

Tagging Things: An incomplete guide to affixing radio transmitters to a variety of animals.

*Please send any additional information, new methods, edits, or comments to
motus@birdscanada.org.*

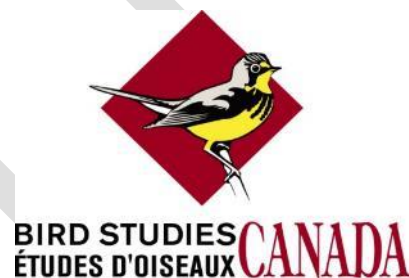


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ÉBAUCHE

Cette version est une ébauche. Une fois le document finalisé, il sera traduit et disponible en français.

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Introduction

Methods for radio transmitter attachment vary considerably among species, tag design, and researchers, but here we attempt to summarize the most common methods across a variety of taxa. Researchers are encouraged to investigate attachment methods independently and seek advice and training from personnel experienced in that method. This is a continual work in progress, so please send any additional information, new methods, edits, or comments to motus@birdscanada.org.

In accordance with published literature on appropriate tag/body weight ratio, the combined tag and harness should weigh less than 3-5% of the individual's mass so as not to harm the bird (Murray & Fuller 2000; Fair et al., 2010, but see Barron et al. 2010).

There is admittedly conflicting evidence regarding the impacts of tracking devices on birds (Calvo & Furness 1992). In a recent meta-analysis, Barron et al. (2010) reported overall negative effects of transmitter devices on bird nest success and productivity, clutch size, offspring quality, body condition, foraging behaviours, energetic expenditure, and survival. However, effects appear to be species-specific; negative effects seem most pronounced in non-passerines, and studies examining passerines indicate minimal or no negative impacts.

The limited studies that directly assess the impacts of transmitters on passerines mostly take place during the breeding period and indicate no or negligible impacts on foraging time (Brigham 1989), stress levels after 48 hours (Suedkamp Wells et al. 2003), clutch size or nest survival (Hill et al. 1999), brooding or provisioning rates of nestlings (Neudorf & Pitcher 1997), overwinter survival (Blackburn et al. 2016), and no effect on fledgling survival, body condition, maneuverability, or range use (Naef-Daenzer et al. 2001). When transmitter effect was assessed during the energetically costly molt period, Gow et al. (2011) found no effect on parental care behavior or nesting success, and found improved physical condition in molting tagged Wood Thrush (*Hylocichla mustelina*) compared to untagged birds. In Savannah Sparrows (*Passerculus sandwichensis*), transmitters did not affect body condition of adults or juveniles during the post-breeding pre-migratory period (Rae et al. 2009). When migration is assessed in Passerines, there appears to be no effect on the return rates of adults or juveniles (Anich et al. 2009), or mass loss after migration (Powell et al. 1998).

*** add paragraph on negative effects in non-passerines and suggest that researchers be aware of the risks associated with tagging or specific tag design recommendations for these groups***

***** NOTE: Altering outer tag covering or antenna length may affect tag performance including frequency and strength of signal *****

Permits and Authorizations

In most jurisdictions the use of any auxiliary marker must be reviewed and approved by the provincial, state, and or federal governments prior to implementation. In almost all cases, auxiliary markers must be used in conjunction with metal bands, which uniquely identify each individual. These activities require a permit, and may also require approval from an accredited Animal Care Committee. In North America these authorizations are managed by the Bird Banding Office in Canada or the Bird Banding Laboratory in the U.S.. Please contact the Bird Banding Office or the Bird Banding Laboratory for more information.

Table 1. Summary of basic attachment methods

	Harness	Glue	Suture
Preparation	Must be constructed in advance (preferable if loop size is known) or on site	No special prep	Need to prep work area, get all materials ready (<i>more specifics required</i>)
Handling Time	Shortest bird handling time (~1min)	Longer handling time while glue dries (~5min)	Longest bird handling time (~5-10min)
Manpower	Single-person	Two people	Two people
Limitations and sizing	Size constraints (loop size), can't use on many non-passerines	No size constraints, larger birds may be able to remove it, however	Mainly for larger birds which cannot take harnesses and may pull off glued tags
Lifespan	Long tag retention	Tag retention variable	Tag retention variable
Bird health considerations	Limited skin contact, bird wears harness and tag for a longer time period.	Possibility of skin abrasion/burning/tearing	Possibility of physical harm during and post procedure i.e. hematomas (?) and infection
Taxonomic Considerations (<i>expand</i>)	Can be useful for species that physically remove tags; species that molt feathers during study period.	Species that do not remove/damage tags or molt feathers during study period	Species that physically remove tags and cannot wear a harness; species that molt feathers during study period

Harness Methods

Figure – 8 Leg Loop Harness

Radio transmitters can be attached using a figure-8 leg loop harness method (Rappole and Tipton 1991). In a comparison of three attachment methods (harness, glued backpack, and tail-mount) on European Starlings, Woolnough et al. (2004) found the harness to be the most reliable in terms of attachment duration. All three methods showed initial behavior effects (pecking at tag), which ceased within a few days. There was no difference in body condition or activity once birds adjusted to the attachment. Application of radio tags with figure-8 loop harness generally can be completed within one minute and birds showing any sign of stress or injury are released without banding or radio-tagging.

Materials: 1mm elastic thread; e.g. Sewing essentials elastic thread (best for smaller birds, or those with high seasonal fluctuations in weight/fat loads) or 1mm “Stretch Magic” thread; Super glue; e.g. LePage ultra gel super glue, or or Loctite control gel (gel is often easier to work with than liquid glue); scissors, ruler, permanent marker



1. Determine leg loop size for your species
 - You can use Rappole and Tipton (1991) and Naef-Daenzer (2007) as a starting guide:
 - Create test tags with multiple sizes to test on a bird
 - Have multiple sizes available during tagging
 - Keep records of mass and size of bird for each leg loop size for future reference

- Harnesses should be snug, but not too tight (reduces perching abilities) or too loose (tag is more likely to fall off prematurely)

Table of example sizes for commonly-tagged species. Full table with sizing for 35+ species available [here](#).

If you have information on figure-8 harness sizes for species not listed (with species, size, weight and sample size), please [contact us](#) and we can update the spreadsheet!

Species	Harness Size (mm)	Sample Size	Bird Weight (g)
Red-eyed Vireo	39-42	100+	15-20
Bank Swallow	32-34	50+	10-13
Swainson's Thrush	48-52	100+	25-36
Blackpoll Warbler	33-36	200+	10-22

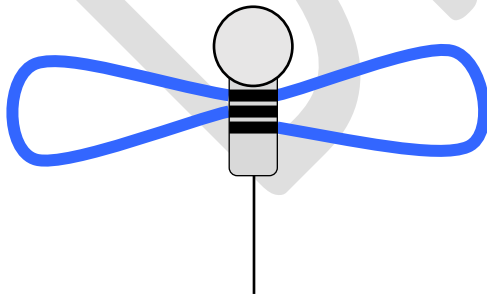
2. Cut lengths of elastic thread to specified measurements using guide below (not to scale). Mark thread with permanent marker where it will be glued to harness (black sections below)



Black: 4mm or width of transmitter gluing sit - glued to harness

Blue: leg loop size eg. BLPW 33-36 mm depending on fat condition. Glue centre of elastic thread to tag. Ensure glue and elastic are on the opposite side of the TagID or label,. Gel glue allows for easier handling and setting of the elastic.

3. Glue outside ends of the elastic thread to the tag to form a “figure-8”. Gluing the central portion to the top and then one side lower than the other helps keep the antenna straight on the bird and minimizes twisting (shown in figure)

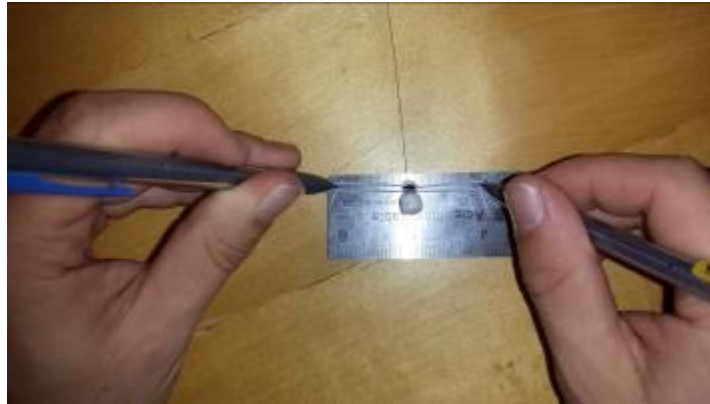


4. Place a small drop of glue on top of thread and spread it around to cover the threads for added security

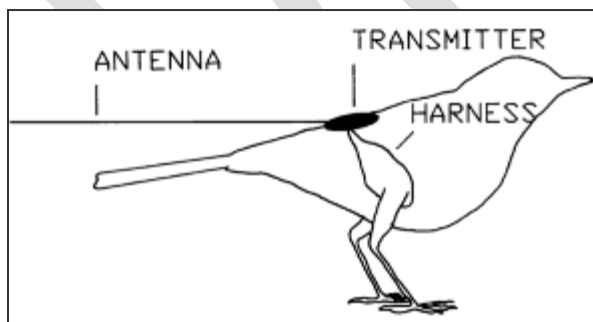
Add figure letters in relation to text



5. When glue is dry affix tag to bird:
- Measure harness again to make sure it did not get malformed during gluing – this is most easily done by stretching the harness (until the slack is gone, but don't stretch it beyond taut) between two pencils along a ruler, see photo:



- Activate tag and record tag number.
- Bring the first leg loop over the foot and over/around the thigh to rest the transmitter on the lower back. The antenna should be hanging off the bird's rump and the elastic threads should be on the bottom, resting on the bird (number side up, figures a-d below).
- While gently holding the tag in place, bend the free leg and slip the second leg-loop from back to front over the bird's knee and past its foot (e). The leg loop should now be loosely around the second leg.
- While still holding the tag in place to keep the first leg loop secure, slide the second leg loop up and over the thigh (straightening the leg a bit often helps), keeping the tag centered on the back (f). A crochet hook can help with this step, and with removing a tag if necessary.
- Ensure that the first leg loop is still in place.
- It is critical that leg loops are over the thighs to ensure the tag won't slide off.



Rappole JH, Tipton AR. 1991. New harness design for attachment of radio transmitters to small passerines. *J. Field Ornithol.* **62**, 335-337.



Replace or supplement diagram above with on ehere -
<http://mncoopunit.cfans.umn.edu/files/2015/02/Streby-et-al.-Harness-Design-and-Transmitter-Attachment.pdf>



6. Before releasing: check that feet are able to perch, wings are free, and double check that harness is around each thigh by blowing feathers out of the way
7. You should not be able to pull the tag back down and over the bird's rump or flip the tag over, but it should be loose enough that the thread is not being stretched.
8. Release the bird very low to the ground, in case it refuses to fly. On occasion, passerines may appear to refuse to fly, but will resume normal behavior after some time passes, or when the tag is removed.

Streby Harness Method

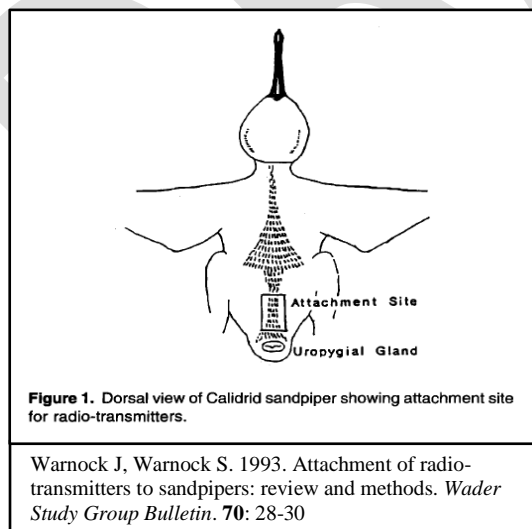
An alternative method widely used for transmitters, geolocators and gps tags is the Streby methods described in detail here - <http://mncoopunit.cfans.umn.edu/files/2015/02/Streby-et-al.-Harness-Design-and-Transmitter-Attachment.pdf>

Shorebird Glue Method

Materials: Scissors, Poly acrylamide glue; eg. LePage Ultra Gel Control Super Glue.

1. Activate tag and record tag number!
2. One person holds the bird and parts the feathers near the rump.
 - One option is to hold the bird with the head towards you, the bird's legs dangling between the ring and middle fingers, and the thumb and pointer finger holding the wings and parting the feathers. Ensure shorebirds legs are free to dangle to prevent capture myopathy.
3. The second person trims the feathers with small scissors to expose a patch of skin the size of the transmitter. The tag should be applied just above the preen gland on shorebirds (see fig by Warnock and Warnock 1993)
4. Add glue to cover the base of the tag and place tag on the skin patch. Gently hold the tag on the bird and ensure the antenna is leading straight down the tail. Place thumb over the tag to secure it in place until the glue dries – it is useful to test the glue beforehand to know roughly how long it takes to dry.
5. Gently tug on the transmitter to ensure the tag is firmly attached and surrounding feathers are not attached to the tag.
6. After releasing the bird, watch for several minutes to ensure it can fly unhindered.

Note: for large and round radio transmitters, a small piece of mesh can be attached beforehand to assist in affixing it to the bird. See - <http://northofthegrid.com/2016/04/21/attaching-nanotags-a-grad-student-perspective/> (Expand)





Bat Glue Method

Materials: Scissors, Surgical glue (SkinBond), Ostomy Glue, or Suture.

1. Activate tag and record tag number!
2. Trim a small patch of fur between the scapulae using trimming scissors and disinfect
3. Apply a thin coat of surgical glue to tag
4. Apply a thin layer of glue to the exposed patch of skin and apply tag
5. Wrap surrounding hair over the tag, allowing the antenna to trail straight behind the bat
6. Hold tag gently to bat for ~5 minutes to ensure glue sets
7. Disinfect all tools and materials used according to WNS decontamination guidelines (https://www.whitenosesyndrome.org/sites/default/files/resource/national_wns_revis_e_final_6.25.12.pdf) before handling another bat



Suture and Glue Attachment

** If suturing tags to the birds, ensure that the tag tubes through which the sutures are run, are as small as possible so birds are not able to slip beak through tubing.

Materials

- Ethicon Prolene, size 4-0, taper point, 3/8 circle, 30". Expired (non-sterile) less expensive
 - Q-tips and isopropyl alcohol
 - Needle drivers (2), scissors (1) – ask for donations
 - Adhesive (Loctite 422, Loctite Gel Epoxy 6 min dry time)
 - Sharps container
 - Head cone/pillow/sheet for bird
1. Activate tag and record tag number.
 2. Rest bird on pillow with head in cone or covered with a sheet (figure a below)
 3. Minimize talking to reduce bird stress and movement
 4. Apply alcohol with Q-tip to part the feathers and check the tag position – it may help to use a toothpick to hold feathers back (b)
 5. Use fingers to tent the skin and needle drivers to insert sutures (top and bottom), check spacing is correct before inserting second stitch (c & d)
 6. Run thread through tag
 7. Apply glue to the underside of the tag (e)
 8. Rest tag on birds back and tie off the thread with a surgeon's knot and 3 square knots. The tension on the 1st throw is the most important. Make sure the knots lie flat (ie. not twisted) (f & g)
 9. Apply glue to each knot
 10. Hold bird still until all glue is dry
 11. Watch bird for several minutes upon release to ensure it can fly and move unhindered.



Raptors

Provide overview of raptor attachment techniques.

Parameters for fitting a Diurnal Raptor with transmitter (citation)

- Using the body condition index (BCI) of 1 – 5, under most circumstances we limit selection of a bird to a BCI of ‘3’ or higher. Note when fitting for a backpack style harness if a bird is a ‘5’ be cautious of amount of slack in the harness as bird may not be this large the majority of the time.
- We tend not to fit birds with full crops, though this is just a personal preference. Two thoughts behind this (1) a large crop is hard to work around and a tender area, (2) it is hard to guess how much the crop contents weigh therefore bird weight is not entirely accurate. Crop index of 0 – 3 we will generally exclude birds with a crop size of 3.
- General appearance of bird – healthy in appearance, no damage to flight feathers, no compromising injuries old or new

Raptor Backpack Harness

For fitting backpack style tags to the harness we had Lotek add end tubes as the ‘attachment’ (photo to right) details are available upon request. It’s difficult to describe but we had to do some interesting sewing in order for the unit to sit flat on the birds back. Over the winter we have talked with folks that have had success relying on a series of overhand knots combined with stitching the knot so it will not come untied.



Nanotag NTQB-3-2 with added ‘attachment’ of end tubes, for use with backpack style harness

Materials

- 2mm neoprene
- 0.18 (3/16th) inch Teflon ribbon (Bally Ribbon Mills, PA)
- 15-20lb test Dyneema fishing line (Spiderwire Brand)
(<http://www.cabelas.com/product/fishing/fishing-line/super-lines/pc/104793480/c/104719680/sc/104612580/spiderwire-174-stealth-fishing-line/1874266.uts?destination=%2Fcategory%2FSuper->

[Lines%2F104612580.uts%3FWT.srch%3D1%26WT.tsrc%3DPPC%26rid%3D20%26WT.mc_id%3DMICROSOFT%257Cfis_Fishing%252BLine_Super%252BLines%257CUSA%26WT.z_mc_id1%3D43700001542333939%26gclid%3DCPHVnrfrzs0CFUdyNwod9O4Ftg%26gclsrc%3Dds\)](#)

- Suture needles (<http://www.havalon.com/suture-needles-half-curved-102-8.html>)
- Contact Cement (<http://www.homedepot.com/p/DAP-Weldwood-3-fl-oz-Original-Contact-Cement-00107/100195615>)
- 4" hemostats (smaller the better)
http://www.tedpella.com/dissect_html/hemostats.htm#53081)
- Alligator clips (<http://www.joann.com/32mm-alligator-clips/5225602.html?gclid=CIfSpenpzs0CFQIcaQod5PAELw>)
-
- Falconers hood fit for species (<http://www.mikesfalconry.com/All-Steve-Tait-Style-Dutch-hoods-p/704a.htm>)
- Gel super glue (partial to gorilla brand gel super glue)
- Sharp scissors
- Seam ripper/ stitch puller

Table 2. Approximate dimensions for ribbon length in raptor harnesses for a variety of

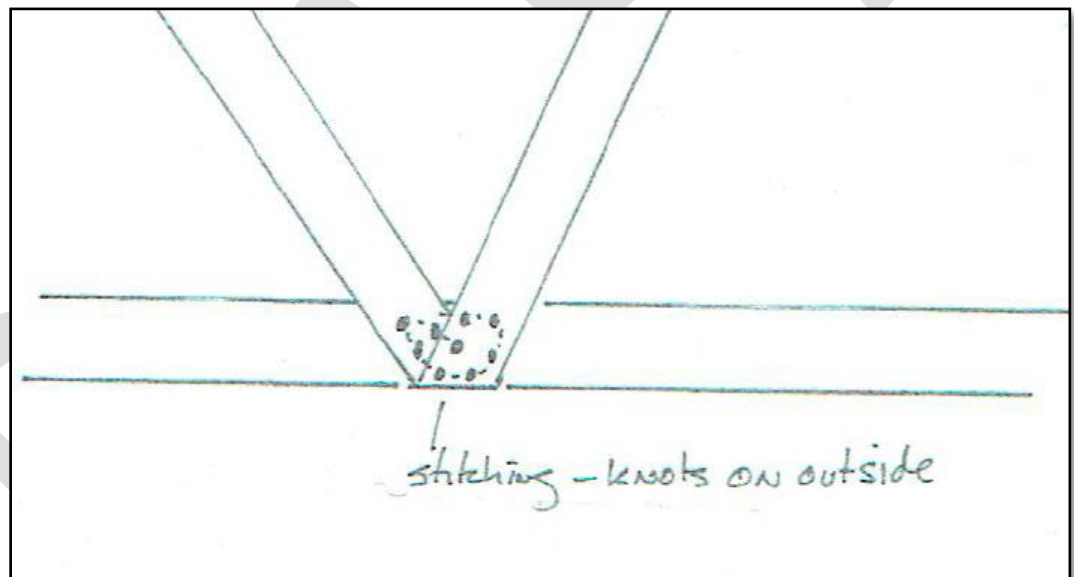
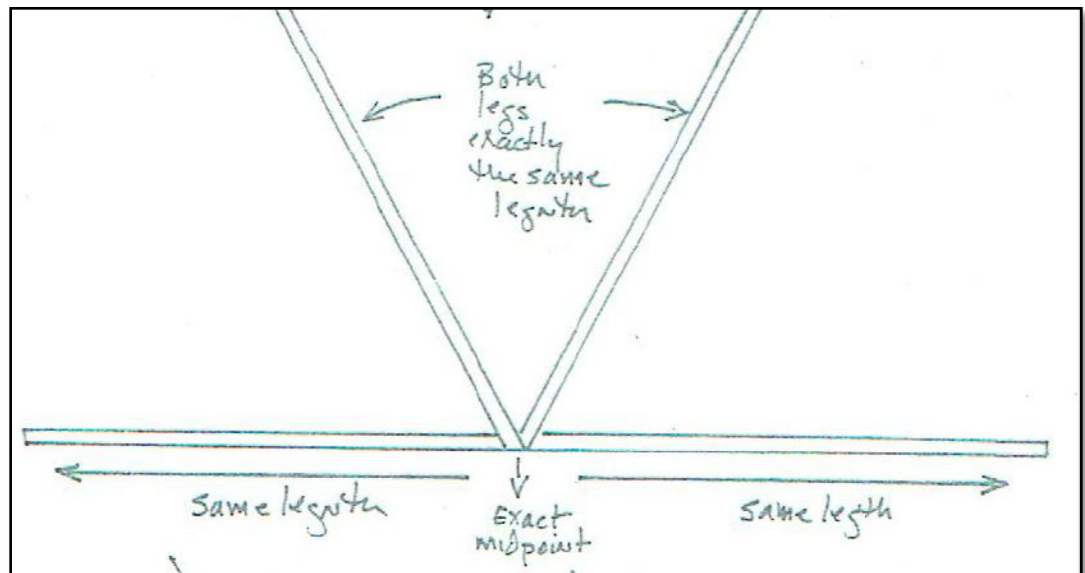
Species	Teflon Ribbon width (inch)	Teflon Ribbon Length (x2)	
Merlin	.18 (3/16)	~50cm	
Harrier	.18 (3/16)	~60cm	
Peregrine	.25 (1/4)	~70cm	
Barred owl	.25 (1/4)	~70cm	
Snowy owl	.25 (1/4)	~70cm	
Osprey	.25 (1/4)	~90cm	
Eagle	.33, .44, or .55	~100cm	

species.

Caution

- Careful with hemostats as excessive twisting, pinching, or pulling can easily abrade the Teflon ribbon
- If you end up having to pull stitches more than once you may need start over with a new harness as the Teflon ribbon damages easily from picking at it with sharp instruments

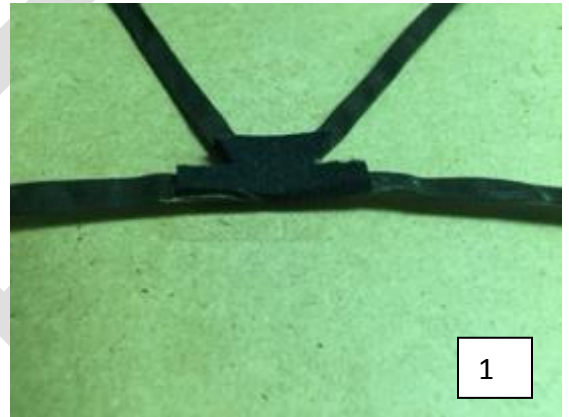
1. Make a harness using Project Snowstorms directions or one similar that has 4 tails; two shoulder tails, and two flank tails. Make sure that at the stitch point each tail is equal in length, one creates a V (shoulder), and the other a straight bottom (flank). Ideally the back of the stitching is covered (after stitching) by 2mm neoprene glued on with contact cement. Allow at least 24 hours for contact cement to dry, apply pressure (eg. A book), to the glued portion of the harness for the first few hours to help ensure a strong bond. All stitching knots should be facing away from the bird. See table below for estimated ribbon lengths by species.



* Drawings and design courtesy of project SnowStorm

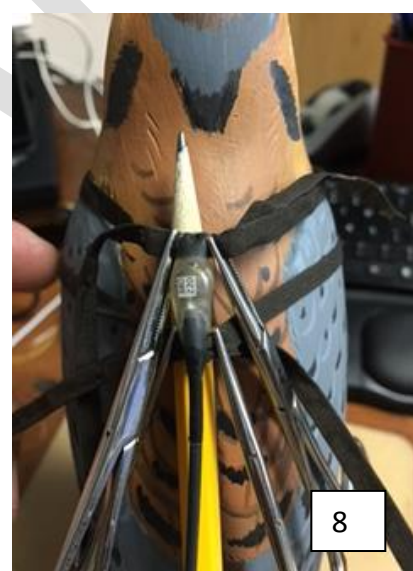
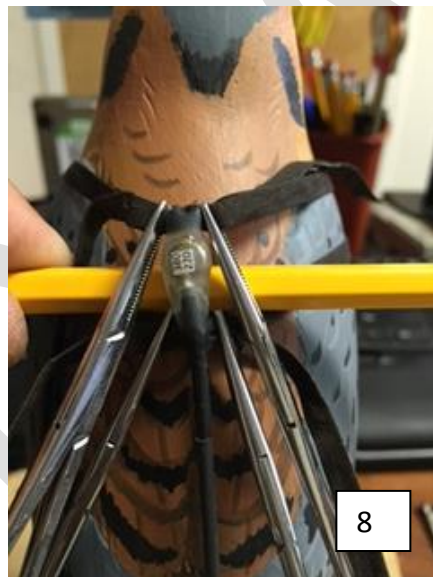
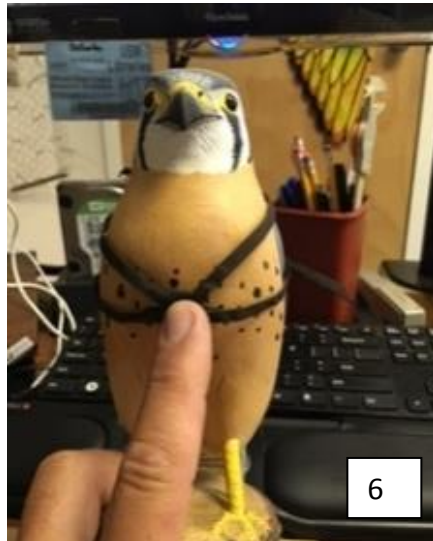
* Bally ribbon mills in PA is the least expensive place to purchase. They prefer to sell in bulk 25yds per roll though will sell smaller quantities with an added cut/handling fee. Telonics think sells the 0.18" ribbon at any length but they tend to be more expensive

2. Feed the tails of the shoulder portion of the harness into the corresponding sides of the top or front tube on the tag.
3. Feed the tails of the flank portion of the harness into the corresponding sides of the lower or back tube on the tag.
4. The harness lengths are long enough so they can be fed into the tubes on the tag prior to placing on the bird.
5. It may be beneficial to place forceps on each of the 4 ribbon ends to prevent them from coming out while placing on the bird



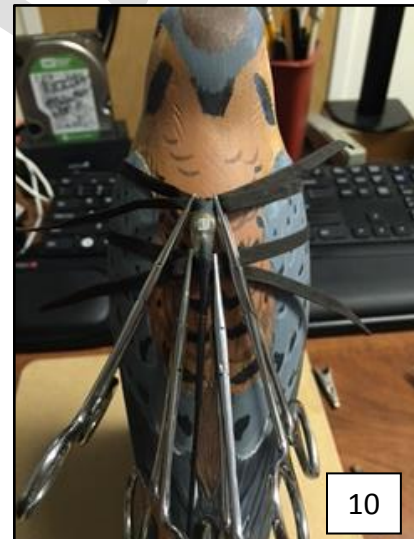
6. Slip the harness 'attached' to the tag over the bird's head and pull wings over the lower (flank) ribbons.
7. Have the person holding the bird place the center of the harness (neoprene patch) over and centered on the keel top to bottom and side-to-side. Hold the patch here until you have made the final clamp of each of the four ribbon ends with the forceps (step 11).
8. Pull the four tails through the tubes, tightening the tag to the bird's body. Take care to avoid the ribbon twisting while pulling it through the tubes. Work the lower (flank) tails first then the shoulder tails next. With a small raptor like a merlin or a sharpie you should be able to fit a number 2 pencil (loosely) between

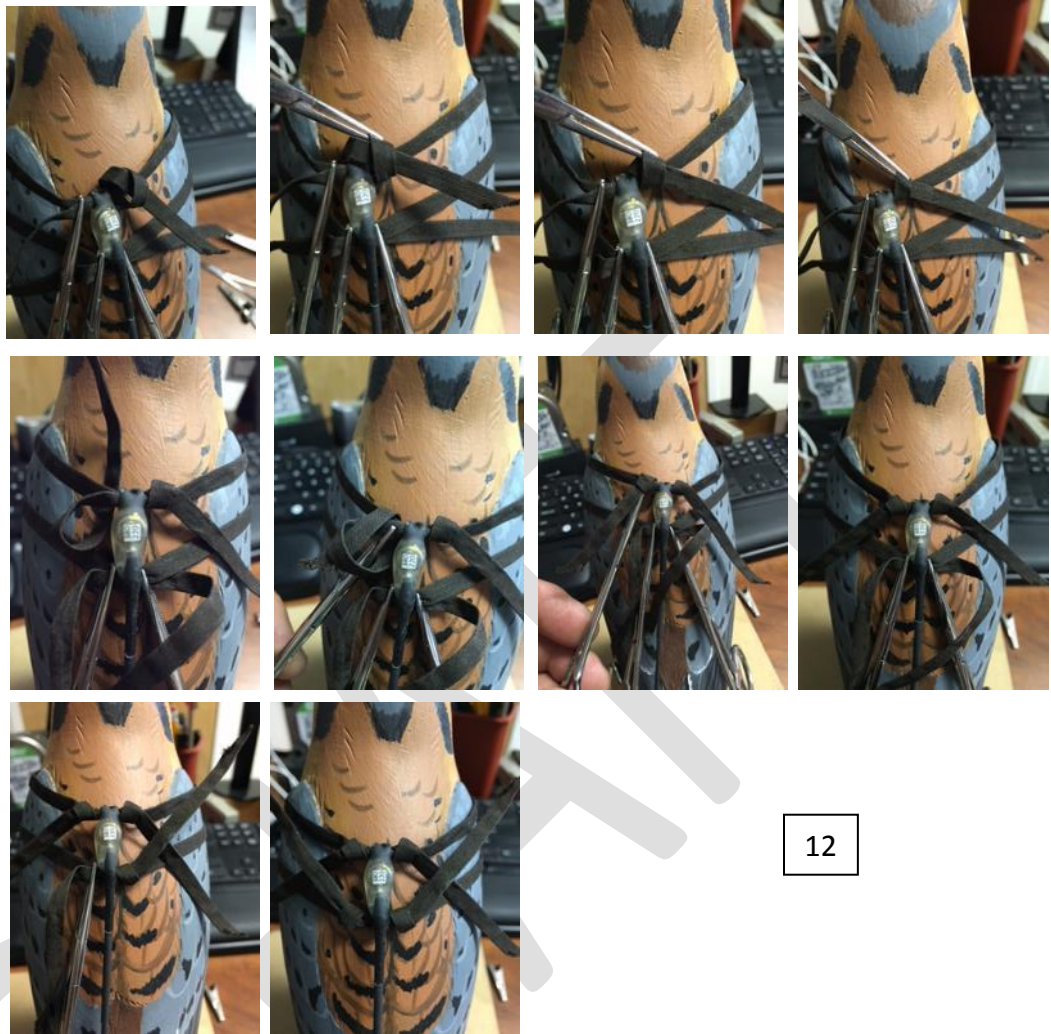
the tag and the bird from all angles. Note the top (front) may be a slightly looser fit than the lower (back). Use the forceps to hold the ribbon in place and keep it from loosening on the bird. Tag should fit in the middle of the birds back and closely centered between top and bottom of wings



9. Using a dull number 2 pencil (or similar object) preen the Teflon ribbon straps under the feathers so the straps are against the body. A thorough job of preening the ribbon is important as this will create a fair amount of slack in the harness. Once a thorough 'preening' job has been done remove all the slack (step 8) so the harness fits well again using the number 2 pencil (pencil test) to create the perfect fit.

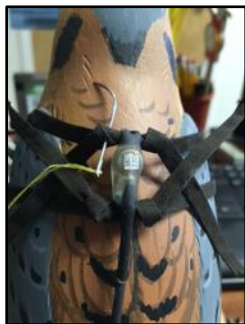
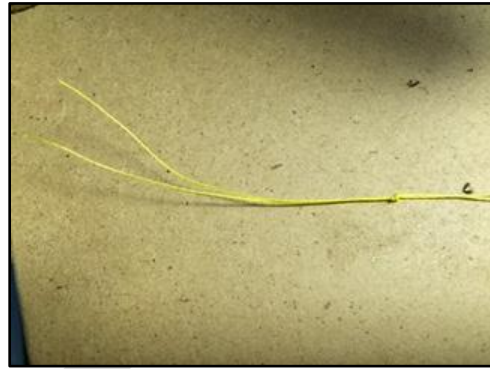
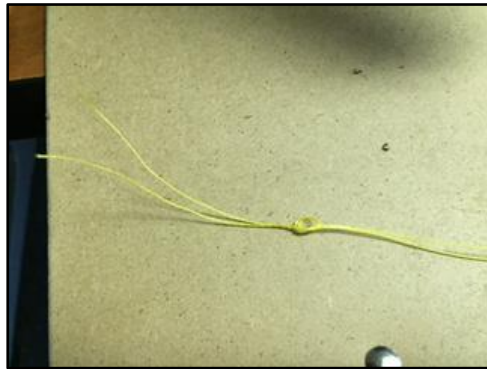
10. At this point tag should be sitting over the spine and in the middle of the birds back. The center patch should still be centered on the keel. Shoulder tails should be equal in length to each other and flank tails should be equal in length to each other. This is a sure fire means of determining that the tag is aligned perfectly with the bird. The shoulder tails do not need to be, and probably won't be, the same length as the flank tails.
11. Once the paired tails are even, the neoprene patch is centered on the keel, and the pencil test is adequate, and tag and antenna orientation are correct, clamp the tails as close to the tag as possible.
12. Once clamps are in place confirm fit is ideal
13. Remove one shoulder clamp and tie an overhand knot in the ribbon incorporating the ribbon alongside it.
14. Once the overhand knot is against the tag and tight, stitch the knot. Cut excess thread leaving about 3-4mm of a tail in the thread. Photo sequence shows our preferred stitching method, others work well too, though we recommend using the surgeons knot for all finishing knots.



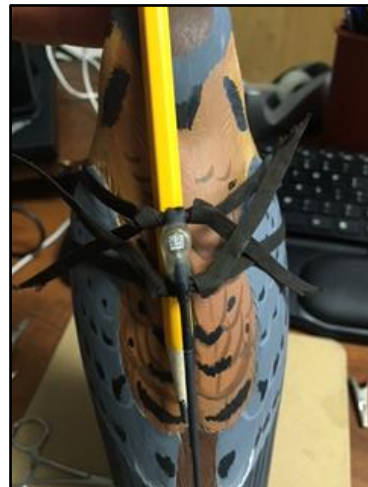
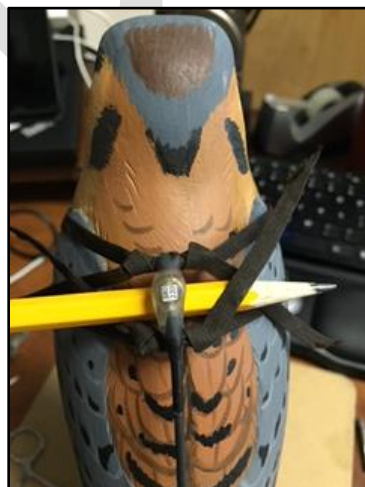


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15. Repeat steps 13 and 14 on other shoulder ribbon.
16. Recheck fit of harness. Center patch on keel, pencil test, and tag/ antenna orientation.
17. Repeat steps 13 and 14 for flank clamps
18. Recheck fit of harness. Center patch on keel, pencil test, and tag/ antenna orientation.
Slide a folded 3x5 index card or something similar under tag and stitching to protect feathers from glue. Glue all knots and thread ends well.
19. Cut Teflon ribbon ends leaving 5 mm of ribbon beyond last stitch. Glue end of ribbon to help hinder fraying. Allow glue to dry before removing index card.
20. Recheck fit



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* Image depicts general placement on birds back. Note that harness attachment has changed since this photo. Earlier harness attachment was complicated and time consuming.

Raptor Trail Mount (Merlin example)

We are still trying to determine the best approach for using tail mounted transmitters on raptors. Literature has shown that there can be lowered survival in northern goshawks with tail mounted transmitters of ~1.5 % body weight (Reynolds et. al. 2004). Tailmounts we have deployed have been at or under 1%, and starting this year we will be lowering our weight allowance more.

Two methods of mounting the radio-encoded tags to the rectrice of a merlin.

1) Traditional 5 minute epoxy or 2) light cured resin (LCR), LCR is preferred as long as fitting the bird can be done indoors. Even indirect sunlight (UV) will harden LCR within seconds.

The position of the bird, ventral or dorsal up is personal preference. We found that both positions were easy to work in though birds tend to prefer to be held dorsal up. We also found that using an abba, weight can or just a hood all seem to work well, we tend to use a hood. We do not recommend using a can in conjunction with a hood. We have specially ordered tail mount tags with a single groove along underside of tag with two to four laces included in casing. The groove fits nicely over the feather shaft and the lacing

can help hold the tag in place with the epoxy dries. Note tying lacings can be considerably difficult.

Using LCR

1. Single out central tail feather for attachment, place 3x5 index card between chosen retrice and remaining ones.
 - a. Note: each tag tends to be slightly asymmetrical, we chose the central retrice that best centers the tag.
2. If using LCR we cut all lacings off of the tag, if using traditional epoxy leave lacings to temporally hold tag in place while epoxy dries.
3. Place tag along the feather shaft proximal to body (almost touching the pygostyle) measure how much of feather shaft the tag will sit along then using a scalpel with a fine point blade trim off barbs on both side of the rachis.
4. Put a bead of LCR along the grove along the underside of the tag and place on feather shaft in the determined place. Once the tag is in the proper position, making sure the antenna is correctly lined with the feather, use the UV flash light to set the LCR.
5. Then using a fine tip on the syringe put a bead of LCR along the side of the feather shaft and tag essentially building up the bond and surface area between the tag and feather shaft. Set the LCR with the UV flashlight.
6. Repeat step 5 on the other side of the tag.
7. Within second of using the UV flash light the tag should be firmly secured to the feather shaft of the bird.

Using 5 minute epoxy

1. Single out central tail feather for attachment, place 3x5 index card between chosen retrice and remaining ones.
 - a. Note: each tag tends to be slightly asymmetrical, we chose the central retrice that best centers the tag.
2. Do not cut lacings, leave lacings to temporally hold tag in place while epoxy dries
3. Place tag along the feather shaft proximal to body (almost touching the Pygostyle) measure how much of feather shaft the tag will sit along then using a scalpel with a fine point blade trim off barbs on both side of the rachis.
4. Put a bead of epoxy along the grove along the underside of the tag and place on feather shaft in the determined place.
5. Tie the lacings and hold tag between fore finger and thumb for the required cure time (5 minutes).
6. Hold onto the bird for another 5 to 10 minutes to while the tag continues to harden while ensuring the correct fit and antenna alignment along the feather.



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Literature Cited:

- Anich, N.M., T.J. Benson, and J.C. Bednarz. 2009. Effect of radio transmitters on return rates of Swainson's Warblers. *Journal of Field Ornithology*. 80(2): 206-211.
- Barron, D.G., J.D. Brawn, and P.J. Weatherhead. 2010. Meta-analysis of transmitter effects on avian behaviour and ecology. *Methods in Ecology and Evolution*. 1(2): 180-187.
- Blackburn, E., M. Burgess, B. Freeman, A. Risely, A. Izang, S. Ivande, C. Hewson, W. Cresswell. 2016. An experimental evaluation of the effects of geolocator design and attachment method on between-year survival on whinchats *Saxicola rubetra*. *Journal of Avian Biology*. 47: 1-10
- Brigham, R.M. 1989. Effects of radio transmitters on the foraging behavior of Barn Swallows. *Wilson Bulletin*. 101(3): 505-506.
- Calvo, B., and R.W. Furness. 1992. A review of the use and the effects of marks and devices on birds. *Ring and Migration*. 13(3): 129-151.
- Fair, J., E. Paul, and J. Jones, Eds. 2010. *Guidelines to the Use of Wild Birds in Research*. Washington, D.C.: Ornithological Council.
- Gow, E.A., T.W. Done, and B.J.M. Stutchbury. 2011. Radio-tags have no behavioral or physiological effects on a migratory songbird during breeding and molt. *Journal of Field Ornithology*. 82(2): 193-201.
- Hill, I.F., B.H. Cresswell, and R.E. Kenward. 1999. Field-testing the suitability of a new back-pack harness for radio-tagging passerines. *Journal of Avian Biology*. 30(2): 135-142.
- Murray, D.L. & Fuller, M.R. 2000. A critical review of the effects of marking on the biology of vertebrates. *Research Techniques in Animal Ecology: Controversies and Consequences* (eds L. Boitani & T.K. Fuller), pp. 15-64. Columbia University Press, New York.
- Naef-Daenzer, B., F. Widmer, and M. Nuber. 2001. A test for effects of radio-tagging on survival and movements of small birds. *Avian Science*. 1(1): 1-15.
- Naef-Daenzer, B. 2007. An allometric function to fit leg-loop harnesses to terrestrial birds. *Journal of Avian Biology* 38(3):404 - 407. DOI: 10.1111/j.2007.0908-8857.03863.x
- Neudorf, D.L., and T.E. Pitcher. 1997. Radio transmitters do not affect nestling feeding rates by female Hooded Warblers. *Journal of Field Ornithology*. 68(1): 64-68.
- Powell, L.A., D.G. Krentz, J.D. Lang, and M.J. Conroy. 1998. Effects of radio transmitters on migrating Wood Thrushes. *Journal of Field Ornithology*. 69(2): 306-315.
- Rae, L.R., G.W. Mitchell, R.A. Mauck, C.G. Guglielmo, and D.R. Norris. 2009. Radio transmitters do not affect the body condition of Savannah Sparrows during the fall premigratory period. *Journal of Field Ornithology*. 80(4): 419-426.
- Rappole J.H., Tipton A.R. 1991. New harness design for attachment of radio transmitters to small passerines. *Journal of Field Ornithology*. 62: 335-337.
- Streby, H.M., T.L. McAllister, G.R. Kramer, S.M. Peterson, J.A. Lehman, and D.E. Andersen. 2015. Minimizing marker mass and handling time when attaching radio transmitters and geolocators to small songbirds. *Condor: Ornithological Applications* 117:249-255.

Suedkamp Wells, K.M., B.E. Washburn, J.J. Millspaugh, M.R. Ryan, and M.W. Hubbard. 2003. Effects of radio-transmitters on fecal glucocorticoid levels in captive Dickcissels. *The Condor*. 105: 805-810.

Warnock J, Warnock S. 1993. Attachment of radio-transmitters to sandpipers: review and methods. *Wader Study Group Bulletin*. 70: 28-30

Woolnough, A.P., W.E. Kirkpatrick, T.J. Lowe, and K. Rose. 2004. Comparison of three techniques for the attachment of radio transmitters to European Starlings. *Journal of Field Ornithology*. 75(4): 330-336.

Additional References (not yet integrated):

Townsend, J. M., C. C. Rimmer, and K. P. McFardland. 2012. Radio-transmitters do not affect seasonal mass change or annual survival of wintering Bicknell's Thrushes. *Journal of Field Ornithology* 83(3):295–301 DOI: 10.1111/j.1557-9263.2012.00378.x

Pedersen, M. C., P. O. Dunn, and L. A. Whittingham. 2006. Extraterritorial forays are related to a male ornamental trait in the common yellowthroat. *Animal Behaviour* 72:479-486 DOI: doi:10.1016/j.anbehav.2006.02.010

Leonard, T. D. P. D. Taylor, and I. G. Warkentin. 2008. Landscape structure and spatial scale affect space use by songbirds in naturally patchy and harvested boreal forests. *The Condor* 110(3):467–481.

Scarpignato, A. L., Harrison, A. L., Newstead, D. J., Niles, L. J., Porter, R. R., van den Tillaart, M., and P. P. Marra. Field-testing a new miniaturized GPS-Argos satellite transmitter (3.5 g) on migratory shorebirds. *Wader Study* 123(3): DOI 10.18194/ws.00046

Kenward. R. E. 1978. Radio Transmitters Tail-Mounted on Hawks. *Ornis Scandinavia* 9(2): 220-223.

Kenward, R. E. 1985. Raptor Radio-Tracking and Telemetry. ICBP Technical Publication 5:409-420.

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