J. Field Ornithol. 76(1):94–97, 2005

A technique to produce aluminum color bands for avian research

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Received 20 January 2004; accepted 15 June 2004

ABSTRACT. We developed a technique to produce metal (aluminum) color bands, in response to concerns about leg injuries caused by celluloid-plastic color bands applied to Willow Flycatchers (*Empidonax traillii*). The technique involves color-anodized aluminum bands (unnumbered blanks and federal numbered bands), with auto pin-striping tape and flexible epoxy sealant, to create a variety of solid, half- and triple-split colors. This allows for hundreds of unique, high-contrast color combinations. During six consecutive years of application, these colored metal bands have resisted color fade compared to conventional celluloid-plastic bands, and have reduced leg injuries in the flycatcher. Although not necessarily warranted for all color-banding studies, these metal bands may provide a lower-impact option for studies of species known to be impacted by plastic color bands.

SINOPSIS. **Técnica para producir anillas de aluminio de colores para estudiar aves**

Desarrollamos una técnica para producir anillas o bandas de aluminio de colores en respuesta a la preocupación de heridas en las patas causadas por anillas plásticas a individuos de *Empidonax traillii*. La técnica envuelve el anodizar anillas de aluminio (ya sean communes o las que provee el laboratorio de anillamiento federal) con cinta de autoimposición y sellador de epoxi, para crear una variedad de anillas de medio hasta tres líneas de colores. Esto permite una amplia combinación de colores. Durante seis años de uso de este tipo de anillas, las mismas han mantenido su color contrario a anillas plásticas convencionales y ha reducido el daño a las patas de las aves. Aunque no necesariamente se puede garantizar su uso en todo tipo de estudio que amerite el uso de anillas de colores, estas nuevas anillas pueden proveer una herramienta útil y de bajo impacto en estudios en donde las anillas de plástico puedan causar daño.

Key words: *Empidonax traillii*, leg injuries, metal bands, Willow Flycatcher

Color-banding is an essential and widely used tool used in avian research, especially for birds too small to carry alternative types of auxiliary markers. In 1996, we initiated a long-term demographic study of the endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*) in central Arizona, and used Hughes celluloid-plastic leg bands to mark individual birds. The following year, we observed a number of returning flycatchers with leg injuries that ranged from swollen tarsi to missing feet; the injuries overwhelmingly occurred on the plastic color-banded leg. Concurrently, Sedgwick and Klus (1997) reported similar leg injuries to Willow Flycatchers in Oregon. We therefore set about to develop an effective and reliable alternative to conventional celluloid-plastic color bands. Here, we describe a preparation technique for metal color-anodized bands, including the use of auto pin-striping tape and flexible epoxy.

METAL BAND PREPARATION METHODS

Preparation materials and tool list. The following materials and tools are necessary: federal aluminum bird bands; non-numbered color-anodized aluminum bands (available in six colors from Gey Band & Tag, Inc.); 3M Scotchcal™ auto pin-striping tape (purchased at local auto paint shops); Rod Wrapping Finish-*Lite Formula* epoxy kit (manufactured by Flex Coat Company, Inc. and available from Cabela's®); 110 volt, slow-speed Rod Drying Motor (manufactured by Cabela's®); metal rod stock of a diameter slightly larger than the inside diameter of the bird bands; wooden corks (approximately 2.5 cm in diameter); acetone; lint free cotton-tipped swabs; razor knife; fine forceps; fine hobby files; and banding pliers.

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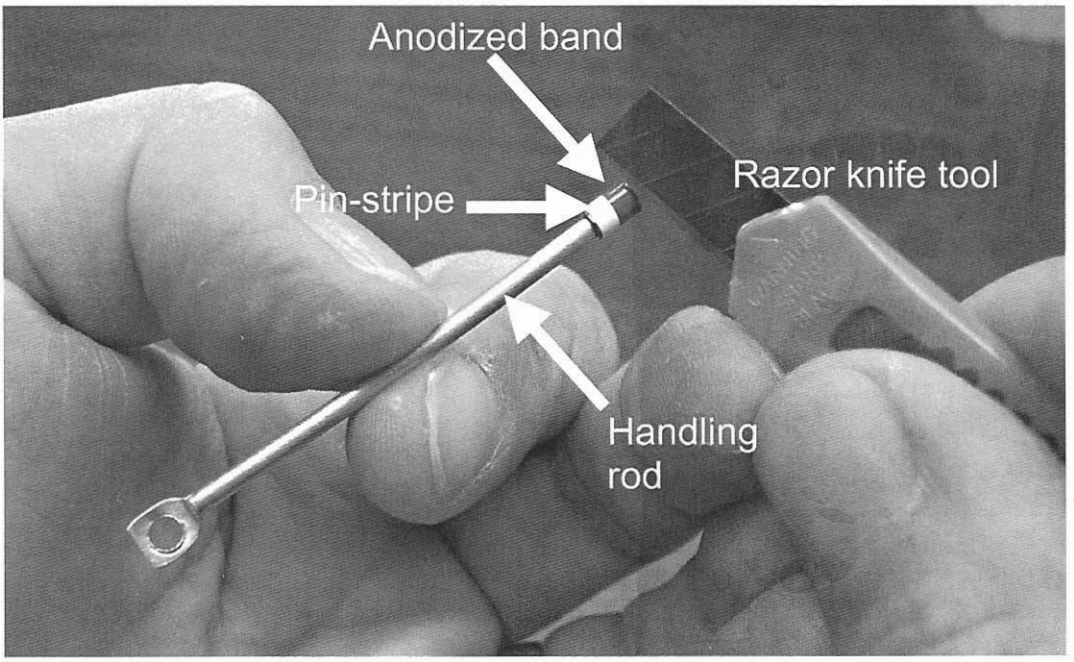

Fig. 1. Materials associated with applying and trimming the pin-striping.

Anodizing bands. Non-numbered aluminum bands can be purchased in anodized colors from band-supply sources (e.g., Gey Band & Tag). The numbered federal aluminum bands can be color-anodized in a variety of colors and hues by local metal anodizing shops. Anodized bands can then be used as-is (for a solid color of a single band) or as the foundation for a pin-striped band (see next section).

Several considerations are important in creating and using anodized bands. Few anodizing shops have experience with processing small items such as bird bands, and it may require contact with several shops before finding one willing to do this type of work. The final color of the bands is determined by the anodizing solution color and length of time that the bands are anodized. Therefore, it is important to work with the anodizing shop to assure the resulting color is as intended, and to keep a record of the processing that was used to produce successful batches. We also recommend providing the anodizers with an example of the target color. Color-anodizing of federal bands requires authorization from the federal Patuxent Bird Banding Laboratory and the reporting of these bands as modified/auxillary markers. Federal bands can be anodized, but should not be pin-striped, as this makes it impossible to read all or part of the band number.

Applying pin-striping tape. See Figure 1. To facilitate easy handling, open each pre-anodized color band wide enough to fit on the bird's tarsus, then snugly fit each opened band on to the tip of separate pieces of metal rod stock approximately 5 cm in length (hereafter denoted as the "handling rod"; the metal holding rods purchased with celluloid-plastic bands work extremely well). The bands are left open until placed on the bird's leg in the field; this reduces the number of times the band is flexed, and therefore the amount of stretching of the color-anodized surface, the pin-striping tape, and epoxy coating of the finished band. Once the bands are on the handling rods, clean each with acetone via a lint-free cotton-tipped swab; this ensures a clean bonding surface for the pin-striping tape. Place the handling rods and bands upright into holes drilled into a foam or wooden block, and let them dry for a few minutes.

Pin-striping tape is available in a wide variety of colors, lengths, and widths. In order to reduce the amount of pin-stripe trimming needed when making a band, we recommend purchasing pin-stripe tape as wide as, or close to, the

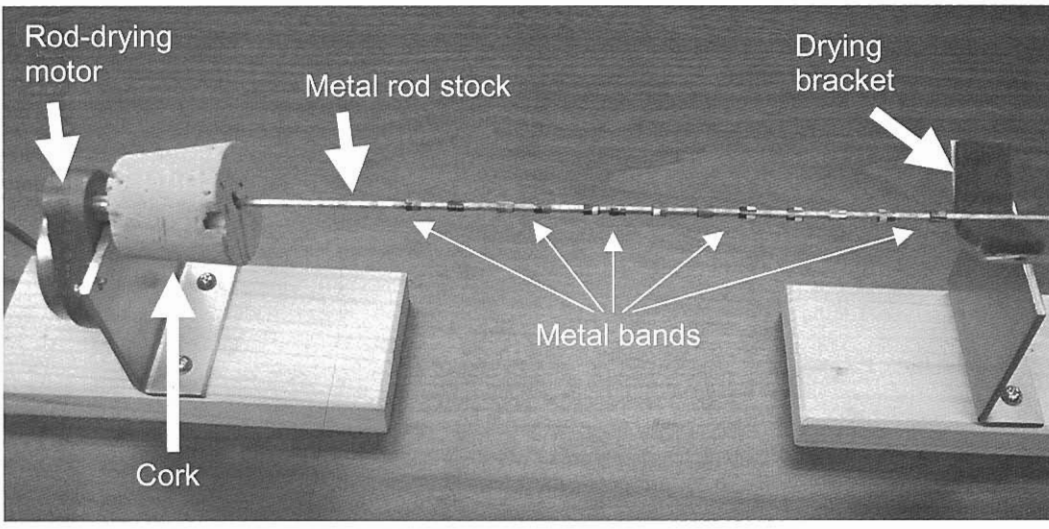

Fig. 2. Materials associated with applying and drying the epoxy coating. Note that the rod drying motor and drying bracket should be secured to a flat, stable surface.

total height for solid color bands, half the band height for two-color split bands, and a third of the band height for triple-split bands. To apply the pin-striping, cut 5–6 cm lengths of the desired color, peel off the non-stick backing, and roll the pin-stripe tape onto the band as you rotate the handling rod and band. For double- and triple-split color combinations on a single band, repeat this to abut different colored pin-stripes together. Next, while rotating the handling rod, trim the pin-stripe (length-wise) with a razor knife. Leave only ca. 0.5 mm of band area exposed on the top and/or bottom of the band and butt ends. This exposed area is essential in providing a surface on which the epoxy will flow to seal the edges of the pin-stripe tape from abrasion (see below). Always use a sharp razor knife blade to trim and fine forceps to remove the trimmed pin-stripe. After all pin-stripe trimming is complete, carefully rub the pin-striping with a handling rod covered with a rubber grommet to ensure even adhesion. Place the handling rod holding the pin-striped bands back into the foam/wooden block holder, and expose them to direct UV light for a minimum of 24 h (see manufacturer's application directions for additional details). Remove the bands from the handling rods and place 18–20 bands, 1 cm apart, onto a metal rod approximately 30 cm long.

Applying flexible epoxy. See Figure 2. Using a c-clamp or other suitable device, secure a slow-speed rod drying motor (used by hobbyists to build fishing rods) and mounting bracket onto a table. Push a large wooden cork firmly onto the output shaft of the motor, with one end of the metal rod with bands pushed into the center of the cork and other end allowed to spin on another mounting bracket. Mix the two-part flexible epoxy per the manufacturer's directions, then turn on the motor so the bands are rotating slowly. With a small brush, apply a thin, even coat of epoxy to the entire outer surface of the bands. To ensure an even distribution of epoxy around the bands while drying, run the motor for at least 2 h after applying epoxy (see manufacturer's application directions for additional details). After a minimum of 8 h drying time, apply a second coat of epoxy and let dry while rotating. With a firm grip and twist, remove the bands from the metal rod. As a final step, use a fine hobby file to carefully remove any excess epoxy from the edges of the bands.

RESULTS AND DISCUSSION

Utilizing standard-issue aluminum federal bands, six different color-anodized federal bands, six commercially available color-anodized blanks (non-numbered aluminum bands), and seven different colors of auto pin-striping

tape, we produced hundreds of unique, high-contrast, solid color, and double- and triple-split color combinations. Our field crews found these metal bands to be more fade-resistant and color-stable than the Hughes celluloid-plastic color bands that we previously used and for which color fade has been noted (Lindsey et al. 1995). The excellent color-fastness and high contrast of our metal color bands enabled us to accurately resight band combinations and identify individuals for up to six years after banding with no apparent fading of colors.

Creating custom metal color bands can be time consuming, and may not be warranted for all color-banding studies. However, a variety of bird species have shown adverse effects to Hughes color bands. These include the endangered Golden-cheeked Warbler (*Dendroica chrysoparia*; Pekins 2002), Common Tern (*Sterna hirundo*; Nisbet 1991), Ochre-bellied Flycatcher (*Mionectes oleaginous*; T. J. Koronkiewicz, pers. obs.), Willow Flycatcher (Sedgwick and Klus 1997; Haas and Hargrove 2003), and Blue-shouldered Robin-Chat (*Cossypha cyanocamper*, J. Holmes, pers. comm.). In our Willow Flycatcher studies, these metal color bands were effective in reducing leg injuries, compared to conventional celluloid-plastic bands. They may also reduce leg injuries in other species reported to have adverse effects from conventional celluloid-plastic bands. Because of U.S. Fish and Wildlife Service permit regulations and concerns regarding use of multiple metal bands on one leg (e.g., Reed 1953), we used only one band per leg for adult flycatchers, and a single anodized federal band for nestlings.

Metal color bands may prove useful for situations beyond those necessitated by reducing leg injuries. For example, Darvic un-plasticized PVC color-bands have been shown to loose shape and flexibility, become brittle, and snap open over a short period of time (Jones 2002). In addition, some bird species have strong bills that readily slice through celluloid bands, rendering color-marking difficult and/or short-term. Metal color bands are much more difficult to destroy or remove (as evidenced by relatively infrequent removal of numbered federal bands), and so may be effective for studies of groups such as parrots, jays, finches, and other large and/or heavy-billed species. In addition, studies involving long-lived species sometimes experience celluloid plastic band fade and loss that require repeated recapture and re-banding; the durability and color-fastness of metal color bands may help reduce or avoid these logistical problems. Finally, the wide variety of anodized/pin-stripe colors allows for a large number of different color combinations, which may be useful for many heavily marked species where combinations are limited by short tarsus length (e.g., multiple celluloid bands do not fit on one leg) or because of simultaneous activities of many different researchers.

ACKNOWLEDGMENTS

This project was made possible by the support and cooperation of many persons and agencies. Funding was provided by the U.S. Bureau of Reclamation (Phoenix Area Office) and the U.S. Geological Survey Southwest Biological Science Center, Colorado Plateau Research Station at Northern Arizona University. We thank the Arizona Game and Fish Department, U.S. Geological Survey, and Northern Arizona University biologists who conducted the field work associated with our banding project. We also thank Anotech in Gilbert, Arizona, for their assistance and expertise in metallurgy. We appreciate the useful review comments from Mary Gustafson and an anonymous reviewer.

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