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REFINEMENTS TO SELECTIVE TRAPPING TECHNIQUES: A RADIO-CONTROLLED BOW NET AND POWER SNARE FOR BALD AND GOLDEN EAGLES

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Research and management of raptors often requires the capture of specific individuals for radiotagging or colormarking. Bloom (1987) reviewed raptor trapping techniques, including several selective methods used for eagles: cannon and rocket nets (see also Grubb 1988), the pit trap, and our bow net. Meng (1963) was first to develop a radio-controlled bow net and Bryan (1988) modified it for use with American kestrels (*Falco sparverius*). The power snare, a "manually-operated, single noose system," was developed for the selective capture of white-bellied sea-eagles (*Haliaeetus leucogaster*) by Hertog (1987).

During studies of wintering and breeding bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) in Washington, California, and Arizona (Hunt et al. 1992a, 1992b, 1992c, 1992d), we constructed a radio-controlled bow net to selectively capture eagles (Fig. 1a). We were able to completely conceal it in loose soil and operate it from distances up to 400 m. In addition, we

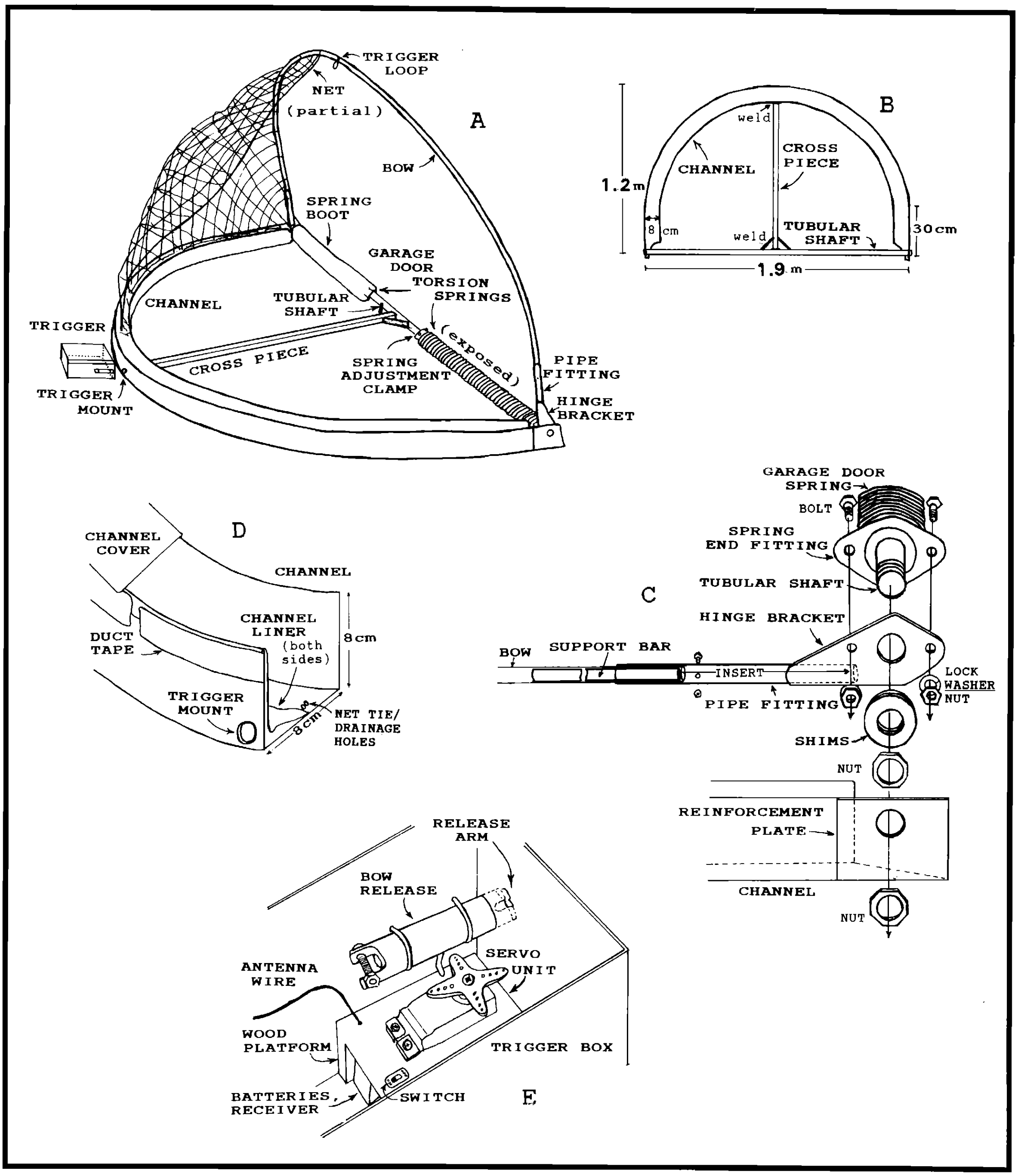

Figure 1. Radio-controlled eagle bow net: (a) bow net opening, showing position of principal components, (b) top view, no springs, (c) detail of spring-hinge-bow-channel attachment, (d) cross section detail of channel at trigger mount, (e) interior detail of trigger box.

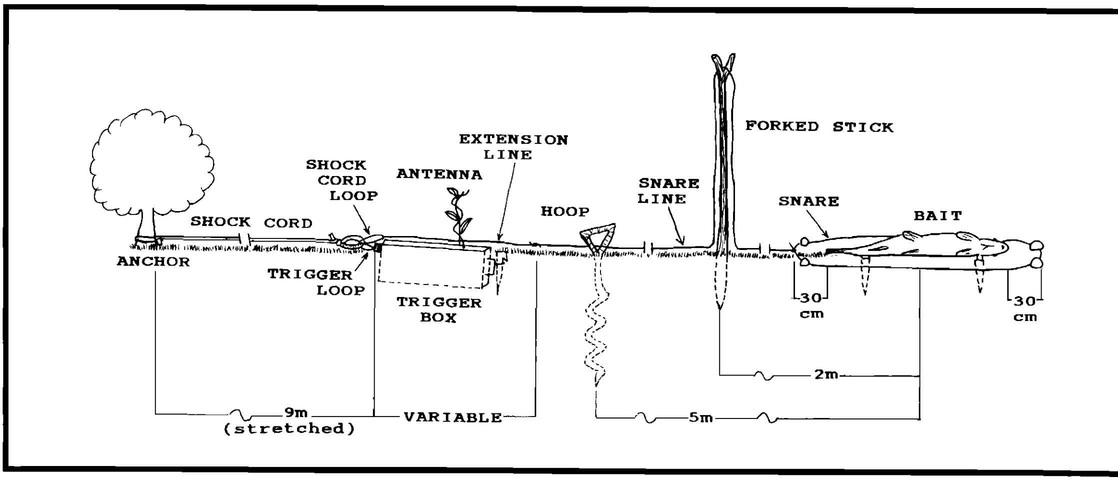

Figure 2. Application of radio-controlled trigger box to Hertog's power snare. Distance relationships between bait, snare, forked stick, and hoop are from Hertog (1987).

modified Hertog's (1987) manually-operated power snare with a radio-controlled trigger device (Fig. 2).

MATERIALS AND ASSEMBLY

Bow Net. The physical dimensions of the bow net, shown in Fig. 1b, allowed the hoop and net to safely capture a single eagle. A larger version was used by A. Harmata (pers. comm.) to capture two eagles simultaneously. Table 1 provides a list of the principal materials for the bow net; a metal fabrication (welding) shop can supply and construct many of the components.

We formed the aluminum bow into a semicircle with a pipe bender. Support bars inside the bow/pipe fitting connection helped distribute the force from the springs to prevent the bow from snapping off (Fig. 1c). We attached the net loosely by placing a large cardboard box (about 1.1 m^2) in the middle of the trap, draping the net over the box and open bow, and tying/taping the net evenly at 5–10 cm intervals to the bow and to a stiff wire secured to the bottom of the channel. Foam pipe insulation protected the bow. A channel liner of plastic sheeting (Fig. 1d) protected the net from snagging inside the channel.

We tightened each spring approximately eight revolutions, both springs in the same direction. If correct, they decreased in diameter and expanded lengthwise when tightened. A plastic "boot" of loosely wrapped plastic sheeting taped around the garage door springs kept grit from fouling the spring action (Fig. 1a).

We tested the completed bow net by placing an eagle-sized cardboard box in the middle of the trap. If constructed correctly, the bow and net released immediately, flew up and over the box without disturbing it, and contacted the other side in about 0.5 sec.

Trigger. The bow net trigger system (Table 1, Fig. 1e) was separately contained in a military-surplus ammunition box. The remote unit consisted of a two-channel radio control system of the type used in model airplanes. The actual trigger was an archery bowstring release, capable of holding extreme resistance yet easily set off with the action of the remote servo unit. The trigger mount on the bow net channel (Fig. 1d) supported the head of the release; a trigger loop of cable was just long enough to reach into the release arm and, when the trap was set, hold the bow down as low as possible in the channel.

Power Snare. We modified Hertog's (1987) power snare with a radio-controlled release system using the trigger described above. Hertog's (1987) dimensions (snare distance relationships) for white-bellied sea-eagles were effective in capturing bald eagles.

The materials necessary to construct a power snare are listed in Table 1; our modified power snare is depicted in Fig. 2. We used a heavier snare material (27 kg breaking strength (test) vs. 18 kg for the smaller white-bellied sea-eagle) and multifilament extension line to connect the snare material to the shock cord. We tied overhand loops to each end of the 5 m nylon-jacketed shock cord. Into one overhand loop we connected the trigger loop and the shock cord loop (Fig. 2, Table 1).

FIELD USE

Bow Net. We chose a site frequented by the target bird in a relatively open area which could be viewed from above We buried the channel up to the rims, the springs just subsurface, and covered the (activated) trigger box after wrapping the antenna around a twig pushed into the ground. We staked the trap down in two places along the crosspiece and cleared debris from around the hinge area We set the trigger loop into the release arm, tested it, and, to conserve batteries and avoid premature triggering, we turned the transmitter unit off until it was time to trigger the trap.

We secured the bait solidly with two pieces of baling wire attached to the middle of the tubular shaft. We laid

Table 1. List of principal materials needed to construct bow net, trigger system, and power snare.

NUMBER NEEDED	ITEM	DIMENSIONS	MATERIALS
		Bow Net	
1	set garage door torsion springs	size used on 5 m (16 ft) sectional garage door (approx. 0.6 m long)	set = right & left springs
1	tubular shaft	190 cm × 2.5 cm (1 in) O.D.	steel torsion bar
1	cross piece	113 cm × 2.5 cm (1 in square)	iron square stock
1	channel	8 cm wide × 8 cm deep	14 gauge steel
1	reinforcement plate	8 cm × 10 cm	14 gauge steel
1	bow	approx. 3.1 m × 1.6 cm (0.625 in) O.D.	0.09 cm (0.035 in) thickness aircraft aluminum type 6061-T6, WW-T-700/6
1	set hinge brackets	0.6 cm (7/32 in) thick (see Fig. 1c)	strap iron
2	pipe fittings	15 cm, 1.6 cm (0.625 in) I.D.	iron pipe
2	support rods	30 cm of 1.3 cm (0.5 in) dia	hardwood dowel
several	shims	2.5 cm (1 in) I.D., 3.8 cm O.D.	steel washers
2	spring boots	approx. 80 cm × 30 cm	3 ml plastic sheeting
2	channel liners	approx. 3.1 m × 20 cm	3 ml plastic sheeting
1	net	approx. 3.5 m × 3.7 m of 9 cm mesh	multifilament salmon gill-netting
1	trigger mount	1.9 cm (0.75 in) I.D.	steel washer
1	trigger loop	approx. 13 cm of 0.16 cm (1/16 in)	plastic coated cable & connector sleeves
1	bow insulation	3.1 m of 1.3 cm (0.5 in) thickness	foam pipe insulation
20	channel covers	20 cm × 10 cm	plastic contact paper over cardboard
		Trigger	
1	bow release		archery bow release
1	radio control system	servo unit, receiver, transmitter	two-channel radio control set
1	trigger box	26 cm × 18 cm × 9 cm	watertight ammunition box
		Power Snare	
1	snare	9 m spool of 27 kg (60 lb) test (black)	plastic coated multi-strand fishing leader cable & connector sleeves
1	extension line	spool of 54 kg (120 lb) test	dark, braided dacron fishing line
1	shock cord	5 m of 5 mm dia	nylon-jacketed shock cord
1	forked stick	approx. 75 cm, 18 cm thick	straight forked branch
1	hoop	approx. 45 cm long, 6 cm opening	dog tie-out (auger) stake
1	anchor	4.5 kg	barbell weight or sand auger
1	trigger loop	10 cm, 113 kg (250 lb) test	plastic coated multi-strand fishing leader cable & connector sleeves
1	shock cord loop	15 cm, 113 kg (250 lb) test	plastic coated multi-strand fishing leader cable & connector sleeves

channel covers (sections of thin cardboard sandwiched between brown plastic contact paper) along the channel at the surface of the soil and used a sifter to sprinkle sand or soil lightly over the covers; thus, the trap was completely hidden. We further camouflaged it with grass and leaves. The entire process required about one hour, longer if soil was compacted or muddy. A. Harmata (pers. comm.) used the bow net in snow, taking precautions to prevent the net from freezing together or snow from freezing over the top.

We chose a blind with an elevated view of the trap site, a factor which also improved radio reception. We placed a recognizable marker (e.g., rock or small bush) just outside the perimeter of the trap to help verify the eagle did not move the bait. The strength of the springs needed to operate this large bow net could injure or kill an eagle if used incorrectly, so we made sure that the eagle was in the center of the trap and taking bites with its head down before triggering. When eagles refused carrion bait, we used live bait. We installed the trap prior to first light to avoid alerting the eagle.

Power Snare. We used the power snare in remote areas (where the heavier bow net could not be easily transported), on rocky substrate, and along wet shoreline areas. When the snare reached partially into the water, we positioned the trigger (water-resistant but not waterproof) on higher ground.

Black fishing leader cable formed the noose around the staked-down bait, extended up and over the forked stick, through the hoop and out toward the trigger box (Fig. 2). We used a simple overhand knot with a 2 cm free end for the noose slip knot. We positioned the trigger box 9 m from an anchor (tree, shrub, buried weight, or sand auger) to which we secured one end of the 5 m shock cord. We used a dog tie-out (auger) stake twisted into the ground for the retaining hoop. All components of the set (bait, forked stick, hoop, trigger, anchor) were in a straight line, cleared of debris.

We activated, buried, and staked the trigger box so the trigger tilted slightly aboveground and pointed at the anchor (Fig. 2). We elevated the antenna wire by wrapping it on a twig pushed into the ground. We set tension on the trap by stretching the shock cord 4 m and setting the trigger loop into the trigger. The amount of stretch in the shock cord was critical to effective operation: too little tension made the snare weak and slow, too much could break the snare cable. We tied one end of the extension line to the shock cord loop; the other end was tied to an overhand loop at the end of the snare line.

We used two rocks to anchor the snare at the head of the bait. The snare operated effectively in shallow water if we used larger rocks to force the far end of the snare to leave the ground last. Two smaller rocks placed at the tail end of the snare (Fig. 2) helped prevent small birds from disturbing the integrity of the noose. We tested each application by placing a hand on the bait to simulate an eagle capture. About one hour was required to set up the power snare.

In contrast to the bow net, we set off the power snare when the eagle's head was up, following a bite or two on the carcass (Hertog 1987). A large carp (*Cyprinus carpio*) carcass placed partially in the water was most effective at bringing bald eagles to the power snare.

DISCUSSION

The radio-controlled bow net was successful in 16 of 19 attempts to capture bald eagles (84% success rate). Failures occurred when: (1) the wires of the trigger box loosened after testing, leaving the trigger inoperable, (2) the water level rose on a reservoir shoreline set, flooding (and shorting out) the trigger mechanism, and (3) the eagle's stoop moved the (small) bait off the retaining wires and outside the center of the trap, thus rendering the trap unsafe for use. We caution the reader to use larger baits, attached securely.

Our attempts to trap golden eagles with this bow net were also successful; we captured 26 of 30 (87%) eagles that approached the bait. Failures included: (1) weak batteries in the trigger box, (2) the transmitting signal did not reach the trigger, and (3) eagles walking toward the bait stepped on the channel covers, became suspicious, and flew off. We corrected the latter problem by using slightly stiffer and wider channel covers.

The radio-controlled power snare was effective five of seven times bald eagles came to bait (71% success). We missed once when the eagle disturbed the snare prior to hopping up on the bait. On another occasion, the snare was set on a relatively steep shoreline, reducing the effect of the forked stick (in bringing the snare up around the legs of the eagle). We later experimented with a taller forked stick which offset the slope's effect.

In our opinion, the eagle capture techniques described in this paper have certain advantages over other selective traps. The bow net is very reliable when properly installed, is less dangerous and more easily camouflaged than a rocket or cannon net, and is mobile, unlike the pit trap On the other hand, the quick action of this spring-powered bow is potentially hazardous, and we advise adherence to our precautions, particularly with regard to the eagle's position at the moment of triggering. The radio-controlled power snare is extremely mobile and safe, but probably less reliable, because the snare can be disturbed by the eagle or other birds prior to triggering.

RESUMEN.—Capturamos individuos especificos de *Haliaeetus leucocephalus,* usando dos sistemas de trampeo radio-controlados. Una red "bow" de dos m de diámetro, activada por resortes de torsión de puertas de cochera, fue altamente confiable ($N = 16$ capturas/19 intentos, 84% de éxito) y puede ocultarse completamente en sustratos sueltos. También capturamos 26 de 30 (87% de éxito) individuos de *Aquila chrysaetos* con este sistema. Modificamos un sistema de lazo tensado y manualmente operado por nuestro sistema radio-controlado de activación. Este sistema fue más adecuado para remotas localizaciones de trampeo, capturandose cinco individuos de *H. leucocephalus* en siete intentos (71% de éxitos).

[Traducción de Ivan Lazo]

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