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ANALYSIS OF BANDING RECORDS OF LOCAL POPULATIONS OF BLUE JAYS AND OF REDPOLLS AT GRANBY, MASS.

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Such is the fascination of bird-banding that the gathering of data can easily become an end in itself. We must not lose sight of the fact that banding is properly a tool of ornithology; the raw data which accumulate in government or private records are of potential rather than real value until studied and shared with others.

Scientific analysis of banding data sounds like a formidable job beyond the reach of most individuals, yet that is far from the truth. Ornithology contains a body of multitudinous small questions of a specific nature which can be answered only by the detailed information in banders' personal files. The data reported to the Fish and Wildlife Service are not necessarily the most fruitful source of answers. Of great value are the repeats and other notes from a single avian community season after season. By their very nature these data are so massive that condensation and analysis must be done by the individual.

Two examples of this form of investigation are offered in the present paper; the one deals with the population of Blue Jays over a two to three-year period at a banding station at Granby, Mass., and the other refers to the appearance of a flock of Redpolls at the same station in the early spring of 1962; the first part is of a qualitative and the second of a quantitative nature. In the course of this study a number of questions have been formulated and partially answered about these two species in the Connecticut Valley.

Status of the Blue Jay in the Connecticut Valley

It seems surprising that there should be gaps in our knowledge about a species as prominent as the Blue Jay, yet there is room for investigation of its behavior, migration habits, and social relations.

The Jay has shown a marked change in habit over the last 100 years. In 1864 Allen (Bagg and Eliot, 1937) referred to the Jay as a forest bird which visited orchards in summer and corn cribs in winter. In contrast, Forbush (1929) noted the bird's reputation as a bold fellow, while Bagg and Eliot (1937) wrote that, though the Jay was still shy in wild areas, adaptable individuals were increasingly nesting near city streets. Apparently a change has occurred. Evidence of the acquired fearlessness of the Jay is the readiness with which it now enters conventional cage traps at banding stations. Between June, 1960, and March of 1963 some 778 Jays were banded at Station #8306, Granby, Mass. (Table 1).

TABLE 1. NUMBERS OF BLUE JAYS BANDED PER MONTH AT STATION #8306, GRANBY, MASS., FROM ITS ESTABLISHMENT IN JUNE, 1960, TO MARCH, 1963.

	1960	1961	1962	1963
January		0	0	123
February		9	0	83
March		4	0	24
April		0	6	
May		19	260	
June	8	0	0	
July	13	10	12	
August	12	11	25	
September	18	16	17	
October	5	8	7	
November	0	19	9	
December	0	3	57	
Totals	56	99	393	230

Although it cannot be doubted that the Jay as a species is a permanent resident in the Connecticut River Valley, there seems room for question as to the status of individual birds. Two populations of Jays exist, according to both Forbush (1929) and Bagg and Eliot (1937). Many Jays are said to be strictly permanent residents, while others belong to a migrant population which passes through the Valley each fall and spring, but winters farther to the south and nests to the north.

As evidence for the permanent residence of individual Blue Jays, Bagg and Eliot (1937) cited two banding records. A Jay banded in June, 1929, in Northampton was found dead in the same location 5 years later, and one banded in Ware, Mass., in July of 1932 was found there again in February, 1935. Evidently the two birds in question were not trapped between the times mentioned. The records would thus officially be called returns, and no evidence was

presented that they had remained in the area over the span of years involved.

Laskey (1958) banded 1,000 Jays in Nashville, Tenn., from 1932 to 1957. She concluded that the bulk of Jays migrates in spring and fall, others are permanent residents in Nashville, but some may change their status between being migrants and residents. One female hatched in Nashville migrated her first winter, returned to breed and winter-over the next year, and again migrated the third winter.

The present contribution is an analysis of the banding records for the 778 Blue Jays banded between June, 1960, and March, 1963, at Station ✱8306, Granby, Mass. Monthly figures show extreme variations from zero for several individual months to 260 for May, 1962; and monthly totals show from 6 for April to 279 for May (Table 1). Examination of the totals from June, 1960, through May, 1962, might lead to the generalization that few Jays are banded in winter, but the figures for the winter of 1962-63 virtually reverse the situation. No annual pattern stands out in Table 1. The total for May, 1962, reflects a mass movement from the south, whence an unusually large number of Jays had migrated, apparently because of a northern acorn shortage (Logan, personal communication).

A study was made of the 40 Jays which had been banded between June, 1960, and November, 1961, and which had been trapped subsequently through December, 1962. The records of their captures have been arranged in Table 2 according to the seasons, spring (February-May); summer (June, July); fall (August-November); winter (December, January). The individuals listed under group A were banded in 1960, those under group B in 1961. Of the 40 Blue Jays, 24 or 60 percent were caught one year or more after banding; three or 15 percent of the 1960-group A birds were trapped two years later.

The majority of the returning birds, 29, were banded in the spring or fall, but these cover a total of 8 months as against two each for the summer and winter seasons. This helps explain the fact that all but two Jays (✱015 and ✱157) were caught in at least one migratory season. Of the 29, 21 were again caught only in these migratory seasons and possibly represent migratory individuals. Nine of them were trapped in the next (half-yearly) migration, while an additional 11 were not retrapped until a full year after banding, presumably headed in the same direction as the first time captured. A bird banded in the fall of 1960 headed south for the winter might again be captured in the spring of 1961 as it returned north to breed, or it might not be identified until the fall migration of 1961, when it was again headed south. Those which were absent from the records on the return migration might have taken a different route when headed the other way, or perhaps simply passed by untrapped. For example, Jay ✱055 was caught one and one-half and again two years after banding.

Of the rest of the 29 Jays banded in spring or fall, 7 appeared in traps also in winter and one in summer. All three birds banded in winter were retrapped in spring or fall. Six of the 8 banded in summer were also caught again in spring or fall. Thus 17 individuals

TABLE 2. CAPTURES OF 40 BLUE JAYS BANDED AT STATION #8306, GRANBY MASS., BETWEEN JUNE, 1960, AND NOVEMBER, 1961, WHICH HAD RETURNED BY DECEMBER, 1962. ONLY THE LAST 3 DIGITS OF THE BAND NUMBER ARE GIVEN; THE COMPLETE NUMBER WOULD READ 643-97000.

Band No.	1960 Sum.	1960 Fall	1960 Wint.	1960 Spr.	1961 Sum.	1961 Fall	1961 Wint.	1961 Spr.	1962 Sum.	1962 Fall	1962 Wint.
Group A.											
001	s	x									
002	s			x							
005	s	x		x							
006	s	x			s						
015	s				s						
019	s									x	
021		x		x							
022		x		x							
024		x		x			w				
051		x		x		x					
054		x								x	w
055		x						x		x	
064		x		x							
068		x		x							
069		x				x					
071		x				x					
081		x				x					
094			w	x		x					
096			w	x							
Group B											
208			w							x	
242				x		x					
028				x				x			
029				x				x			
031				x						x	w
043				x				x		x	
045				x				x			
157					s		w				
159					s	x				x	
165						x				x	
166						x		x			
170						x					w
172						x				x	
182						x					w
188						x					w
246						x				x	
254						x				x	
256						x		x	s		
270						x		x			
275						x	w				
277						x		x			

First symbol for each bird represents banding; subsequent symbols refer to later captures.

x = captured in migratory season.

s = captured in summer; w = captured in winter.

were captured in the migratory seasons and in either summer or winter. One of the 8 summer-banded birds (⁂157) was trapped only in winter, one (⁂015) only in the summer, and one of them (⁂006) was retrapped in the fall and summer, and so was included among the above 17 individuals. Jay ⁂157, since it was trapped in both summer and winter, must have been a permanent resident that year and, as these are non-migratory seasons, the other 7 summer-banded birds, the summer-caught "migrant", the 3 winter-banded birds, together with the 7 winter-trapped "migrants" might also represent permanent residents instead of summer or winter residents, or they may have undergone changes in status.

Since the Jays do not exactly follow the "migratory seasons" (February-May and August-November) used here, some of the 21 individuals which were trapped only in spring or fall may actually have been summer, winter, or permanent residents. Jays seem to respond only irregularly to traps; repeat records showed only a handful of them that gave evidence of their presence at the station for more than a few days, whereas surely some must have stayed longer than that. Thus the fact that a given Jay was not trapped in summer or winter does not necessarily suggest its absence, as it might with other species. And 8 of the birds banded in migratory months were later trapped in summer or winter.

If some Jays are permanent residents (⁂157 and probably others, even though as yet banding records fail to prove them so) this would agree with the belief of Forbush (1929) and Bagg and Eliot (1937) that Jays exist locally as at least two populations in the Connecticut Valley — permanent resident and migrant. Until further analysis is made over a longer period, one must not rule out the possibility of some individuals being summer and others winter residents; still others (e.g. ⁂024, ⁂094, and ⁂159) have given evidence in different years of both resident and migratory status for a given season. This lends support to the conclusion of Laskey (1958) that individual Jays may change status in an area from migrant to resident or the reverse more than once in a lifetime.

The regular spring and fall migrations by Jays are made in "straggling bands" (Bagg and Eliot, 1937). Forbush (1929) referred to fall movements by groups from under 50 to over 100 birds, but he wrote that in spring the Jays commonly appear in pairs, which might be traveling slowly northward. The irregular local winter movements in search of food are executed by large flocks. It may be wondered whether these groups represent stable associations of Blue Jays, or whether they are strictly transitory. Some evidence was found in the return and repeat data, for 8 groups or pairs of Jays appeared together at the banding station more than once: ⁂002 and ⁂005; ⁂022 and ⁂024; ⁂064 and ⁂068; ⁂069, ⁂071, and ⁂081; ⁂043 and ⁂045; ⁂182 and ⁂188; ⁂246 and ⁂254; ⁂270 and ⁂277. Care must be used that the regularity of migration is not taken as indicative of associations that do not actually exist among the Jays. The case is definitely not clear-cut, and data covering a far longer span of time would allow much more valid investigation.

Conclusions:

1. The Blue Jay has changed since the turn of the century from a shy bird to a regular customer at feeding stations.

2. Jays may exhibit great fluctuations in numbers in an area from month to month.

3. From a preliminary study of return data for individual birds, some Jays are permanent residents in the Connecticut Valley; many appear to be migrants; others may even be summer or winter residents, and some may alter their status from year to year.

4. Records indicate that Jays move in semi-permanent associations or pairs.

Analysis of Repeat Records of an Invasion of Redpolls

Though no major invasion of Redpolls occurred in Massachusetts in 1962, a flock frequented the banding station at Granby from March 3 to April 5 and 122 of them were banded. Through measurements it was confirmed that two of them were Greater Redpolls, *Acanthis hornemanni exilipes* while the remainder were the Common Redpoll, *A. linaria linaria.*

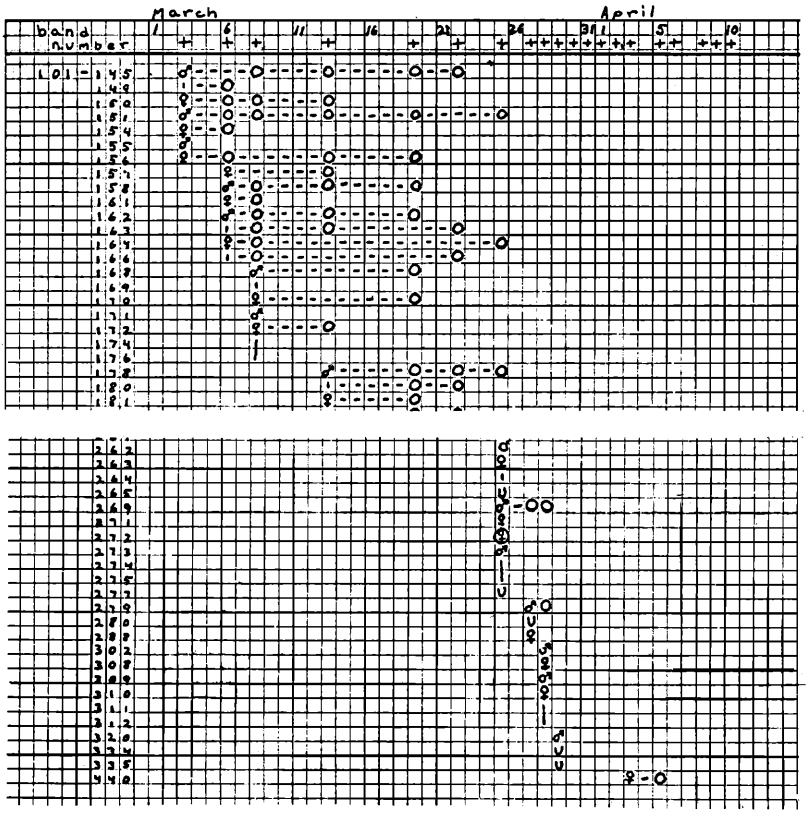
Compared with, for example, Tree Sparrows, the likelihood of recoveries of Redpolls is slight once they have returned to the north. However, exactly half, 61, of those banded were recaptured during this invasion period at the station and these repeats were accurately recorded. What questions might be answered through an analysis of these repeat data? Borror (1948) by using statistical methods on repeat data of White-throated Sparrows was able to present a number of fruitful conclusions. He wrote that his paper was "a new approach to the solution of certain problems of bird migration and bird behavior . . . ." Though Borror's study involved many seasons' work with a migratory species which passed through each year in a regular manner, his methods seemed applicable to the Redpoll problem. Three categories of information about the invasion were sought, 1) lengths of stay for individuals and the flock, 2) the changing population pattern produced by the invasion movement from day to day, and 3) whether the number of birds passing through the station was much larger than the number entering traps.

The birds were sexed by color when possible. Those captured comprised 37 males, 74 females, and 11 unknowns; a ratio favoring the females. A similar imbalance was found in an incursion of Evening Grosbeaks (Mason and Shaub, 1949), and this was attributed to differences in the winter movements of the two sexes and not to an actual surplus of females in the species. Possibly the same phenomenon occurs among Redpolls. There appeared to be negligible differences in the arrival, average length of stay, and repeat behavior of the two sexes, so the Redpolls were treated as a single group in the present investigation.

The data for the 122 banded Redpolls were organized as illustrated in Figure 1 with the first and last 24 individuals trapped. Certain information was obtained from an analysis of these records.

Figure 1. Sample of banding records of Redpolls at Station #8306, Granby, Mass. Shown are the first and last 24 individuals banded from the Spring, 1962, flock.

♂ male trapped	o repeat
♀ female trapped	- assumed present
u unknown trapped	+ trapping day



1) Repeats and length of stay.

In comparison with birds banded at the onset of the invasion, those banded late rarely repeated and were presumably in the area only a short period after banding. Thus of the first 24 trapped 19 became repeats and stays varied from three to 22 days, while of the last 24 birds banded only 4 repeated and the maximum stay was 4 days.

The analysis also revealed a correlation between the time a bird stayed and the number of times it was caught (Table 3). Thirty-six individuals repeated once staying at least one to 13 days, 14 twice remaining 4 to 20 days, 8 three times remaining 9 to 17 days

TABLE 3. SUMMARY OF REPEATS PER LENGTH OF STAY FOR A FLOCK OF REDPOLLS AT STATION #8306, GRANBY, MASS., IN SPRING OF 1962. SEE TEXT FOR EXPLANATION.

Length of Stay in Days	Number of Repeats 1	2	3	4	5	Total Birds for each Length of Stay	Aver. No. Captures per Trap Day
1	1					1	2.00
2	1					1	1.00
3	2					2	1.00
4	9	1				10	1.00
6	1					1	1.00
7	13	2				15	.89
8	1					1	.67
9	1		1			2	.58
10	4	5	1			10	.87
11			1			1	1.00
12	2					2	.53
13	1	2	1	1		5	.64
14			2			2	1.00
16		1				1	.50
17		1	2			3	.73
18		1				1	.38
20		1		1		2	.66
23					1	1	.86
Total	36	14	8	2	1	61	
Aver. No. Captures per Trap Day	.92	.76	.73	.65	.86		Grand Average .85

while two repeated 4 times staying 13 and 20 days, and one 5 times staying at least 23 days. The correlation is seen as a tendency for figures to cluster about a diagonal line from upper left (short stay few repeats) to lower right (long stay, many repeats). Since numbers were small, a statistical test of correlation was not performed.

Blake (1948) discussed the variables affecting the spacing of repeats. Using Junco repeats as an example, he found that no familiar statistical distribution fitted the spacing of repeats. The period between captures depended on a great number of factors, among them the rate at which the bird made its rounds of nearby food sources, the duration of trap shyness after a given capture, weather, accidental factors, and, a major element, the timing of trap operations. A bird might be in the zone of attraction of the traps, yet would not be captured if traps were inoperative. Thus if a bird were trapped the first day and were present the third and fifth days, while trapping was done the fourth and sixth days, the bird would be assumed present for only one day, a highly erroneous judgement.

In the case of Redpolls, the effect of spaced trapping was probably not so disastrous to results as in the above example, for the banded birds appeared to be confined to the vicinity of the banding station, indicating that they had a very narrow feeding range. If so, then any bird present would be nearly certain to be in the banding zone

whether it was a trapping or a non-trapping day. It should be noted that banding occurred sometimes daily, but sometimes after a lapse of from one to 4 days, which caused some distortion of the figures in Table 3; thus large numbers of Redpolls are grouped at stays of 4, 7, and 10 days.

2) Daily Populations.

Mathematical methods of population estimate using the capture and marking of but a portion of the population studied are as a rule based on the Lincoln Index, named after the man who adapted Petersen's fish study methods to bird-banding. For a summary of other statistical methods, the reader is referred to Davis (1951). The basic Lincoln Index equation reads:

$$\frac{\text{total marked in population}}{\text{total population}} = \frac{\text{marked recaptured in sample}}{\text{total sample}}$$

Since the other three of the parameters are known, total population may be calculated. The main difficulty lies in the degree of sampling error. Borror (1948) selected two forms of the Lincoln Index for independent estimation of total daily populations. These have now been employed for estimation of Redpoll populations and are represented in Table 4. The data as referring to the trapping day of March 8 have been chosen to illustrate the application of both methods.

Method 1:

Assuming that the sample of birds trapped on a particular day is representative, banded individuals will appear in it in the same proportion as in the population at large:

$$\frac{\text{Number of banded birds trapped, B}}{\text{Number of banded birds present, A + B}}$$

$$= \frac{\text{Number of unbanded birds trapped, U}}{\text{Number of unbanded birds present, N} - (\text{A + B})}$$

$$= \frac{\text{Total number of birds trapped, C}}{\text{Total number of birds present, N}}.$$

Since $\frac{C}{N} = \frac{B}{A+B}$, then $\frac{N}{C} = \frac{A+B}{B}$. Quantities for all but N are known, and the equation in its final form is written

$$N = \frac{C(A+B)}{B}.$$

TABLE 4. BANDING DATA AND ESTIMATES OF DAILY POPULATIONS FOR A FLOCK OF REDPOLLS AT STATION #8306, GRANBY, MASS., IN SPRING OF 1962.

	Banding Data					Estimates of Daily Populations Method #1		Method #2	
Date	U	B	C	A	K	N	C/N	N	C/N
3/03	7	0	7	0	7	—	—	11.9	.59
3/06	7	5	12	1	13	14.4	.83	20.0	.60
3/08	7	9	16	2	18	19.5	.82	56.5	.28
3/13	36	9	45	4	49	65.0	.69	86.5	.52
3/19	16	23	39	10	49	56.0	.70	100.0	.39
3/22	25	18	43	6	49	57.5	.75	98.5	.44
3/25	11	17	28	8	36	41.1	.68	76.5	.37
3/27	3	3	6	10	16	26.0	.23	48.5	.12
3/28	6	11	17	1	18	18.6	.93	39.5	.43
3/29	3	0	3	4	7	—	—	30.5	.10
3/30	0	2	2	2	4	4.0	.50	5.5	.36
3/31	0	1	1	1	2	2.0	.50	3.0	.33
4/01	0	0	0	2	2	—	—	2.0	.00
4/02	0	0	0	2	2	—	—	2.0	.00
4/03	1	2	3	0	3	3.0	1.00	3.0	1.00
4/05	0	1	1	0	1	1.0	1.00	2.0	.50
4/06	0	0	0	0	0	—	—	0.5	.00
	total 122 birds trapped					average .69		average .35	

U = number of unbanded birds trapped.
B = number of banded birds trapped.
C = total number of birds trapped (U + B).
A = number of banded birds assumed to be present but trapped at a later date.
K = total number of birds known to be present (C + A).
N = estimated total number of birds actually present.

For March 8 this would be N = 16 (2 + 9) ÷ 9 = 19.5. That is, the population of Redpolls on March 8 is estimated to have been 19.5 individuals (Table 4).

Method 2:

The second method of estimating population uses the Lincoln Index directly. Each banding day in turn is taken as the marking day (d1), and the total number of birds known to be present is obtained (K); the next banding day (d2) is taken as the sampling period, and the resulting value of N is regarded as applicable to both days (d1 and d2) involved. Since each day is used both as d1 and as d2, two values of N are obtained for a given day, and their average represents the final value of N. The equation is

$$\frac{\text{Total no. birds known present on d1, } K_{d1}}{\text{Total no birds actually present on d1 and d2, N (d1 \& d2)}} = \frac{\text{No. banded birds trapped on d2, B d2}}{\text{Total no birds trapped on d2, C d2 .}}$$

Thus $\frac{N(d1\ \&\ d2)}{K\ d1} = \frac{C\ d2}{B\ d2}$ and $N(d1\ \&\ d2) = \frac{K\ d1 \times C\ d2}{B\ d2}$. The March 8 population estimate would be the average of $N = 13 \times 16 \div 9 = 23.1$ and $N = 18 \times 45 \div 9 = 90$, or 56.5 individuals.

The results from the two methods are best compared in graph form (Figure 2). It is apparent that the Redpolls arrived in a single wave which crested near the center of the invasion period. The estimated population figures greatly exceed the actual number of birds known to be present (K), though all three lines converge at either end. This may be explained by the fact that the actual figure (K) is inflexible, while the estimated figures allow more or less for the continuous process of arrival and departure of individuals within the population.

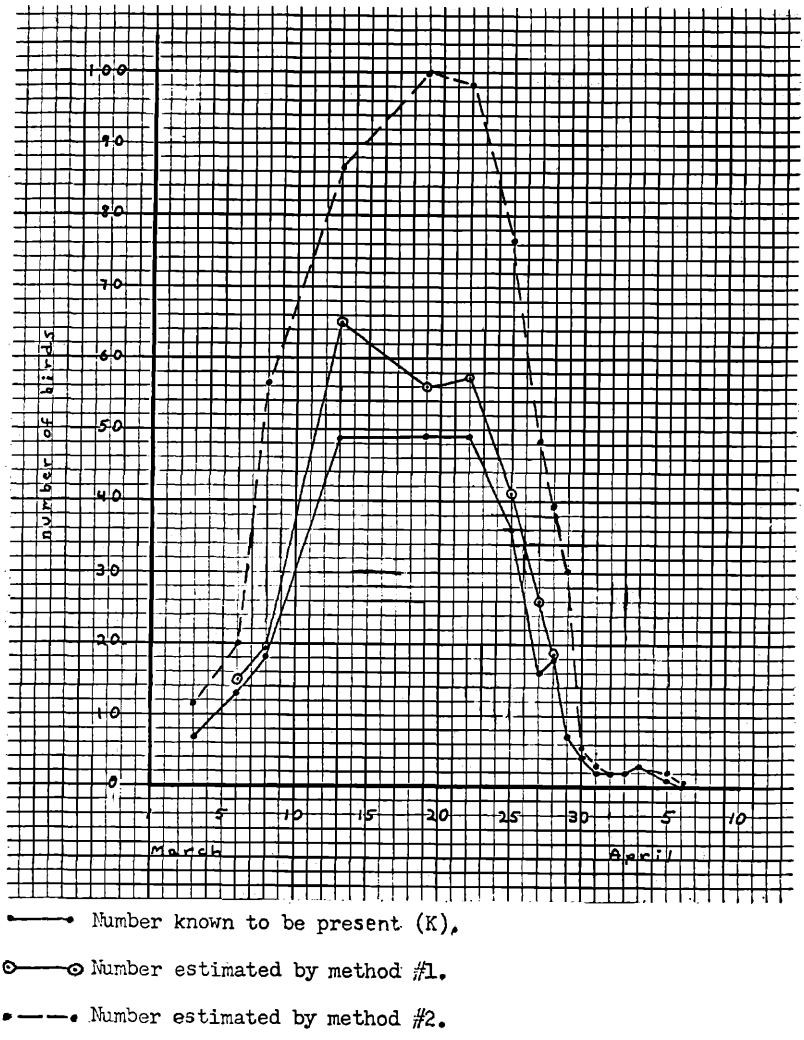
The estimated figure by method 1 is by far the more conservative, since a minimal figure (A + B) was used for the number of banded birds present. Borror (1948) considered this the more reliable of the two methods of calculation.

Use of the Lincoln Index and its modifications involves several assumptions that should be examined in relation to bird trapping (Hayne, 1949, and Davis, 1951). Unless special allowance is made, the population must be closed (i.e. negligable mortality, no addition or disappearance of bands). For representative sampling, marked animals must be randomly distributed throughout the population, and must stand no better or worse chance of capture than the unmarked individuals.

The present investigation allowed for rapid population turnover by considering the invasion as a series of short periods during each of which the population was regarded as closed. Hayne (1949) pointed out that use of very short periods is subject to error due to necessarily small samples, while allowance of a long interval between marking and sampling would tend to inflate estimations of original population.

One flaw in the taking of samples lay in the possible development of trap-shyness or trap-habit among banded birds. As a test of this, the average numbers of captures per trap day were figured both according to length of stay and number of repeats (Table 3). The average was calculated as the number of times a bird was captured (repeats + 1 for banding) divided by the number of opportunities for capturing it (number of trapping days) during the period of its known stay. For example, two birds stayed 9 days: band ⁂218 had $\frac{2\ \text{captures}}{4\ \text{trap days}} = .50$, while ⁂248 had $\frac{4\ \text{captures}}{6\ \text{trap days}} = .66$; the average for 9 days is thus .58 captures per trap day. It should be noted that no constant change in averages occurred either as stays grew longer or as more captures were experienced by the individual (Table 3). Thus trap-shyness and trap-habit seem negligible.

Figure 2. Estimated daily populations for a flock of Redpolls at Station #8306, Granby, Mass., in Spring of 1962.



3) Total number of Redpolls in flock.

It may now be asked whether the actual number in the flock frequenting the banding station much exceeded the number banded.

First, the probability (p) of a bird being trapped must be found. It has been calculated in the following two ways:

1. By averaging the number of captures per day of repeating birds, giving .85 (Table 3).

2. By dividing the number of birds trapped (C) by the estimated number in the population (N), the resulting C/N value depending on whether method 1 or method 2 was used in obtaining N (Table 4).

Once p is found, (1-p) is the probability that a bird will not be caught in a day, since the probabilities that an event will and will not occur must, by definition, be equal to one. For a bird present n days, $1-(1-p)^n$ is the chance that it will be caught, and thus $1-1-(1-p)^n = (1-p)^n$ is the probability that it will not be caught at all during its stay. In other words, in a group of birds staying an average of n days, about $(1-p)^n$ will come and go without being trapped. The fact that $(1-p)^n$ rapidly approaches zero in the course of the invasion (Table 5) shows that birds banded late were prob-

TABLE 5. ESTIMATION OF THE TOTAL NUMBER OF REDPOLLS PASSING THROUGH STATION #8306, GRANBY, MASS., DURING THE SPRING OF 1962.

		p aver. no. captures per day (Table 3) .85		p aver. of daily C/N values (Table 4) Method 1, p .6900		Method 2, p .3500	
n	YN	$(1-p)^n$	Tn	$(1-p)^n$	Tn	$(1-p)^n$	Tn
1	1	.1500	1.18	.3100	1.45	.6500	2.86
2	1	.0225	1.02	.0960	1.10	.4223	1.73
3	2	.0034	2.00	.0300	2.06	.2745	2.76
4	10	.0005	10.00	.0092	10.10	.1785	12.19
6	1	.0000	1.00	.0009	1.00	.0754	1.08
7	15	.0000	15.00	.0003	15.00	.0490	15.78
8	1	.0000	1.00	.0000	1.00	.0318	1.03
9	2	.0000	2.00	.0000	2.00	.0207	2.02
10	10	.0000	10.00	.0000	10.00	.0135	10.12
11	1	.0000	1.00	.0000	1.00	.0088	1.00
12	2	.0000	2.00	.0000	2.00	.0057	2.00
13	5	.0000	5.00	.0000	5.00	.0037	5.00
14	2	.0000	2.00	.0000	2.00	.0024	2.00
16	1	.0000	1.00	.0000	1.00	.0010	1.00
17	3	.0000	3.00	.0000	3.00	.0007	3.00
18	1	.0000	1.00	.0000	1.00	.0004	1.00
20	2	.0000	2.00	.0000	2.00	.0002	2.00
23	1	.0000	1.00	.0000	1.00	.0000	1.00
Total	61		61.20		61.71		67.57
Ti			122.5		123.5		135.1

p = probability of a bird being captured on 1 day.
n = length of bird's stay in days (Table 3).
Yn = no. of repeating birds that stayed n days (from Table 3).
Tn = total no. of birds that stayed n days.
Ti = total no. of birds in flock.

ably actually late arrivals, since the probability is low by then that any bird could have been present the entire time without being trapped.

To estimate the number of Redpolls present, calculations were based on the number of repeats per length of stay from Table 3:

No. repeating birds that stayed n days, Yn
= Total no. in group, Tn
× probability a bird will be caught at least once, $1-(1-p)^n$.

Since all but Tn are known, the equation is rearranged,

$$Tn = \frac{Yn}{1-(1-p)^n}.$$

Thus Tn is an estimate, made on the basis of repeats, of the number of birds that stayed n days. Values were calculated separately for each stay group from one to 23 days using three p values (Table 5). These values from any one method may now be summed up to give an indication of the total number of birds which stayed for all periods from one to 23 days; the results give 61.20, 61.71, and 67.57, as compared with a total of 61 known birds.

These figures are, however, based on repeating birds only. If it is assumed that non-repeating birds stay, on the average, as long as the repeating ones, then the following ratio gives an estimate of the total number of birds (Ti) that were present at one time or another in the flock, whether they were trapped or not:

$$\frac{\text{Total number of birds banded, 122}}{\text{Total number in flock, Ti}} = \frac{\text{Number of birds repeating, 16}}{\text{Number that stayed for all periods, Tn.}}$$

Then $Ti = 122 \times Tn \div 61$.

Several assumptions are involved in this method of calculating Ti. First, it is assumed that the birds passing through do, in reality, stay different lengths of time, and that the stay groups are not just an artifact of the trapping schedule. The second assumption is that all birds have an equal chance of being caught in one day. The third is that non-repeating birds on the average stay as long as the average of those repeating.

The results from all three values of p, 122.5, 123.5, and 135.1 (Table 5), are very close to the number of birds actually banded, namely, 122. An examination of the assumptions seems to show them valid in this case, though there is still the danger of sampling error. If the results are correct, then it may be concluded that nearly every bird in the group frequenting the station was banded, sooner or later. This is supported by Logan's impression that virtually all birds present were banded (personal communication).

Conclusions:

1. There was no significant sex difference in length of stay or repeat behavior.
2. Birds stayed for various lengths of time; longer stays were correlated with more captures.
3. The Redpolls arrived in a single wave that crested near the center.
4. Nearly all birds that arrived at the trapping station were banded.

Both of these investigations should be extended before definite conclusions can be reached, but they are offered as a stimulus to other banders to make a similar analysis of their data and perhaps in this way contribute to a better understanding of the behavior of certain species of birds.

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A THIRTY-YEAR SUMMARY OF THE NESTING OF THE BARN OWL ON MARTHAS VINEYARD, MASSACHUSETTS

By ALLAN R. KEITH

Introduction

The island of Marthas Vineyard is particularly suited as a habitat for all kinds of avian predators. Most of them, including the Barn Owl (*Tyto alba*), are more abundant there than on the adjacent mainland. There are several reasons for this. One is the slightly milder climate in winter due to the influence of the surrounding ocean, and particularly of the Gulf Stream a few miles to the south. Thus, average winter temperatures are higher, and the ground is