Short Communications

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Challenges Adapting a Backpack Harness for Use on Gray Hawks (*Buteo plagiatus*)

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Abstract.—Raptor biologists have successfully used backpack-type harnesses to attach transmitters to a wide range of raptor species for research. As part of a graduate research project with Gray Hawks (*Buteo plagiatus*) in south Texas, we attached harnesses to 58 individuals and experienced problems with seven birds removing the harnesses and with all females covering the solar panels of the OrniTrack-10 GPS-GSM transmitters, preventing them from functioning properly. We appear to have resolved these issues by trimming nape feathers (short-term solution), switching to a different harness material, stitching through the knots, switching to a different brand of glue, and using a transmitter with an elevated solar panel for females, which are typically larger than males.

Key Words: *Gray Hawk*; Buteo plagiatus; *backpack harness*; *GPS-GSM transmitter*; *Spectra*; *VHF transmitter*.

DESAFÍOS AL ADAPTAR UN ARNÉS DEL TIPO MOCHILA PARA SU USO EN *BUTEO PLAGIATUS*

Resumen.—Los biólogos de rapaces han utilizado con éxito arneses del tipo mochila para sujetar transmisores a una amplia gama de especies de rapaces con fines de investigación. Como parte de un proyecto de investigación de posgrado con *Buteo plagiatus* en el sur de Texas, colocamos arneses a 58 individuos. Experimentamos problemas con siete aves que se quitaron los arneses y con todas las hembras, al cubrirse entre las plumas los paneles solares de los transmisores OrniTrack-10 GPS-GSM, impidiendo que funcionen correctamente. Creemos que hemos resuelto estos problemas recortando las plumas de la nuca (solución a corto plazo), cambiando a un material de arnés diferente, cosiendo a través de los nudos, cambiando a una diferente marca de pegamento y usando un transmisor con un panel solar elevado para las hembras más grandes.

[Traducción del equipo editorial]

Introduction

As part of research studying home range dynamics and juvenile dispersal of Gray Hawks (*Buteo plagiatus*) we captured and fitted 58 with backpack-type harnesses and either an OrniTrack-10 GPS-GSM transmitter (Ornitela, UAB, Vilnius, Lithuania) weighing approximately 10 g or a custom-built VHF transmitter (American Wildlife Enterprises, Monticello, FL, USA) weighing approximately 13 g. Fuller (1987) pointed out successful techniques have been better documented than failures in transmitter attachment techniques. Herein we highlight failures and subsequent successful adjustments in transmitter attachment methods in our Gray Hawk study so future researchers may benefit from our experiences.

Transmitter Attachment: Problems and Solutions

Raptor researchers have used Teflon ribbon as a suitable backpack harness material for a wide range of raptor species (Foster et al. 1992, Millsap et al. 2004, 2013,

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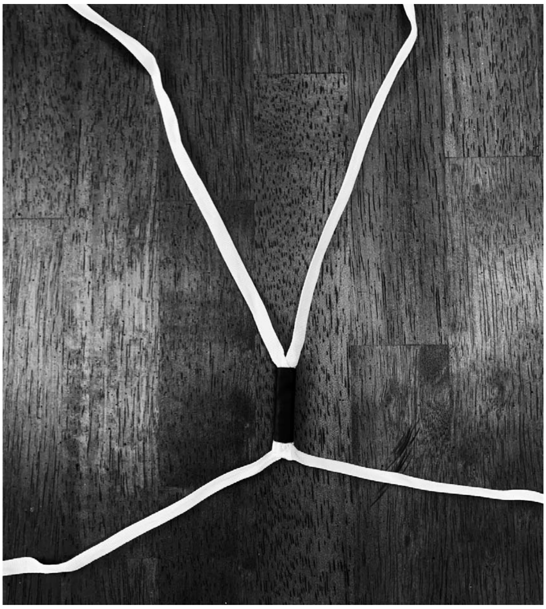

Figure 1. The Y-transmitter Spectra harness attachment design with a reinforced sternum-connecting-ribbon consisting of one additional piece of Spectra and a piece of flexible plastic cutting board mat, covered by heat shrink tubing

Humphrey and Avery 2014, Murphy et al. 2017, García et al. 2021). We therefore expected no problem with using Teflon ribbon for backpack harnesses on Gray Hawks, yet four of the first six Gray Hawks we tagged severed the Teflon ribbon and removed their harness within 10 wk or less. Our Ornitela transmitters charged their batteries via solar panels, which could be disrupted if birds move feathers over the panel (Fuller 1987). When we fitted the transmitters, the position on the birds' back gave no indication that feathers covering the solar panel could cause problems, but we found the feathers of the female Gray Hawks could cover the entire transmitter, which led to significant difficulty charging the battery. With trial and error, we found solutions to both issues.

We initially used a Y-transmitter harness attachment design similar to Buehler et al. (1995), with 6.35-mm wide natural tubular Teflon tape (Bally Ribbon Mills, Bally, PA, USA) and neoprene padding at the suture points (Millsap et al. 2013). We used waxed dental floss rather than nylon thread for securing the 30-cm straps. We added pieces of neoprene to the bottom of the transmitter and to the sternum-connecting-ribbon for comfort; the pieces were cut to fit the length and width of the transmitters and the sternum-connecting-ribbon, then attached using contact cement or stitching. The sternum-connecting-ribbon was 2 cm for males and 4 cm for females. We used Gorilla

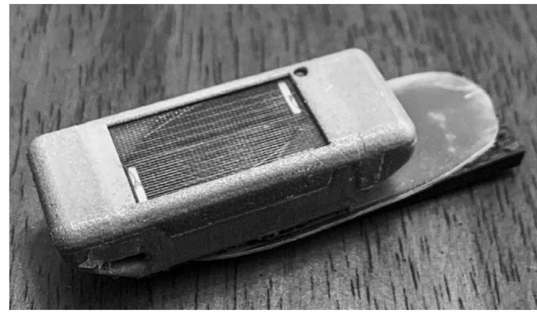

Figure 2. OrniTrack-10 GPS-GSM transmitter with 54-mm long piece of neoprene and flexible plastic cutting board mat extending 20 mm towards the nape. This was intended to cover and divert the bird's nape feathers so they would not obscure the solar panel.

Super Glue (The Gorilla Glue Company, Cincinnati, OH, USA) to seal the knots of the first nine harnesses (Kenward 2001). We attached the straps to the GPS-GSM transmitters by tying knots at one top attachment point and two bottom attachment points, and to the VHF transmitters by tying knots at one top and one bottom attachment points.

Subsequent adjustments to this design included sewing through the knots with waxed dental floss by wrapping the knot four times in dental floss. We then applied Krazy Glue All Purpose (Newell Brands, Atlanta, GA, USA) beginning with the seventh harness. Because Krazy Glue was less viscous than the Gorilla Glue, we think it better penetrated and sealed the knots. After the first eight harnesses, we began using 6.35-mm wide natural tubular Spectra tape, also from Bally Ribbon Mills, instead of Teflon. An experienced researcher described Spectra as lighter and more abrasion-resistant than Teflon, so it seemed the most suitable replacement (D. Johnson, The Global Owl Project, pers. comm.). With the eleventh harness, we began reinforcing the sternum-connecting-ribbon with one additional piece of Spectra, plus a 0.76-mm thick piece of flexible plastic cutting board mat and a piece of 4.76-mm-diameter dual-wall adhesive marine heat-shrink tubing cut to fit the connecting ribbon between the suture points for the straps (Fig. 1). The cutting board mat was enclosed in the heat shrink, providing a hard yet smooth protective covering to prevent rubbing.

When we discovered females were capable of completely covering the transmitters with feathers by preening, we began trimming the nape feathers of all birds as a short-term fix. To address this problem over the long term, we added a 54-mm long piece of flexible plastic cutting board mat, with the corners rounded for comfort, extending 20 mm toward the bird's nape, with an additional piece of neoprene for an additional 3 mm of lift (Fig. 2). The extra neoprene and cutting board mat added an additional 1.1 g,

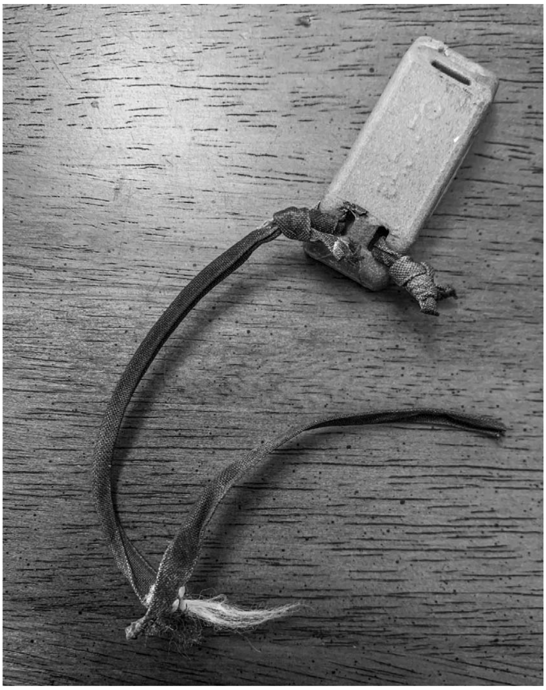

Figure 3. OrniTrack-10 GPS-GSM transmitter with what remained of the Y-transmitter Teflon harness 65 d after deployment, recovered from an adult male Gray Hawk. The clean cut on the right strap resulted from removing the harness with scissors, not damage by the hawk.

Figure 4. OrniTrack-10 GPS-GSM transmitter recovered from an adult female Gray Hawk 20 d after deployment; none of the Teflon harness material was found. We initially assumed the hawk had been killed because of the complete removal of the harness and most of the neoprene, but she was later resighted.

almost all due to the neoprene. The cutting board mat was added to prevent the hawks from simply chewing through and removing the neoprene; it was attached using contact cement. As a permanent fix, we deployed 16 OrniTrack-E10 transmitters, a modified model with an elevated solar panel; total weight was approximately 11 g.

Four of six Gray Hawks equipped with Teflon harnesses and GPS-GSM transmitters removed their harnesses within 10 wk. All seemed to easily chew through the Teflon anywhere they could reach it, whether through the straps or the knots (Fig. 3, 4). Only one of 48 Gray Hawks, an adult female, removed a Spectra harness. She accomplished this by chewing through the sternum-connecting-ribbon (Fig. 5). After we began using Spectra harnesses, modifying the sternum-connecting-ribbon, and reinforcing stitching at the attachment knots, no Gray Hawks removed their Spectra harnesses ($n = 47$). We recovered the transmitters and harnesses after five mortalities, and no portion of the Spectra ribbon had been damaged, including the knots (Fig. 6). At the time of writing in early 2021, 21 GPS-GSM transmitters were still deployed and birds had been wearing the harnesses an average of 273 ± 56 d (SD). Similarly, 14 VHF transmitters had been deployed for an average of 257 ± 80 d.

As of 13 April 2021, only one Gray Hawk was still wearing a Teflon ribbon harness, an adult female who is also the only female not wearing an OrniTrack-E10 with an elevated solar panel. This harness was deployed 25 February 2020, our eighth deployment, and the first harness to have the knots sewn and the additional neoprene and flexible cutting board extension; in addition, we trimmed the bird's nape feathers. Her battery dropped to a low of 54% while she was incubating but returned to 100% on 2 May 2020. On 25 June 2020, the battery began a gradual decline with occasional slight increases, with the battery level at 50% by 8 August 2020. This decline coincided with the annual prebasic molt, and by 20 October 2020 the battery level had reached 0%. Of 12 birds wearing an OrniTrack-E10 from September 2020 through February 2021, the battery level for six males averaged 86.2% ± 2.0 (SD) and for six females averaged 82.5% ± 15.6.

After experiencing harness failure in six of 10 Teflon harnesses on adult Gray Hawks and one Spectra harness failure, we deployed 47 Spectra harnesses with no subsequent failures for an average of 8.2 mo (range = 96—413 d). The natural tubular Spectra tape was much tougher to cut through than the Teflon and it frayed less; we feel this increased abrasion resistance was the main factor that contributed to our success. We believe extra stitching at the knots and use of Krazy Glue further improved our design. We found that Ornitela's OrniTrack-

Figure 5. OrniTrack-10 GPS-GSM transmitter with what remained of the Y-transmitter Spectra harness, recovered from an adult female Gray Hawk. She removed the harness by biting through the sternum-connecting-ribbon in <27 d.

Figure 6. OrniTrack-E10 GPS-GSM transmitter with an intact Y-transmitter Spectra harness, recovered from an adult male Gray Hawk that was apparently killed by a predator. There was no damage to the straps, knots, or the reinforced sternum-connecting-ribbon after the bird wore the harness for 155 d.

E10 transmitter had solar panels sufficiently elevated to preclude coverage by nape feathers, whereas our attempts to post-modify the original OrniTrack-10 transmitters to accomplish this were not successful.

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