Backpack-style harness for tag attachment to non-passerine birds

1. Scope and Field of Application

The 'backpack-style', or 'wing' harness, consisting of a neck and a body loop was first described by Brander (1968). Backpack-style harnesses are a preferred method for long-term attachment (over 2 months) of tracking devices to continuous-flight aerial insectivores (Åkesson et al. 2012, Knight 2017, Ng et al. 2018) and other acrobatic non-passerines such as Hummingbirds (Williamson and Witt 2021) since the positioning of the tag between the wings centers the weight on the bird's body. Backpack-style harnesses are also recommended for falcon species that capture prey with their talons, for which a leg-loop harness may impair leg movement (Biles et al. 2022), as well as species with short legs, such as Red Knot, as the absence of an external 'knee' causes a leg-loop harness to slip off the legs soon after deployment (Chan et al. 2016). Because backpack-style harnesses are adjustable in the field, they will require tags to have anterior and posterior attachment points (tubes or eyelets), which will increase the weight of the tag.

Harnesses can be secured by creating knots or using crimps. Knots are a preferred method for light-weight birds. Further modifications in securement are available to reduce weak points (e.g., two-knot method as performed in Williamson and Witt 2021). Additionally, attachment methods have been successfully used on red knot, a long-distance migrant that may experience substantial changes in body size during the period of attachment, by fitting harnesses loosely but securely on the bird when it is not at its peak weight (Chan et al. 2016).

2. Purpose

To provide instruction for the preparation and application of a backpack-style harness to attach tracking devices to birds.

3. Considerations

Fitting this harness on a bird is a two-person job, without exception. One person will hold the bird, and the other will fit the harness. The holder should be very comfortable holding birds with a firm, but not tight, grip, and should be confident they will not release a bird with equipment attached until the tag is completely fitted, under any circumstances. If a bird shows signs of stress before deployment is complete, all equipment must be removed from the bird before it can be released. Ideally, the holder will have relatively small hands so that the fitter has plenty of access to the bird's back and chest. The fitter should have experience fitting auxiliary tags and have a good sense of how tight a harness should be. We strongly recommend that the fitter practice deploying this type of harness before attempting it on a live bird. This harness requires that the jewelry cord be knotted or threaded through small crimp beads during fitting, so the fitter must have good fine motor skills and close vision.

Methods that involve fitting, tying, crimping, cutting, and gluing harnesses during bird handling often require >5 minutes per bird.

Migratory Bird Permits (CWS) will be required, with specific permissions related to attaching tracking devices to birds. Additional permissions will be needed if the study species is a Species at Risk.

4. MATERIALS AND EQUIPMENT

Knot harness

- 0.7 mm plastic cord (e.g., Stretch Magic jewelry cord)
- Scissors
- Pliers
- Crochet hook
- Medical tape or heat-shrink tubing
- Tracking device

Crimped harness:

- 4 x 1.3 mm flawless aluminum crimp beads (plus extra in case some are dropped). Flawed beads (e.g. with dents) will not fit over your harness thread and you will have to cut your harness off and start again.
- 1 x 1.5 mm flawless aluminum crimp bead (plus extra in case dropped)
- Headlamp (if tagging in the dark)
- All materials listed under *Knot harness*

5. PROCEDURE

The knot variation of the backpack harness was adapted from Åkesson et al. (2012), whereas the crimped harness preparation and deployment methods (description and images) were taken from Knight (2017), with permission from E. Knight. Cord lengths will vary depending on species (e.g., approx. 80 cm for nightjar).

5.1 Preparation of harnesses

- Determine the neck loop size for your species.
- Cut required length of cord.
- Thread the length of cord through both anterior eyelets on the tag until the two strands are of even length on either side.

Knot harness

- Stretch a loop around calipers to measure required size of loop.
- Create a figure-eight knot to secure the loop.
- Wrap heat-shrink tubing or medical tape around the breast knot (to prevent chafing against the bird).
- Even out the two strands of cord and cut the minimal amounts to make them perfectly even. This will allow you to ensure your harness is symmetrical when you put it on.

Crimped harness

- Slide one 1.3 mm aluminum crimp bead over each strand.
- Slide one crimp bead as close to the tag as possible and crimp it firmly closed using pliers, then slide the other crimp bead close enough to the tag that the tag

will not slide around (you may have to tug on the cord slightly), and crimp it firmly closed (Fig 1a).
- Wrap the 1.5 mm crimp bead with a thin length of medical tape (to prevent chafing against the bird; Fig 1b).
- Slide the 1.5 mm crimp bead over both lengths of the cord to within a few inches of the tag (Fig 1c); this will create the loop that goes over the head.
- Even out the two strands of cord and cut the minimal amount to make them perfectly even. This will allow you to ensure your harness is symmetrical when you put it on.

5.2 Tag deployment

- Set yourselves up in an area where you and your partner can directly face each other, with plenty of room to move around. Harness materials and tools should be readily at hand (including a backup harness).
- **Holder:** remove the bird from the bag and hold the bird with both hands, with your thumbs on its back and your fingers on its chest. Keep the wings close to the body with your palms and fingers (Fig 2). The bird should be facing away from you and towards the fitter.
- **Fitter:** put the loop of the harness over the head of the bird so that the tag rests on the back of the bird and the knot/crimp bead at the chest. The tag should sit directly between the shoulders (Fig 3).
- **Holder:** place one thumb over the tag where the fitter has placed it and hold the tag in place. The tag should not move from this position.

5.2.1 Knot harness

- **Holder:** Adjust your grip so that you can keep the bird controlled while extending one wing. Extend the wing slightly so that the fitter can slide one end of the cord under the wing.
- **Fitter:** Slide the two lines underneath the wings.
- **Fitter:** Pass the end of the lines through the eyelets at the rear end of the tag.
- **Fitter:** pull the ends of the cord through until there is no loose material on the harness.
- As often as deemed necessary, use a crochet hook to pull body feathers out from under the harness strands to improve fit. Some birds have dense body feathers, and the harness should be fit under those feathers, otherwise, it may become too loose if the bird preens some feathers out after attachment.
- **Fitter:** Compare the length of your two strands to check that your harness is symmetrical and centered. Because you cut the two strands to exactly the same length when you built the harness, they should remain the same length once you put the harness on. If they are drastically different, you will need to adjust the harness, or cut it off and start again.

- **Fitter:** take the bird from the holder and use your crochet hook to do a thorough pulling of body feathers from under the harness before you tighten it. Make sure:
    - you can find the harness on all parts of the bird;
    - that it is not cinching anything;
    - that the tertials are not caught in the harness; and,
    - that the 'breast knot' is still in a good location (offside the keel and just below the furcular hollow).
- **Fitter:** hand the bird back to the holder, then pull the ends of the cord with equal pressure to tighten the harness. Check that the strands are even. Check for harness fit.
- **Fitter:** The tag should be snug. You should not quite be able to slip your pinky finger under the tag (more space required for species experiencing fluctuating weights during the time of tag deployment, see Chan et al. 2016), but there should be some lateral and ventral wiggle room.
- **Fitter:** Tie a knot between the two ends.
- **Fitter:** Cut the excess cord off the harness.

5.2.2 Crimped harness

- **Fitter:** slide the crimp bead up towards the bird until it sits just below the furcular hollow and just to the side of the keel.
- **Holder:** place one finger on the crimp bead to keep it in place. The crimp bead should not move from this position.
- **Fitter:** check that the tag is still in the right place on the back of the bird. Use a crochet hook to pull body feathers out from under the harness strands around the neck. Check that the crimp bead is still in the correct location. Adjust as necessary, until the loop around the neck is properly fitted and the tag and crimp bead are sitting in the proper locations.
- **Fitter:** use your pliers to flatten the crimp bead, creating a fixed circumference loop. Note that you cannot undo this step, so check your crimp and tag location carefully.
- **Holder:** replace the fitter's finger on the crimped bead on the chest to keep it in place. Adjust your grip so that you can keep the bird controlled while extending one wing. Extend the wing slightly so that the fitter can bring one end of the cord under the wing.
- **Fitter:** bring one end of the cord under the wing and around to the back. Be very careful to bring it around the wing between the tertials and the body feathers. Some birds (e.g., nightjars) have heavy tertials, which can easily be caught in the harness if you are not paying attention. Repeat the same process for the other wing.
- **Fitter:** check that your tag and chest crimp bead are still in the right places. Adjust as necessary.

- **Fitter:** slide a 1.3 mm crimp bead over one of the ends of the cord. Thread that cord through the posterior tag eyelet on the side on which you're working, and slide another 1.3 mm crimp bead over the end. Take the other end of cord and thread it through the crimp bead, the other eyelet, and crimp bead on the opposite side; this will be a snug fit. Tips:
    - You don't need to do this in the order listed above. Do whatever works best for you.
    - It can help to have the holder help keep track of the crimp beads so they don't slide away on the cord and get lost in the bird's feathers.
    - Try this step with 1.5 mm crimp beads if the process is too difficult with 1.3 mm crimp beads.
- **Fitter:** pull the ends of the cord through until there is no loose material on the harness.
- As often as deemed necessary, use a crochet hook to pull body feathers out from under the harness strands to improve fit. Some birds have dense body feathers, and the harness should be fit under those feathers, otherwise, it may become too loose if the bird preens some feathers out after attachment.
- **Fitter:** Compare the length of your two strands to check that your harness is symmetrical and centered. Because you cut the two strands to exactly the same length when you built the harness, they should remain the same length once you put the harness on. If they are drastically different, you will need to adjust the harness, or cut it off and start again.
- **Fitter:** take the bird from the holder and use your crochet hook to do a thorough pulling of body feathers from under the harness before you tighten it. Make sure:
    - you can find the harness on all parts of the bird;
    - that it is not cinching anything;
    - that the tertials are not caught in the harness; and,
    - that the crimp bead on the chest is still in a good location (offside the keel and just below the furcular hollow).
- **Fitter:** hand the bird back to the holder, then pull the ends of the cord with equal pressure to tighten the harness. Check that the strands are even. Check for harness fit. The crimp beads ensure that the harness fit will not slip once you have tightened because they are biting the cord and holding it in place. Note that you will probably have to pull harder than you think to tighten the harness because of this.
- **Fitter:** repeat the previous step until you are comfortable with harness fit. The tag should be snug. You should not quite be able to slip your pinky finger under the tag (more space required for species experiencing fluctuating weights during the time of tag deployment, see Chan et al. 2016), but there should be some lateral and ventral wiggle room. The holder can double-check the harness fit as well.
- **Fitter:** crimp the remaining two crimp beads with your pliers and cut the excess cord off the harness (Fig 3).

5.3 Ensure proper fit, and release bird

- Check the harness one last time for fit. If there is uncertainty in the fit, the harness should be removed and a new one attached if the attachment can be completed without the bird having to be handled more than 20 minutes, and the bird is not showing signs of stress. If the fit is good, then the bird can be released.
- The bird should be released near the capture location (but not within 100 m from the net).
- Release the bird very low to the ground, in case it does not easily fly away at first.
- If the bird does not fly away immediately, place it on the ground.
- If it does not fly away from the ground, flick the underside of the tail gently a couple times to encourage it then leave the bird to sit in a safe area away from sound and light for 5-10 minutes between each attempt; repeat these steps a few times if necessary.
- If the bird still does not fly away, cut off the harness and reattempt release.

6. CATEGORY OF INVASIVENESS

- C – Minor stress or pain of short duration (e.g. capture using methods with little or no potential to cause injury and marking of animals for immediate release; short periods of restraint beyond that for simple observation or examination, but consistent with minimal distress). Category selected based on the *Categories of invasiveness in animal experiments* outlined by Canadian Council on Animal Care (CACC 1991).

7. REFERENCES (INCLUDING POLICIES)

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8. DOCUMENTATION (E.G. ANY FORM ASSOCIATED WITH THIS SOP)

9. REVISION HISTORY

10. APPENDICES

Appendix 1. Figures

Figure 1a. Jewelry cord strung through the front tube on tag, and crimp beads closed next to tag body.

Figure 1b. A small piece of medical tape to be wrapped around 1.5 mm crimp bead, to prevent chafing against bird body.

Figure 1c. Taped 1.5 mm crimp bead strung over both ends of jewelry cord.

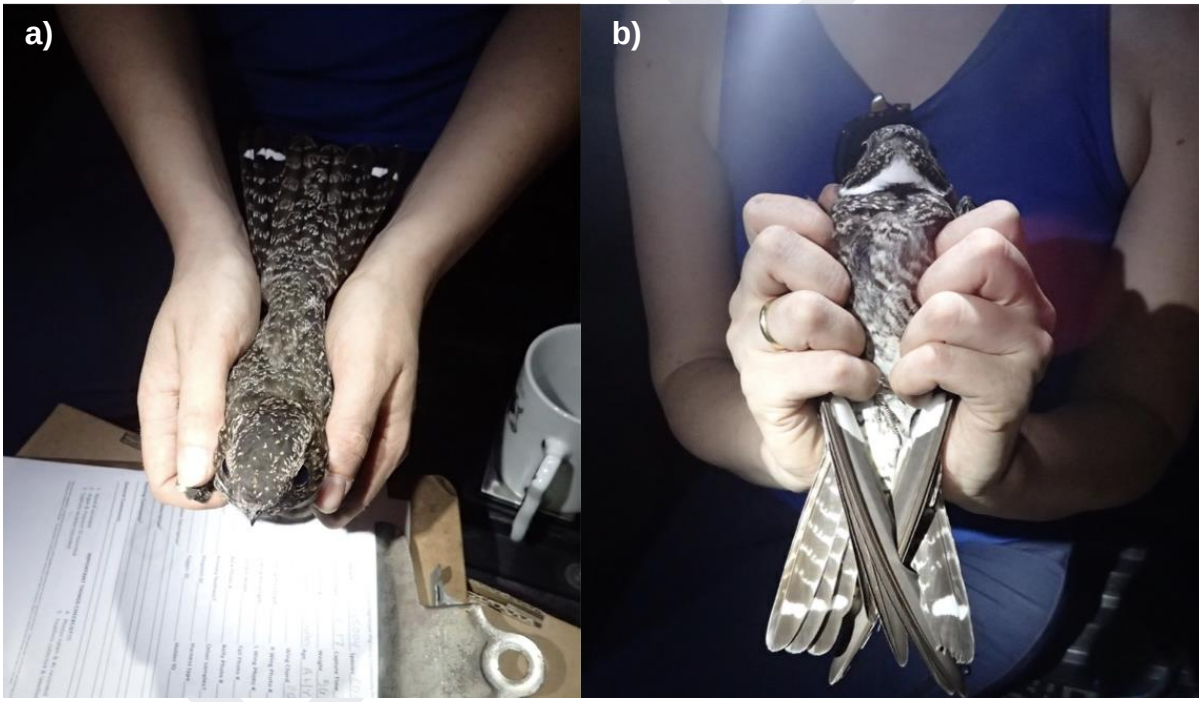

Figure 2. Harness grip on nightjar showing access to the back (a) of the bird and the front (b) of the bird.

Figure 3. Completed harness attachment, showing location of tag between the shoulders.