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Tools and Technology

Development and Testing of a Mechanical Lure for Raptor Trapping

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ABSTRACT Raptor trapping and banding at migration stations rely upon the use of live lure birds to attract hawks to the trapping area. The use of these lure animals may present raptor researchers with legislative, regulatory, ethical, and logistical challenges. We developed and tested a mechanical alternative to reduce the demands imposed by the use of live lures. The mechanical lure was able to withstand the rigors of field use and was as effective at attracting hawks to the trapping station as live lures during tests in the Marin Headlands, California, USA, 2001. Although resulting in significantly fewer captures, the use of a mechanical lure may be an appropriate alternative in situations where the regulatory and/or ethical environment prohibit the use of live lures and where the logistical demands of maintaining a captive colony of live lures is impractical. © 2013 The Wildlife Society.

KEY WORDS banding, hawk, mechanical, migration, raptor, ringing, trapping.

Raptor banding at migration bottlenecks relies on the use of lures to attract hawks to the trapping station (see Bloom et al. 2007). Lures are typically live birds that require a great deal of care in the form of maintenance of a housing facility and provisioning of food and water throughout the study period. The legislative, regulatory, ethical, and logistical challenges of maintaining a colony of lure animals may limit opportunities to study predatory birds (see Boal et al. 2010). Use of artificial lures would reduce regulatory constraints, eliminate the need for maintenance of a colony of live lures (see Jacobs 1996), and broaden the opportunity for raptor-banding studies in situations where the use of live lures is not an option (Boal et al. 2010). In 1987, the Golden Gate Raptor Observatory initiated a multi-year effort to develop a mechanical lure that would effectively attract and allow subsequent capture of raptors. Our objectives were to develop and field-test a mechanical lure and subsequently to compare capture efficacy between live and mechanical lures.

STUDY AREA

The Golden Gate Raptor Observatory study site includes 4 trapping stations located in the coastal scrub headlands along the central coast of California, USA, at the tip of the Marin peninsula between the San Francisco Bay and Pacific Ocean (37°49′49″N, −122°29′59″W). The north–south orientation of the Marin peninsula and flanking shorelines provides strong leading lines that focus raptor migration southward to the headlands at the southern terminus of the peninsula. The funneling effect created by this geography provides an opportunity to study a large concentration of raptors as they prepare for the water crossing from the Marin Headlands across the Golden Gate. The trapping stations are located near the tops of the coastal hills at elevations ranging from 235 m to 264 m and take advantage of local topography and vegetation to provide opportunities and cover for raptor trapping. Comparison of live and mechanical lures was conducted at the trapping station at the southernmost site located on Hawk Hill (238 m) that has historically had the greatest number of captures and allowed for the greatest comparison between the 2 luring systems.

MATERIAL AND METHODS

Mechanical Lure-Skin Preparation

We developed mechanical lures to replicate the size of the 3 species of birds commonly used as lures for trapping raptors: rock pigeons (*Columba livia*), European starlings (*Sturnus vulgaris*), and house sparrows (*Passer domesticus*; Fig. 1). Skins for the mechanical lures were obtained from road kill and collected under a special purpose salvage permit from the U.S. Fish and Wildlife Service. We dried the skins in a drying box using a mixture of borax and cornmeal. We prepared skins as several pieces (separate wings, head, and body with tail and legs attached) for convenience in covering the mechanism (Proctor and Lynch 1993). If needed, we used a small amount of water to moisten the skins to facilitate attaching the skin to the mechanism. We then wired the wings to polystyrene struts (25-mm × 40-mm cross-section) that fit into the sockets of the motor-driven flapping mechanism.

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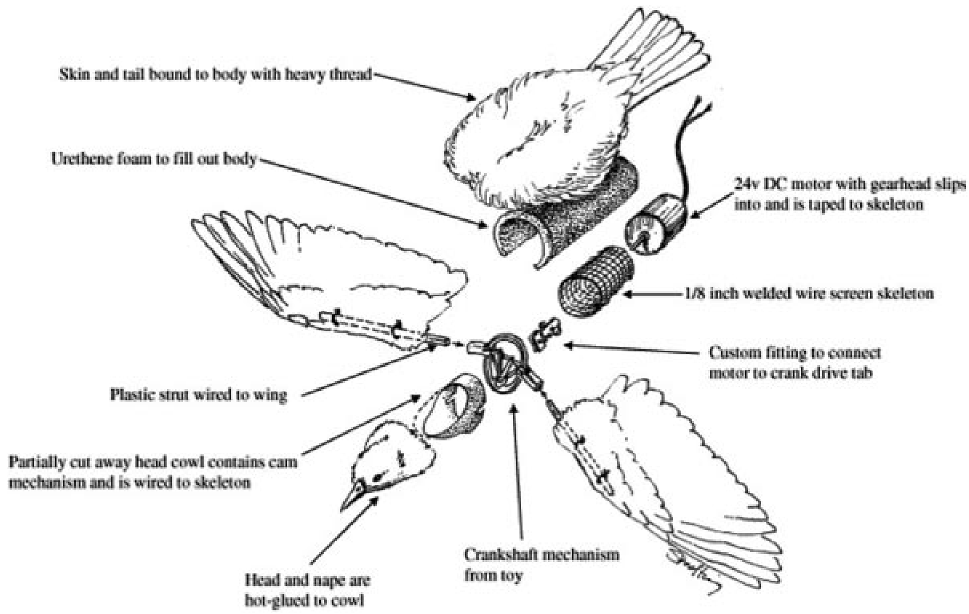

Figure 1. Exploded-view diagram of mechanical raptor lure, including notations describing the materials used during lure assembly.

We attached the head to the mechanism frame with hot glue and then wired it in place. The body and tail were glued to felt cut-outs of a matching shape and size, and then attached to foam that insulated the mechanism using velcro and heavy thread. The felt acted to increase durability of the skin as well as to provide a substrate for the velcro attachment. We prepared extra wings for each lure so that they could be easily replaced in the field if broken.

Mechanical Lure Design

The flapping action of the mechanical lure is based on a cam mechanism found in commercially available toy birds (Tim Bird by Schylling, Rowley, MA; www.schylling.com). To power wing motion, we used the motor and gear combination manufactured by Maxon Precision Motors, Inc. (Fall River, MA) for large and medium lures (or a smaller motor from the same manufacturer without the necessity of a gear attachment for small lures). To align the shaft of the motor with the crank, we encased the motor in a wire cage (using 1/8-in. [0.3-cm] welded wire). We fabricated a brass connector using brass tubing with an interior diameter matching the motor shaft to connect the motor to the shaft and used 2 set-screws to fasten the connection. We flattened the motor shaft on one side to provide the set-screw better purchase and a more secure fit. To reduce the noise of the mechanism and to buffer against impact from raptors, we enclosed the mechanism in polyurethane foam and secured it to the welded wire using 26-gauge non-rusting wire.

To this mechanism we added plastic hobby struts (0.25 cm wide × 0.40 mm high in cross section and 5–15 cm in length depending on the size of the lure) that fit into the sockets of the cam mechanism. These struts formed the framework for the lure's wings. We attached the struts to the wings of the skins using 26-gauge non-rusting wire. To provide power to the mechanism we used two 12-V batteries, wired in series, with a regulator to vary the voltage (and, thus, the rate of flapping). We ran electrical wire from the trapping blind to the mechanical lure at the trap and used a foot pedal (Treadlite II, catalogue no. T-91-S; Linemaster Switch Corporation, Woodstcock, CT) as an on/off switch, which allowed the trappers' hands to be free to manipulate the lure lines controlling the lure's position (Fig. 2). We then attached the completed lure to the lure and electrical lines.

Comparative Trapping Success

To determine the relative efficacy of mechanical and live lure systems at attracting and capturing raptors, we implemented a comparative study from 20 August through 10 December 2001, between the hours of 1000 hours and 1600 hours each day. During trapping operations, we alternated hourly between mechanical lures and standard lures. We selected mechanical lures matching sizes of live lures so that size of lure would not be a factor in the raptors' response. We randomly selected the lure system used at the start of each day. We examined the behavior of raptors relative to the lures within a standard area that was defined by readily identifiable landmarks approximately 0.40 km from the trapping blind. Only 180° of visibility of the arc are available from the site because the blind is situated against a hill and faces out toward a valley. Therefore, the resulting area we examined was approximately 25 ha. This area roughly described the area in which previous trapping experience suggested that live lures influenced the behavior of raptors. Raptor trappers recorded the number of captures and attractions for each raptor entering this area.

We defined a capture as any raptor that was captured during trapping operations. We used the attraction category to document occasions when raptors were drawn to the trapping area as a result of luring activities. Because our

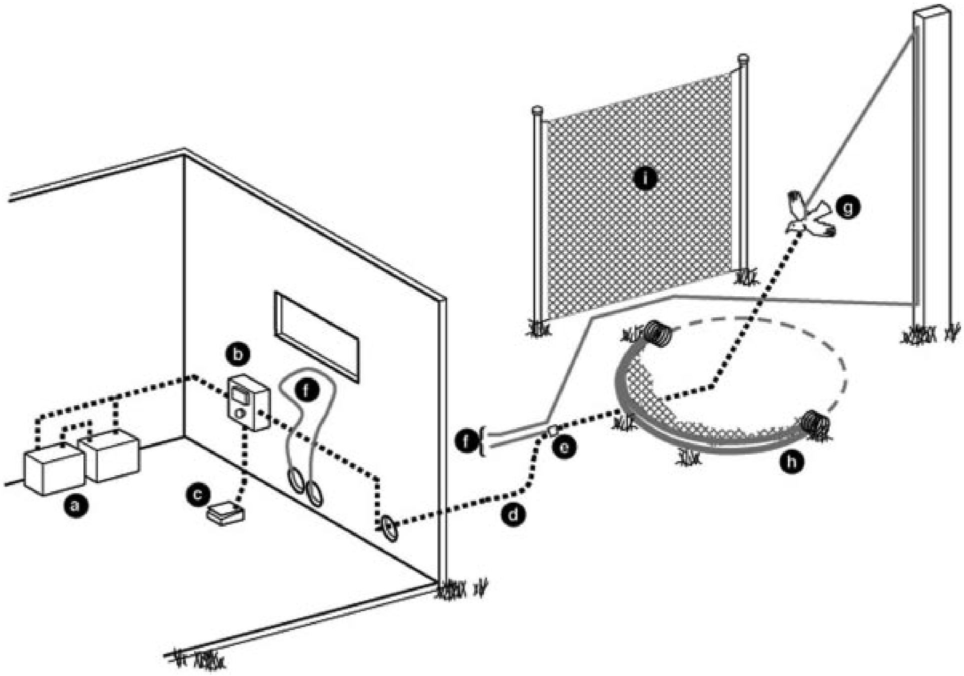

Figure 2. Raptor-trapping set-up with mechanical lure. Two series-wired lead-acid batteries (a) provided 24 V direct current to a variable voltage regulator (b), so when foot switch (c) was pressed, lure wings flapped from the electrical signal sent through a power cable (d) that was attached at a mechanical connector (e) to lure lines (f), which routed through the blind wall to the interior to raise and lower the mechanical lure (g), the flapping motion of which attracted raptors into either spring-loaded bow-net (h) or passive dho-gazza net (i).

intent in use of the attraction category was to document the number of raptors that responded to the lures and not to quantify the intensity of response, we recorded only a single attraction even when a raptor displayed several of the behaviors described below. We recorded an attraction for any bird that 1) was captured during trapping operations, 2) stooped on a lure (i.e., a high-speed attack), 3) hit the lure, or 4) changed direction of flight to investigate the lure, but did not engage in a direct stoop. We captured raptors using a combination of mist nets, dho-ghazzas, and bow-nets (Clark 1981, Bloom 1987).

Statistical Methods

We used Yate's corrected chi-square tests to test for a difference in the proportion of birds that were attracted and captured using the 2 lure systems. We also examined whether there was a difference in within-species trapping success between passive traps (mist nets and dho-ghazzas) and active traps (bow-nets) that require raptors to land and hold the lure. We examined responses by red-tailed hawks (*Buteo jamaicensis*), sharp-shinned hawks (*Accipiter striatus*), and Cooper's hawks (*A. cooperii*) individually due to the high proportion of captures for these 3 species. We also examined a pooled group of all raptor species, which included those examined individually, as well as merlin (*Falco columbarius*), American kestrel (*F. spaverius*), peregrine falcon (*F. peregrinus*), prairie falcon (*F. mexicanus*), northern harrier (*Circus cyaneus*), and red-shouldered hawk (*B. lineatus*). We used a Bonferroni correction to assess significance across multiple tests ($P = 0.05/8 = 0.00625$; Rice 1989).

RESULTS

We found no significant difference between live and mechanical lures in the rate of attractions in any of the groups examined (Table 1). The proportion of raptor attractions that resulted in captures was higher for live lures (28%) than mechanical lures (10%), and this difference was significant in all cases except among red-tailed hawks (Table 1). We found that live lures were significantly more effective at attracting raptors that were subsequently trapped, regardless of use of passive or active traps, for both sharp-shinned and Cooper's hawks ($P < 0.001$ for all comparisons). No statistical difference in trapping success for red-tailed hawks was observed between mechanical and live lures when using either passive nets ($P = 0.910$) or active nets ($P = 0.009$). However, while not meeting the threshold of statistical significance ($\alpha = 0.008$), the comparison in efficacy between mechanical and live lures when using active traps suggests that live lures outperform mechanical lures as was the case with both sharp-shinned and Cooper's hawks. Only 12 red-tailed hawks were trapped in passive nets during the course of our study (4 with mechanical lures and 8 with live lures) limiting our ability to make a meaningful inference about the relative efficacy of mechanical and live lures when using passive nets.

DISCUSSION

Our development and field-testing of the mechanical lure resulted in a lure that was able to withstand the rigors of field deployment throughout the course of a banding season.

Table 1. Summary by lure method of total number of birds encountered between 20 August and 10 December 2001 in the Marin Headlands, California, USA. Significant χ^2 results are indicated with an asterisk; we used a Bonferroni correction to assess significance across multiple tests ($P = 0.05/8 = 0.00625$; Rice 1989). The "All hawks" category includes all raptor species encountered during the study, not just red-tailed, sharp-shinned, and Cooper's hawks; therefore, the total in these categories is greater than the sum of the 3 subsequent categories.

Species	Total	Attractions (%)	χ^2; *P*-value	Captures (%)	χ^2; *P*-value
All hawks					
Mechanical	1,455	535 (36.8)		56 (3.8)	
Live	1,829	758 (41.4)	3.12; 0.08	215 (11.8)	37.98; <0.0001*
Red-tailed hawks					
Mechanical	571	189 (33.1)		11 (1.9)	
Live	742	293 (39.5)	2.47; 0.12	43 (5.8)	6.59; 0.01
Sharp-shinned hawks					
Mechanical	401	182 (45.4)		25 (6.2)	
Live	462	229 (49.6)	0.45; 0.50	73 (15.8)	10.79; <0.0001*
Cooper's hawks					
Mechanical	220	103 (46.8)		18 (8.2)	
Live	277	142 (51.3)	0.25; 0.62	103 (37.2)	15.75; <0.0001*

However, our study of comparative trapping success indicated that use of mechanical lures resulted in significantly fewer captures for all species examined regardless of trap type (passive or active) except for red-tailed hawks. Though not meeting the threshold of statistical significance following correction for multiple tests, the live lure system resulted in noticeably more captures of red-tailed hawks than did the mechanical lure system. We believe that if the sample size of red-tailed hawks were increased, a significant difference in capture success would be observed, particularly when using active nets.

Because an equivalent number of raptors were attracted to live and mechanical lures we think that, at a distance, the mechanical lures provided a reasonable facsimile of a live bird. Our data indicate that there was a decrease in mechanical lure effectiveness as raptors approached the mechanical lure. This decline in efficacy at closer distances is supported by the significantly fewer attractions that subsequently resulted in captures in the mechanical lure group.

The mechanical lures withstood field conditions that involved exposure to sun, wind, fog, humidity, and repeated encounters with raptors. We identified several maintenance issues during field-testing of the mechanical lures. First, a surplus of wing struts was necessary due to struts being broken by impacts with hawks. An alternative solution would be to use a more flexible wing-strut material. Second, the voltage needed to be monitored carefully due to increased wing-loading in larger lures (i.e., the force exerted on the wing struts). This could exceed the level that resulted in snapping of the struts; this issue also suggested that an alternate wing-strut material may perform better in the larger lures. Third, the wings and bodies of the lures needed occasional replacement following heavy use. Fourth, to minimize burning out motors, the power distribution system should include polarized connectors where interchangeable lures were plugged in at each trap and the voltage regulators were provided with diode protectors to prevent damage to the circuitry from reverse polarity. Fifth, to increase battery life, we switched from automotive lead-acid batteries to marine batteries. Last, the electrical connection between the electric line and the lure needed occasional replacement.

A logical first step in improving trapping efficacy of the mechanical lure system may be to determine what aspects of lure performance discouraged final approach by raptors at close distance. Potential reasons for decreased capture efficiency include the unnatural noise generated by the motor, the addition of a heavy electrical line in the trapping area that increased visual distractions, and the increasingly detectable unnatural wing motion as the hawk approached the mechanical lure. Solutions to the first 2 concerns may be relatively easily addressed. Use of an alternate motor along with insulating material could help to reduce noise and lighter weight electrical line or internal batteries could be used to reduce the visual distractions around the trapping area. The motion of the wing may be the most difficult concern to address. Significant additional engineering would be necessary to create a more natural wing motion in the lure and would need to be balanced against the robustness of the lure to field conditions. Notably heightened aggression toward live lures has been observed at other trapping stations (e.g., Goshute Mountains in eastern NV, Boise Ridge in ID, and the Fishermans Island station in coastal VA; A. C. Hull and J. M. Hull, personal observation), suggesting that use of mechanical lures may result in a higher proportion of captures than was seen during this study. Mechanical lures provide an alternative for trapping target individuals (e.g., at nest sites) or in cases where relatively few individuals of a target species are needed. Specifically, mechanical lures may be useful in augmenting other trapping methods that rely on inanimate decoys to attract raptors to a trapping area. In such cases, the movement of the mechanical lure may increase trapping success.

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