based on recoveries occurring before July of the second calendar year following the calendar year of banding.

To elucidate the basis of different recovery rates of birds banded with and without supplementary bands, we compared proportions and recovery rates of bands reported directly by the finder with those reported in other ways (see footnote a, Table 5 for details).

To determine the effectiveness of the different addresses, we compared recovery rates for birds banded in 1984-1986 (using only the U.S. address) with those banded in 1988-1990 (with only the

Canadian address). This was not an entirely unequivocal test of the effects of the two addresses because the size A and B supplementaries with the U.S. address lacked the word INFORM that was on all other supplementary bands. Also, we compared the locations of recoveries of birds wearing bands with the U.S. and Canadian addresses.

The statistical significance of differences in recovery rates was tested both for single band sizes and jointly for several band sizes using a hierarchical log-linear model (Sokal and Rolf 1981, Norusis 1986).

Before we adopted the Canadian address, we tested whether a letter bearing the address would be consistently delivered by the postal service. We also tested an alternative address bearing a postal code. The two addresses tested were NAT MUS, OTTAWA, CANADA and NAT MUS, CANADA, K1A 0M8. Twenty envelopes, 10 with one address and 10 with the other, were mailed. Each envelope was mailed at a different location in Toronto, Richmond Hill, Waterloo, and surrounding areas of Ontario between 6 and 11 February 1987. Four additional letters bearing the first address plus a return address in the upper left-hand corner were mailed in the Richmond Hill area on 18 February 1987. Tests of the address outside Canada were more haphazard. Eight envelopes with the first address were given to a person travelling in the U.S. in March 1987, but we were never informed whether they had all been mailed. Two others were mailed in Louisiana and two more in Venezuela in March 1987. Henri Ouellet compiled returns for us at the National Museum of Canada.

RESULTS

Effect of supplementary address bands

Bandings and recoveries of birds banded on the Long Point peninsula with and without supplementary address bands from 1975 to 1990 are summarized in Tables 1 and 2. For band sizes 0 through 1A, bandings per recovery ranged from 616 for size 1A to 6,638 for size 0 when address bands were not used. With supplementary address bands the number of bandings per recovery varied from 534 for size 1A to 2513 for size 1. The number of bandings per recovery for size 2 bands

(506 for all years 1975-1990, Table 2) was similar to that for 1A bands with supplementaries but considerably fewer bandings were required to obtain a recovery with a size 3 band (191 in 1975-1990, Table 2).

For the band sizes for which we have the largest sample sizes (0 and 1B), overall recovery rates increased by 3.5 and 4.9 times respectively when supplementary bands were used.

For size 1A, however, the increase with supplementary bands was only 1.2 times and for size 1 the recovery rate decreased to 0.9 of that with regular bands (Table 1).

Log-linear analyses of recoveries in the first two years after banding showed that the third order interaction, band size x supplementary band x recovered, was not significant ($P = 0.1210$), which indicated that the effect of supplementary bands on recovery rate did not vary significantly with band size, despite the wide range of effects recorded

Table 1. Recoveries (reported to December 1992) of birds banded at LPBO with and without supplementary address bands and regular bands of sizes 0, 1, 1B and 1A.

		Regular Band Size			
		0	1	1B	1A
Without Address Band 1975-1984	No. Banded	59,743	8,784	23,724	6,771
	No. Recovered Anytime	9	4	4	11
	No. Recovered First 2 Years*	9	2	4	9
	Recovery Rate** Anytime	0.15	0.46	0.17	1.62
	Recovery Rate** First 2 Years*	0.15	0.23	0.17	1.33
	Bandings/Recovery Anytime	6,638	2,196	5,931	616
With Address Band 1984-1990	No. Banded	56,276	7,540	23,127	5,344
	No. Recovered Anytime	30	3	19	10
	No. Recovered First 2 Years*	25	1	16	7
	Recovery Rate (anytime)	0.53	0.4	0.82	1.87
	Recovery Rate** First 2 Years*	0.44	0.13	0.69	1.31
	Bandings/Recovery (anytime)	1,876	2,513	1,217	534

* "First 2 years" means before July of the second calendar year following the calendar year of banding; e.g., for birds banded in 1990, recoveries in the first 2 years includes birds reported recovered on dates on or before 30 June 1992.

** Recovery rates are expressed as number of recoveries per 1000 banded.

for different band sizes. The second order interaction, supplementary x recovered, had a significant partial chi-square ($P = 0.0008$), indicating that supplementary bands had a significant positive influence on recoveries across all band sizes. The final model excluded the three-way interaction term and showed that the average effect of the supplementary bands was to increase the recovery rate in the first two years by about 2.24 times.

Table 2. Recoveries (reported to December 1992) of birds banded at LPBO in 1975-1984 and 1985-1990 with regular bands of sizes 2 and 3 only.

		Regular Band Size	
		2	3
Banded in 1975-1984	No. Banded	4,848	4,527
	No Recovered Anytime	10	28
	No. Recovered First 2 Years*	8	20
	Recovery Rate**, Anytime	2.06	6.19
	Recovery Rate**, First 2 Years*	1.65	4.42
	Bandings/Recovery (anytime)	485	162
Banded in 1985-1990	No. Banded	4,255	4,060
	No. Recovered Anytime	8	17
	No. Recovered First 2 Years*	7	14
	Recovery Rate** Anytime	1.88	4.19
	Recovery Rate** First 2 Years*	1.65	3.45
	Banding/Recovery (anytime)	532	239

* & ** See footnotes, Table 1.

A similar analysis using all recoveries received to December 1992 (not just those received in the first two years) indicated that the overall recovery rate increased by an average of 2.45 times when supplementary bands were used. Given that more recoveries of supplementary-banded birds than of regular-banded birds probably remain to be reported, this is likely to be an underestimate of the effect of the supplementaries. The analysis also provided an estimate of the average number of birds banded to obtain a recovery with and without supplementaries, based on all recoveries reported so far (Table 3).

Table 3. Estimated number of bandings to obtain one recovery using regular bands with and without supplementary address bands.*

	Number banded per recovery using regular bands of size			
	0	1	1B	1A
Without address bands	5,063	3,919	3,489	940
With address bands	2,069	1,604	1,428	387

* The numbers banded per recovery in this table are estimates based on the model that best fit the data in Table 1, according to the hierarchical log-linear analysis. The model does not include the non-significant interaction band size x supplementary band x recovered; and therefore it assumes that the effect of supplementary bands on recovery rate is the same for all band sizes and that the effect of band size on recovery rate is the same for bandings with and without supplementary bands. These estimates of the average number of bandings needed to obtain one recovery are likely to be maximum values (especially with address bands) because reporting of recoveries is probably incomplete.

Analyses of recoveries of size 2 and 3 bands showed that there was no effect of period of banding (1975-1984 vs 1985-1990) on recovery rate in the first two years ($P = 0.5491$) or on overall recovery rate ($P = 0.2332$). Also the difference in recovery rates between the two band sizes was unaffected by the period of banding ($P = 0.6944$ for recoveries in the first two years; $P = 0.5982$ for all recoveries).

Source of recovery reports with and without supplementary address bands

We compared the number of recoveries reported directly by the finder with those reported in other ways, for birds banded with and without supplementary address bands (Table 5). Reports by the finder increased significantly from 39% (11/28) without address bands to 65% (40/62) when address bands were used ($\chi^2 = 5.00$, d.f. = 1, $P = 0.025$). A log-linear analysis of recoveries received by December 1992 showed that the rate of re-

Table 4. Recoveries of birds banded at LPBO with supplementary bands bearing two different addresses and regular bands of sizes 0, 1, 1B and 1A.

		Regular Band Size			
		0	1	1B	1A
U.S. address*** 1984-1986	No. Banded	24,720	4,458	11,576	2,668
	No. Recovered Anytime	10	1	11	6
	No. Recovered First 2 Years*	8	1	8	4
	Recovery Rate** Anytime	0.40	0.22	0.95	2.25
	Recovery Rate** First 2 Years*	0.32	0.22	0.69	1.50
Canadian Address*** 1988-1990	No. Banded	22,971	2,297	8,784	1,855
	No. Recovered Anytime	16	2	7	3
	No. Recovered First 2 Years*	14	0	7	2
	Recovery Rate** Anytime	0.70	0.87	0.80	1.62
	Recovery Rate** First 2 Years*	0.61	0	0.80	1.08

* & ** See footnotes, Table 1.
*** See methods for details of the addresses.

porting of recoveries by finders increased significantly by an average of 3.96 times when supplementary bands were used ($P < 0.0001$). Other recovery reports also increased by 1.46 times, when supplementaries were used, but this increase was not significant ($P = 0.2406$).

Alternative addresses

We tested for differences in recovery rates of birds banded with supplementary address bands bearing U.S. and Canadian addresses. Although there seemed to be an increase in the recovery rate of size 0 bands when the Canadian address was used, the same was not true of the other band sizes (Table 4). Nevertheless, the effect of the alternative addresses on recovery rates did not vary significantly with band size ($P = 0.5154$ for recoveries in the first two years; $P = 0.4059$ for all recoveries) nor was there a significant effect of the address on recovery rate across all band sizes ($P = 0.3426$ for recoveries in the first 2 years; $P = 0.4196$ for all recoveries).

Table 5. Numbers of recoveries reported directly by the finder and in other ways for birds banded with and without supplementary address bands and regular bands of size 0, 1, 1B and 1A.

	Reported by	
	Finder*	Other*
Without address band**	11	17
With address band**	40	22

* Finder = Who Reported Code 21 (reported by finder, his or her family or other acquaintances). Other = Who Reported Codes 20 (miscellaneous), 22 (reports by federal, state or provincial conservation agency personnel of bands found by themselves or reported to them by members of the public) and 23 (reports by bird banders other than those covered by code 22).

** Recoveries received to December 1992 of birds banded without address bands in 1975-1984 and with address bands in 1984-1990.

Location of reported recoveries in relation to the address on the supplementary band

Recoveries in the U.S. decreased from 54% to 43% and those in Canada increased from 39% to 50% when supplementary bands with the Canadian return address replaced those with the U.S. return address, but these changes were not significant (Table 6, $\chi^2 = 0.69$, d.f. = 2, $P = 0.707$).

Tests of delivery of letters bearing alternative Canadian addresses

Ten letters mailed in Ontario bearing the address NAT MUS OTTAWA CANADA were delivered 4-10 days after mailing (mean 6.6 days). Ten letters with the address NAT MUS CANADA K1A 0M8 were delivered 3-9 days after mailing (mean = 5.7 days). Four additional letters with the first address plus a sender's return address were delivered 5 or 6 days after mailing (mean = 5.8 days).

Two letters (with the first address) mailed in Ohio, one in Georgia, one in Florida and one in California were correctly delivered within 13 days of mailing. Two others mailed in Louisiana both arrived safely. Only one of two letters mailed in Venezuela was delivered.

Table 6. Numbers of recoveries reported in Canada, U.S. and elsewhere of birds banded at LPBO with supplementary address bands bearing U.S. and Canadian return addresses.

	Recovery Location		
	U.S.	Canada	Other*
U.S. address**	15	11	2
Canadian address**	12	14	2

* With the U.S. address: 1 in Belize and 1 in Guatemala; with the Canadian address: 2 in Cuba.

** See methods for details of the addresses. Recoveries are of birds banded with regular bands of sizes 0,1,1B and 1A, with U.S. address bands in 1984-1986 and with Canadian address bands in 1988-1990.

DISCUSSION

The results reported here do not constitute a strictly controlled experiment on the effectiveness of supplementary address bands as a means of increasing recovery rates, because bandings with and without supplementary bands were done in different periods and the proportions of species involved may have differed. We did not undertake a controlled experiment because we were convinced that supplementary bands would have a positive effect on recovery rates and we wished to reap the benefits to the greatest extent possible rather than continuing to band thousands of birds without supplementaries, as would be necessary to conduct a rigorous experiment. Nevertheless there is ample evidence from our work that supplementary address bands increase the numbers of recoveries.

Recovery rates by the public of sizes 0, 1, 1B and 1A bands increased by an average of 143% (2.43 times) for birds banded during the period when supplementary bands were used (1984-1990) compared with rates for the preceding period when they were not used (1975-1984). There was no change in recovery rates between the two periods (1975-1984 vs 1985-1990) of sizes 2 and 3 bands, which were used without supplementary bands throughout.

Supplementary address bands can affect recovery rates in two ways. First, the mere presence of a second band may increase the chance that a finder notices that a bird is banded. Second, the inscription on the supplementary band provides an obvious and reasonably clear instruction to the finder. A higher proportion of recoveries originated from a report by the finder (65%) when supplementary address bands were used than when they were not used (39%). Moreover, the reporting rate by finders increased and the rate from other sources did not change significantly. The latter result indicates that the increased recovery rate of birds with supplementary bands is primarily attributable to the address on the band, because the presence of a second band should have an equal effect on reporting rates from all sources. Overall, these results support the hypothesis that the finders of birds with a regular band often do not see the address on the inside of the band. The finder

may report the band to a conservation agency or to a bander, but probably many recoveries are not reported because the finder does not know what to do. Our evidence indicates finders of supplementary bands more often respond by sending a report directly to the address on the band. Supplementary bands did not result in a reduction in reports from other sources (there was a non-significant increase of 1.46 times), indicating that the increased reporting rate by finders did not represent a redirection of reports that would otherwise have been channelled through conservation agencies and bird banders. There is little doubt that the response of finders to the clearly visible inscription on the supplementary band is the main reason for the increased recovery rates of birds banded with supplementary address bands.

Replacement of the standard U.S. address by a Canadian address on the supplementary bands had no significant effect on the recovery rate or upon the location of recoveries (U.S. versus Canada). Nevertheless, there was an interesting tendency for there to be more recoveries in the country named on the band. Also, the recovery rate of size 0 bands almost doubled when the Canadian address replaced the U.S. address (Table 4), although the difference was not significant. If real, this difference may be related to the lack of the word INFORM on sizes A and B of the U.S. address supplementaries, rather than to the different addresses. The possible importance of a direct instruction such as INFORM, WRITE or ADVISE should not be overlooked. However, larger sample sizes will be needed to confirm these effects, if they are real.

At present prices and exchange rates, the supplementary bands used at LPBO cost approximately 8 cents (U.S.) each. Therefore, banding of 92,287 birds with supplementary bands from 1984 to 1990 cost \$7,383.00. Sixty-two recoveries have been obtained instead of the approximately 24 that would have been expected at the rates that occurred without supplementary bands in 1975-1984. Therefore, the additional 38 recoveries cost about \$194.00 each, although this amount will decrease if more recoveries are reported. This seems costly, but it is a relatively small proportion of the real total cost per recovery of birds banded at LPBO and it represents a substantial return of additional information on the investment made in banding.

Nevertheless, the more economical way to make the address more obvious is to place it on the outside of the regular band. It has been argued that there is not enough space on the smaller band sizes for both the address and a long series of numbers. There are two changes that can contribute to a solution to this problem. First, the numbers and letters could be made smaller. Size 0 bands have two rows of numbers: the prefix on the first line and the suffix on the second. Currently the suffix is printed in larger numbers than the prefix. Both sets of numbers have to be read. The prefix is legible and there is no reason for the suffix to be printed in larger characters. Moreover, the alphabetic characters on the inside of regular size 0, 1, 1B and 1A bands and those on the outside of size 2 bands, as well as those on our supplementary bands and both the alphabetic and numeric characters on the smallest sizes of BTO bands are all about half the height of the prefix number on size 0 bands, yet all are perfectly legible. Clearly, there is plenty of scope for reducing the size of the inscriptions. Secondly, the length of the band "number" that has to be used can be reduced by including alphabetic characters in the prefix, as is common practice in many other banding schemes. Because there are 26 letters in the alphabet but only 10 digits in the decadecimal numbering system, many more unique combinations are available with a given number of characters if alphabetic characters are used.

The Fish and Wildlife Service recently introduced a new design of size 0 band and we understand that similar changes will soon be made to sizes 1, 1B and 1A. The new size 0 is slightly smaller in diameter than the old one and is therefore more suitable for birds with small feet and tarsi such as Golden-crowned Kinglets (*Regulus satrapa*). The serial numbers are smaller and the words "OPEN" and "ABRE" are inscribed vertically adjacent to the butt-ends of the band. Another change is that the inscription on the inside of the band is BIRD BAND LAUREL MD 20708 USA.

This new design appears to be a step in the right direction, but as far as we are aware its effects on recovery rates have not been tested. It remains to be determined whether finders of these bands will follow the instruction to open them and will send their reports to the address indicated. The effect of the change in the address and omission

of the word "AVISE" are unknown. Another concern is that people who find or capture live birds will attempt to open the bands--a difficult and dangerous procedure even for experienced bird banders. Moreover, if the band is successfully removed, the bird may be released without the band.

The impact of the new design on recovery rates needs to be thoroughly tested and assessed before it is accepted as the solution to the low recovery rates of the small bands. We know that banders can increase substantially the recovery rates of the birds they band by adding supplementary address bands bearing a return address. The recommendation that follows from that knowledge is that the small band sizes and their numbering systems should be redesigned to accommodate a return address on the outside of the band. We should not be satisfied with other options unless they have been proven to perform equally well or better.

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