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A method for color-marking birds at resting sites

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ABSTRACT. A short-term color-marking technique suitable for non-breeding birds was developed by altering a common method used to mark incubating birds. A dye paste was spread on the ground at resting sites used by Herring (*Larus argentatus*) and Great Black-backed (*L. marinus*) gulls. Gulls first contacted dye by walking, standing, or sitting in the paste. When preening, birds transferred small amounts of dye over their feathers, creating unique patterns. Marks remained visible an average of 27 d.

SINOPSIS. **Método para marcar con colores aves en sus lugares de descanso**
Una técnica de marcar temporalmente con colores, adecuada para aves que no se están reproduciendo se desarrolló alterando un método común que se utiliza para marcar aves mientras están incubando. Una pasta seca de tinte fue regada en el suelo en los lugares utilizados para descansar por individuos de *Larus argentatus* y *L. marinus*. Las gaviotas entraron en contacto con el tinte mientras andaban, se quedaban paradas o se sentaban sobre el tinte. Cuando las aves se acicalaban transferían pequeñas porciones del tinte sobre sus plumas creando un patrón de marcas que podían observarse por un periodo promedio de 27 días.

Key words: dyes, Great Black-backed Gull, gull predation, Herring Gull, marking

The development of simple, effective, and safe color-marking techniques has greatly facilitated study of the movements of many birds. Paton and Pank (1986) described a method for marking nesting birds without capture. They spread a dye mixture over Cattle Egret (*Bubulcus ibis*) eggs, so that birds marked themselves when incubating. Cavanagh et al. (1992) and Belant and Seamans (1993) further developed and refined the technique in *Larus* gulls, experimenting with different dyes and carriers and using dummy eggs to reduce embryonic mortality. Dye-soaked sponges placed in the nest to mark breeders (e.g., Monaghan et al. 1989) and techniques to spray dyes on incubating birds (e.g., Moseley and Mueller 1975; Burger 1984) have also been effective and do not require trapping. Large numbers of nesting birds can now be marked quickly and easily using inexpensive materials and with minimal human disturbance.

Few comparable methods are available to researchers wishing to mark non-breeding birds. Invasive procedures involving trapping and marking birds in the hand are time-consuming and often disruptive. They have the potential to alter behavior and are thus inappropriate for many studies. Dye-spraying devices (e.g., Moffitt 1942; Wendeln et al. 1996) require assembly and, in some cases, habitat alteration or bait (C. E. Donehower, pers. obs.) to attract birds to the vicinity of the spray. During the course of a gull predation study tracking the behavior and movement of gulls specializing upon tern prey in Maine in 2003, we developed a simple modification of the Paton and Pank (1986) technique that allows marking of non-breeding birds. The main advantage of this technique is that roosting or loafing birds can be marked quickly without capture. In this paper, we describe the color-marking procedure, evaluate its use on Herring (*Larus argentatus*) and Great Black-backed (*L. marinus*) gulls, and suggest future applications.

METHODS

Study site. The study was conducted on Eastern Egg Rock (43°52′N, 69°23′W), a 2.9-ha island located 10 km east of New Harbor in Muscongus Bay, Maine, USA. Over one hundred Herring and Great Black-backed gulls reside on the island daily, but these species are not permitted to breed at the site. Nests and eggs of the few gulls that attempt to breed an-

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nually are destroyed as part of gull control measures carried out by National Audubon Society personnel to improve nesting opportunities for terns (*Sterna* spp.) and Atlantic Puffins (*Fratercula arctica*).

Marking procedure. Batik dye powder (deep purple, Jacquard Procion MX Fiber Reactive Dye, Rupert, Gibbon and Spider, Inc., Healdsburg, CA) was dissolved in a 1:1 water-70% isopropyl alcohol solution at a concentration of 430 g/liter. This liquid was then stirred into petroleum jelly (150 ml/kg) to make a dye paste. Petroleum jelly has been identified previously as an inexpensive yet effective dye carrier (Cavanagh et al. 1992). Batik dye was chosen because of its availability, solubility in water, persistence (Wadkins 1948), and relative safety compared to other dyes (picric acid, explosion hazard; Rhodamine B, possible carcinogen; Nyanzol D, hazardous ingredient, explosion hazard; see manufacturers' Material Safety Data Sheets for details). Nevertheless, we recommend further testing to assess the toxicological properties of batik dye and all other color-marking dyes used on wildlife.

Since the focus of this study was to monitor gull predation in the tern colony, the dye paste was spread on loafing and hunting ledges frequented by predatory Herring and Great Black-backed gulls. These areas were identified during daily watches from a tower. Observers recorded gull intrusions into the colony and noted locations of predator departure and return. Layers of paste (approximately 0.5–1 cm thick) were painted onto the ground in streaks, providing the greatest coverage possible while using the least amount of dye. The size of the area covered ranged from several cm^2 to several m^2, which depended upon local topography and the loafing patterns of the target individuals. Dye placement areas were selected to minimize the likelihood that non-target species contacted dye. We avoided placing dye within the seabird colonies. Dye was removed from the ground as soon as the target gull was well-marked. In some cases, individuals were marked within three hours of dye application to the rocks. In most cases, dye remained on the ground over two days.

RESULTS

Gulls were not deterred by the dye paste spread over their loafing areas, as birds would walk through, stand, or sit in it. In the process of preening and scratching, gulls transferred small amounts of paste over their feathers, creating unique patterns. Most gulls were marked on the head and neck. Gulls that sat in the dye marked their tails or ventral regions.

At least 27 gulls (6 Herring Gulls, 21 Great Black-backed Gulls) were marked. It is possible that additional gulls were marked but never detected because of high turnover rates of gulls at this site. Accurate data on dye retention were obtained for six gulls. Fourteen gulls were never re-sighted and presumably went elsewhere, although we cannot rule out the possibility that dye wore out rapidly on these individuals. Seven gulls that were not known predators were inadvertently marked because they shared (a) loafing site(s) with a predatory gull. These gulls were excluded from retention estimates because we did not ensure that they were well-marked prior to dye removal. Marks lasted a minimum of 7–39 d, or a mean (± SD) 26.5 (± 12.5) d ($N = 6$), and ranged in size from 30–150 cm^2. Marked gulls were visible at 70 m with 10× binoculars and 135 m with a spotting scope.

To our knowledge, no gull or seabird mortality resulted from our color-marking program. The technique did not appear to disrupt thermoregulatory capabilities of feathers since only small amounts of dye contacted plumage, but temporary eye irritation was evident in one marked Great Black-backed Gull. This individual appeared to recover fully within 24 h. Any skin irritation would have been difficult to detect because of the presence of feathers, but no aberrant behaviors were noted. Despite efforts to keep non-target species out of the dye, we noticed several Atlantic Puffins with faint abdominal marks. None appeared to suffer any adverse effects. It is likely that additional seabirds were marked with traces of dye but never observed.

DISCUSSION

Cavanagh et al. (1992) and Belant and Seamans (1993) reported that color marks resulting from dye placed in gull nests persisted 28–42 d and 3–5 wk, respectively. In our study, gulls marked by spreading dye paste over loafing areas retained marks for 7–39 d. The lower persistence and high dispersion of marks in this study can be attributed to the variable nature

of gulls' exposure to dye, premature termination of re-sighting efforts, use of different marking ingredients, and small sample size. Since gulls marked themselves in an unconfined area, we had little control over the quantity of dye contacted and quality of the subsequent mark. While not measured, it appeared that placement of larger amounts of dye resulted in larger, darker, and more persistent marks. Leaving dye on the rocks for several days also ensured that target gulls were well-marked. Our estimates of mark persistence are biased low because our re-sighting effort was terminated before some marks began to noticeably fade. Two of the six gulls used to calculate dye retention still had strong marks on the final day of observation (31 d and 7 d post-marking). We used batik dye, not Rhodamine B, and a slightly different combination of fixatives and carriers than those described by Cavanagh et al. (1992) and Belant and Seamans (1993). Use of other dyes or ingredients may improve longevity in future trials. Finally, high variation in mark persistence may simply reflect our small sample size of six gulls.

In our experience, marks produced by nest-marking (e.g., Cavanagh et al. 1992; Belant and Seamans 1993) are not usually individually distinguishable because all birds are marked on the breast/ventral region of the body and the appearance of the marks changes considerably over time. Water-soluble dyes like Rhodamine B spread out over the feathers with preening and exposure to water, expanding in area and fading over time (Evans and Griffith 1973; Cavanagh et al. 1992; Belant and Seamans 1993). Although batik dye is water-soluble, marks in our study remained identifiable because of their unique locations on the body and varied shapes. Researchers seeking a more easily recognized individual pattern or wanting to avoid placing dye at the nest site may find our technique useful. Unlike nest-marking, our technique is not suitable for studies requiring long-distance recognition (>135 m) as the marks produced are small.

We successfully targeted and marked six predatory gulls. At least six additional predatory gulls were not marked because their loafing patterns were unknown, they could be recognized using unique plumage characteristics and color-marking was unnecessary, or their resting sites were used heavily by non-target species (we did not place dye in these areas). The greatest challenge was to mark only target birds. Seven gulls that shared loafing areas with predatory gulls were accidentally marked. Dye removal from the rocks proved more difficult than expected, and residual dye sometimes resulted in secondary marking of the same individual and/or marking of non-target species. These drawbacks can be minimized by careful dye placement (at sites used exclusively by target birds) and timely, conscientious dye removal.

Our technique appears suitable for short-term marking of non-breeding gulls and may be applicable to other birds with light-colored plumage. By applying dye paste to roosting and loafing sites, researchers can mark birds with minimal time, effort, and disturbance. When used in combination with careful observation, specific individuals can be targeted. Because of the danger of marking non-target species, the technique is probably best suited for unselective marking of birds using a common resting site (e.g., seabirds, waterfowl). We advise against the indiscriminate application of large quantities of dye to areas used by birds and suggest that others adopting our technique try it first on a small scale prior to large-scale implementation.

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