Some color-banding techniques for flocking birds

Martha Hatch Balph

In studies of avian behavior or ecology, it is sometimes necessary to identify individual birds in the field without recapturing them. Colored plastic leg bands often are used for this purpose and can be highly effective. However, certain problems may arise. For example, if large numbers of individuals must be color-banded, it may be difficult to identify particular color combinations quickly and accurately and to maintain records efficiently. Further difficulties may ensue if one must observe color-banded birds under poor lighting conditions or if the birds are able to remove their bands. All of these are problems I have encountered while studying the social behavior of several species of winter-flocking finches. This paper describes some techniques by which I have attempted to reduce or eliminate such problems. These methods may be familiar to banders who have conducted studies similar to mine. For any who plan to initiate such studies, I hope that my comments may be of help.

Band arrangements

The arrangement of bands on a bird's legs can have an important influence upon the speed and accuracy of field identification. I find it helpful, first, to use only one type of band arrangement consistently for all individuals of a given species. For example, if I have decided to use the four-band arrangement shown in Figure 1-A, I do not mark any birds with a pattern of two bands on the right leg and one on the left (Figure 1-B) or vice versa. Secondly, I find it best to place bands on both legs, rather than on a single leg (Figure 1-C).

There are at least three advantages in using these techniques. The first, and perhaps the most important, is that one can thereby determine immediately whether or not all of a bird's bands have been noted. For example, if I invariably use two bands on each leg but believe I have seen the combination in Figure 1-B, I know that this observation is incorrect and that I must continue to search for an additional band on the bird's left leg. Using a single type of band arrangement can be especially valuable for avoiding error if the weather is cold, so that birds fluff their feathers and partially conceal their bands, or if one's view of a bird is hasty.

A second advantage applies particularly to studies of species that are capable of removing their own bands. As Buckley and Hancock (1968) have pointed out, using only one type of band arrangement facilitates the detection of band loss. It also prevents possible confusion of identities, e.g. between the birds in Figures 1-A and 1-B if the former should lose the upper band from its left leg.

Finally, banding both legs permits rapid discrimination between unbanded and banded birds in the field, even when only one leg is visible. Alternatively, if one uses single-leg band arrangements, and if only one of a bird's legs is visible and that leg has no bands, much time may be wasted waiting for the bird to shift its position to learn whether or not it is banded at all. The ability to distinguish quickly between unbanded and banded birds is particularly useful if one must determine many individual identities in the space of a few minutes or if one wishes to collect field data on ratios of unmarked to marked birds to estimate population size.

The band arrangement I have found most successful is a four-band combination with two bands on each leg — the U.S.F.W.S. aluminum band and one colored band on one leg and two colored bands on the other leg (Figure 1-A). This arrangement permits a relatively large number of unique color combinations (to be discussed); yet at the same time there are sufficiently few bands per leg that even species with short tarsi, such as Pine Siskins (*Carduelis pinus*), generally can accommodate them. To record the identity of a bird banded in this manner, I note the initials of the colors on the bird's right leg (upper followed by lower) and then do the same for the bird's left leg. I abbreviate the U.S.F.W.S. band as "X". Thus, the combination shown in Figure 1-A (aluminum upper right, blue lower right, red upper left, yellow lower left) is recorded as "XBRY". I often find such combinations easier to remember if I mentally pronounce the initials as an acronym while making field observations.

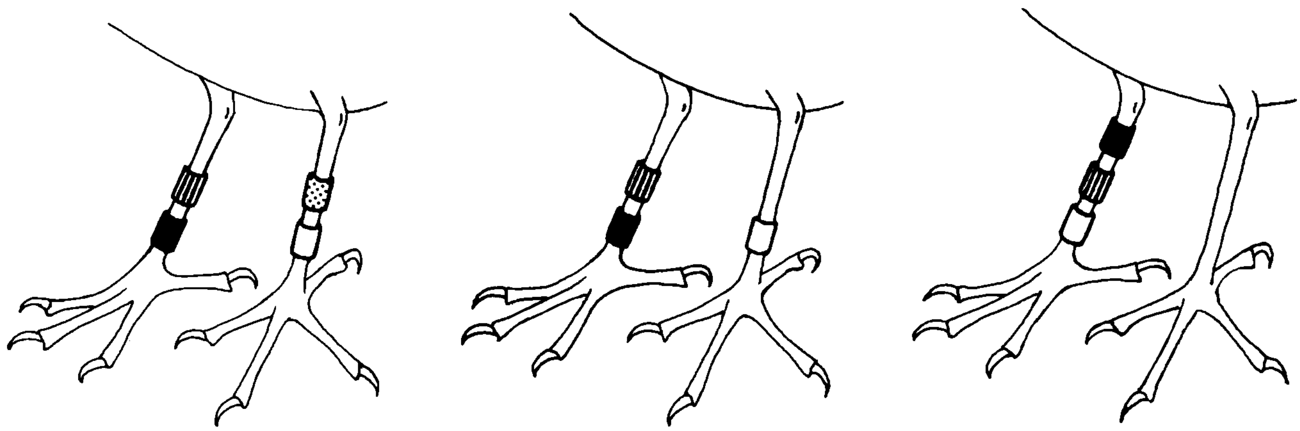

Figure 1. *Three different arrangements of bands.*

Band colors and color combinations

In addition to the type of band arrangement, the particular colors one uses can affect observational speed and accuracy. It is important to use colors that are both easy to detect and easy to distinguish from one another in the field. This factor can become critical if bands are small or if lighting conditions are poor, as on overcast days or early in the morning. The colors I generally prefer to use are red, yellow, dark blue, light green, and (if necessary) orange and/or purple (A.C. Hughes Regd. bands). Conversely, I sometimes find it difficult to discriminate between such colors as yellow and white, dark blue and dark green, or light blue and light green. I have not experienced difficulty in identifying adjacent bands of the same color, although this element is a problem in some studies (see Duncan 1971).

The number of colors in use has a substantial effect upon the number of unique color combinations possible. If one U.S.F.W.S. aluminum band and three colored plastic bands are included in each combination, this relationship is described by the equation:

$$P = 4n^3,$$

where P = total number of unique four-band combinations and where n = number of available colors exclusive of aluminum (see Buckley and Hancock 1968 for a generalized equation of the relationship and Duncan 1971 for further refinements). As one adds to the set of permissible colors, the number of permutations rises sharply (Table 1). At the same time, however, it becomes increasingly difficult to distinguish the various colors quickly and accurately. Thus, I find it helpful to estimate in advance the probable number of birds to be banded and to use only enough colors to guarantee that number of unique combinations. For example, I have used four colors for Dark-eyed Juncos (*Junco hyemalis*), which winter in relatively small, sedentary flocks, as compared to six colors for Evening Grosbeaks (*Hesperiphona vespertina*), Cassins's Finches (*Carpodacus cassinii*),

Table 1. Number of unique four-band color combinations in relation to number of available colors.

Number of colors[1]	Number of combinations[2]
2	32
3	108
4	256
5	500
6	864
7	1372
8	2048

[1]Not including U.S.F.W.S. aluminum
[2]Assuming that one U.S.F.W.S. band is included in each combination.

and Pine Siskins, which occur in larger and less stable flocks.

Record maintenance

In studies such as mine, where large numbers of individual birds must be color-banded and subsequently observed in the field, record-keeping can present a challenge. For example, if one wishes to locate a particular bird's color combination in a large file to document a sighting or behavioral observation, how is one to avoid searching through the entire file, particularly if many banded birds are observed each day?

To increase the efficiency of record maintenance, I mentally encode each available color as a number (U.S.F.W.S. aluminum = 0, red = 1, yellow = 2, blue = 3, etc.). I then use the various unique four-band color combinations in numerical order. Thus, the first individual that I band of a given species is XRRR (= 0111), the second is XRRY (=0112), and so forth. Using color combinations in a predetermined, systematic order allows one to locate particular combinations readily in a file or list. Moreover, this procedure may reduce the likelihood of accidentally using the same color combination for two different birds.

Band retention

As many banders are aware, birds of certain species may remove their own bands. Further losses may occur from other causes. The color-banding system I have described does prevent error by allowing one to detect band loss as it occurs. Nevertheless, if a bird loses a band, one is obliged to spend time attempting to recapture the bird so as to determine its individual identity and replace the missing band.

Of the species I have studied, Evening Grosbeaks and Cassin's Finches sometimes may partially open or remove their bands (typically a colored plastic band), whereas Pine Siskins and Dark-eyed Juncos apparently do not. I have been able to lessen this problem in the larger-billed species by closing the ends of the U.S.F.W.S. band to meet as exactly as possible and by sealing the split in split-ring colored bands with acetone. Band loss in my color-banded birds now averages a few percent at most each year.

Summary

This paper describes some procedures to facilitate field observations of individually color-banded birds. Consistently using a single type of band arrangement (e.g. two bands per leg) reduces observational error and simplifies the detection of band loss. Banding both of a bird's legs permits rapid discrimination between unbanded and banded individuals. Colors should be as conspicuous as possible and readily distinguishable from one another. The number of colors in use should be just large enough to generate the desired number of unique color combinations. Using color combinations in a systematic order allows one to locate particular combinations rapidly in a file and may decrease the likelihood of accidentally using the same combination twice. Applying acetone to plastic colored bands may reduce the incidence of band loss in certain strong-billed passerines.

Literature cited

Buckley, P.A., and J.T. Hancock, Jr. 1968. Equations for estimating and a simple computer program for generating unique color- and aluminum band sequences. *Bird-Banding* 39:123-129.

Duncan, K.W. 1971. A generalized computer program in Fortran IV for listing all possible color band permutations. *Bird-Banding* 42:279-287.

Department of Wildlife Science, UMC 52, Utah State University, Logan, UT 84322.