RECOVERY RATES AND LOSS OF ALUMINUM, TITANIUM, AND INCOLOY BANDS ON HERRING GULLS

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The loss of standard aluminum bands from long-lived species such as the Herring Gull (*Larus argentatus*) precludes the use of recovery data for certain biological studies. Earlier studies of the problem in Herring Gulls (Kadlec and Drury, 1968, 1969) prompted a trial of bands made of titanium and of incoloy, an alloy principally of nickel, chromium, and iron. To evaluate the new bands, two questions needed to be answered. Do the new bands remain on the birds longer? Are the new bands recovered and reported as readily as the standard aluminum bands?

MATERIALS

The titanium and incoloy bands were manufactured for this study by Lambournes (B'ham) Ltd. of Birmingham, England. They were of the butt-end type, similar to the standard U.S. Fish and Wildlife Service aluminum band. After consultation with Lambournes and the Service, the design was modified slightly to take advantage of a somewhat greater width to make the digits larger. This facilitated the study of band retention by reading band numbers on free-living territorial adults by telescope.

The band materials incoloy and titanium are, of course, substantially harder and stiffer than aluminum. Further, these characteristics led to the speculation that someone finding a dead gull with such a band might be less likely to remove it, flatten it, and return it to the Bird Banding Laboratory.

METHODS

Band Loss

Evaluating comparative band loss was approached by double-banding territorial breeding adults and periodically examining a sample of birds on territory in subsequent years. This method avoided the confounding influence of uncertain reporting of recovered bands to the Bird Banding Laboratory.

Breeding adult Herring Gulls were double-banded on Milk Island, Massachusetts, in 1967. Each bird received an aluminum band on one leg and either a titanium (958 birds) or an incoloy band (1,000 birds) on the other leg. Thus, approximately one-third of the 6,000 $\pm$ breeding adults were double-banded. This made it feasible to examine breeding adults with telescopes for band numbers and missing bands in 1968, 1969, 1971, and 1974.

Recovery Rate

Recovery rates were evaluated by banding young gulls because they have sufficiently high mortality rates to provide an adequate sample of recoveries. Routine banding procedures were used to

band 23,066 flightless young gulls during three years; each young gull received only one band. In all, 7,628 aluminum bands, 7,688 titanium bands, and 7,750 incoloy bands were used. To minimize variation due to differences between years and gull colonies, bands were allocated so that about one-third of the total young banded at each colony in each year received each kind of band. Banding took place in 1967, 1968, and 1969 on islands off the coast of Maine and Massachusetts, and in 1969 on Block Island, Rhode Island. Recovery data were obtained from the Bird Banding Laboratory on IBM punch cards, and processed on the University of Michigan computer system. Statistical analyses were based on methods for binomial distributions (Steel and Torrie, 1968).

RESULTS AND DISCUSSION

Band Loss

In contrast to expectations based on previous work (Kadlec and Drury, 1968, 1969), little loss of aluminum bands occurred over seven years (Table 1). Kadlec and Drury (1968) estimated that loss of aluminum bands commenced about year 4, and increased rapidly to about 20 percent per year by year 6; this was consistent with the information then available on population dynamics. The data in Table 1, however, suggest a very small aluminum-band loss through year 4, and a cumulative loss of only

TABLE 1.
Loss of bands from adult Herring Gulls double-banded in 1967.

	Incoloy			Titanium			Total	
Year	Bands read	Missing Alum.	Inc.	Bands read	Missing Alum.	Tit.	Bands read	Missing Alum.
1968	185	0	0	132	0	0	317	0
1969	168	2	0	152	0	1	320	2
1971	132	0	0	92	1	0	224	1
1974	99	3	0	65	2	2	164	5

about 3.05 percent (95% limits, 1.00 - 6.88%) through year 7. The picture is clouded by the unexpected loss of some titanium bands, which probably leads to a small underestimate of the loss of aluminum bands.

A further complication is the consistently lower number of titanium band numbers read each year. This might be explained by differences in locations of banding and band-reading within the colony, but work on the colony in 1968 and 1969 showed 23 of 30 dead gulls had titanium bands. Perhaps the titanium bands were put on gulls in a portion of the colony where the mortality rate was higher. The suspicious area is the level grassy interior of the island where (a) band reading is difficult and hence we may simply have missed many birds with titanium bands, (b) territories are large,

perhaps suggesting they are less in demand and the turnover of adults is high and (c) the Great Black-backed Gull (*Larus marinus*), which dominates Herring Gull adults, occurs in large numbers.

In spite of these complications, the loss of aluminum bands is clearly later than Kadlec and Drury (1968) believed. However, the condition of the aluminum bands after 7 years was very bad. They were frequently deeply notched at the lower front edge (apparently they do not rotate on the leg) and some numbers were completely worn away. Therefore, it still seems likely that band loss will be severe even though a substantial fraction of the cohort is still alive.

Recovery Rate

Records processed as of 31 August 1973 showed recoveries of 169, 181, and 163 bands of aluminum, incoloy, and titanium respectively (Table 2). The total recoveries averaged 2.22 percent; analysis showed no significant differences ($P > .05$) among the three types of bands.

TABLE 2.
Recoveries from bandings with aluminum, incoloy, and titanium bands, 1967-1969, New England.

	Aluminum	Incoloy	Titanium	Total
Number banded	7,628	7,750	7,688	23,066
Recoveries				
Total No.	169	181	163	513
Percent	2.22	2.34	2.12	2.22

Because the data in Table 2 represent a summation over years, regions, and age at recovery, they were sub-divided to consider the effects of those variables. First-year recoveries are usually a substantial fraction of all recoveries. Statistical comparisons of variations in first-year recovery rates (Table 3) on a pair-wise basis revealed only one significant difference (.05 level)—the recovery rate for incoloy was significantly greater than that for aluminum in 1969 in Massachusetts. The titanium recovery rate in Massachusetts in 1969 was not significantly different from either the aluminum or the incoloy rate. Perhaps the significant difference between aluminum and incoloy rates is spurious; 21 pair-wise comparisons among band types within years and regions were made. Thus one might expect at least one wrong rejection given a long series of trials. The conclusion also is questionable because other trends are noted in the other regions (Maine and Rhode Island). The safest conclusion seems to be that the variations in Table 3 could well be due to sampling error. Note that this is true even though the numbers of recoveries are relatively large; the number required for detecting small differences in recovery rate probably is beyond most field studies.

TABLE 3.
First-year recovery rates, as a percent of number originally banded.

	Aluminum			Incoloy			Titanium		
Year	1967	1968	1969	1967	1968	1969	1967	1968	1969
Maine									
No. banded	323	475	1,933	366	248	1,947	370	256	1,947
Rate	1.24	1.68	1.35	.55	.81	1.23	1.35	1.56	1.03
No. recoveries	4	8	26	2	2	24	5	4	20
Massachusetts									
No. banded	539	885	3,125	480	862	3,099	479	874	3,089
Rate	1.30	1.13	1.06*	1.46	1.39	1.74*	1.46	1.49	1.23
No. recoveries	7	10	33	7	12	54	7	13	38
Rhode Island									
No. banded			348			748			673
Rate			2.30			1.47			0.74
No. recoveries			8			11			5

*Difference between starred rates statistically significant, 0.05 level.

TABLE 4.
Recovery rates, areas combined; 1967-1969 bandings with aluminum, incoloy, and titanium.

	Aluminum			Incoloy			Titanium		
	1967	1968	1969	1967	1968	1969	1967	1968	1969
No. banded	862	1,360	5,406	846	1,110	5,794	8,49	1,130	5,709
Recovery rates									
First year	1.28 (11)[1]	1.32 (18)	1.24 (67)	1.06 (9)	1.26 (14)	1.54 (89)	1.41 (12)	1.50 (17)	1.10 (63)
Second year	0.46 (4)	0.59 (8)	0.31 (17)	0.71 (6)	0.36 (4)	0.35 (20)	0.59 (5)	0.26 (3)	0.51 (29)
Third year	0.34 (3)	0.22 (3)	0.20 (11)	0.12 (1)	0.27 (3)	0.24 (14)	0.12 (1)	0.09 (1)	0.28 (16)
Fourth year	0.46 (4)	0.00 (0)	0.28 (15)	0.12 (1)	0.18 (2)	0.28 (16)	0.00 (0)	0.26 (3)	0.16 (9)
First four years	2.55 (22)	2.13 (29)	2.03 (110)	2.01 (17)	2.07 (23)	2.40 (139)	2.12 (18)	2.12 (24)	2.05 (117)

[1]Number of recoveries in parentheses.

Combining areas (Table 4) permitted comparisons of the band types in each year after banding. No differences were detectable in pattern of recovery; that is, no band type had more or fewer early or late recoveries than the others.

TABLE 5.
Recoveries for first four years following banding in 1967-1969, years and band types combined.

	Maine	Massachusetts	Rhode Island
No. banded	7,865	13,432	1,769
Recovery rates			
First year	1.21 (95)[1]	1.35 (181)	1.36 (24)
Second year	0.42 (33)	0.39 (53)	0.57 (10)
Third year	0.17 (13)	0.27 (36)	0.23 (4)
Fourth year	0.22 (17)	0.19 (25)	0.45 (8)
First four years	2.01 (158)	2.20 (295)	2.60 (46)

[1]Number of recoveries in parentheses.

The analysis of the detailed data in Table 3 included pair-wise comparisons among areas within years and band types, and among years within areas and band types. No differences were significant at the .05 level. This suggested combining areas, years, and band types to increase sample sizes. Therefore, to compare recovery rates among areas (Table 5), years and band types were lumped; but no significant differences were found. Variations in recovery rate with year of banding (Table 6) also were not significant.

TABLE 6.
Variations in total recoveries over the first four years dependent on year of banding.

	Year banded		
	1967	1968	1969
No. banded	2,557	3,600	16,909
Recovered first four years			
Number	57	76	366
Percent	2.23	2.11	2.16

CONCLUSIONS

The study of band retention on double-banded adult Herring Gulls suggests band loss is negligible for 5 or 6 years; even at 7 years, it was only about 3 percent. This has implications for previous analyses of band loss and population dynamics (Kadlec and Drury, 1968, 1969), which will be presented elsewhere. However, the analysis of comparative recovery rates is not biased by differential band loss.

The absence of significant differences in recovery rates might be due to either a real situation or inadequate sample sizes to demonstrate differences. Sample sizes in some cells (combination of year, area, and band type) are clearly too small. I consider any cell with fewer than 10 recoveries with question. Nevertheless, the banding program was designed to permit lumping to examine differences among band types. This increased sample size to a level where it can only be concluded that the three band types did not differ significantly in recovery rates.

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