A Low-disturbance Capture Technique for Ground-nesting Double-crested Cormorants (*Phalacrocorax auritus*)

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Abstract.—Capturing breeding adults of colonially nesting species can entail risks of nest failure and even colony abandonment, especially in species that react strongly to human disturbance. A low-disturbance technique for capturing specific adult Double-crested Cormorants (*Phalacrocorax auritus*) at a ground-nesting colony was developed to reduce these risks and is described here. Nesting habitat enhancement was used to attract Double-crested Cormorants to nest adjacent to above-ground tunnels constructed so that researchers could capture birds by hand. Using this technique, Double-crested Cormorants (n = 87) were captured during the incubation and chick-rearing stages of the nesting cycle. Unlike alternative capture techniques, this approach allowed targeting of specific individuals for capture and recapture, minimized local disturbance, and eliminated colony-wide disturbances. The tunnel-based system presented here could be adapted to capture adults or to access the nest contents of other ground-nesting colonial species that are inclined to nest in areas of enhanced nesting habitat and adapt to anthropogenic structures in their nesting area. This system would be particularly beneficial for other wary and easily disturbed species. *Received 29 September 2014, accepted 13 December 2015.*

Key words.—avian capture, capture method, Double-crested Cormorant, *Phalacrocorax auritus*, social attraction, Suliformes.

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Studies of avian ecology often require the capture and handling of birds for banding, measurements, sampling, or deployment of instrumentation used to gather data on free-ranging birds. Many studies require a technique that allows for the capture or recapture of specific individuals to obtain consecutive tissue samples, retrieve costly tracking equipment, or download data from logging devices. Circumstances or study design may also necessitate the use of a capture technique that minimizes sample recovery time, the duration the bird is held, or the amount of disturbance to other breeding or roosting birds (Benson and Suryan 1999; Courtot *et al.* 2012).

Several techniques have been used to capture colonial ground-nesting birds, all of which have drawbacks. Some species or individuals do not tolerate the approach of a noose pole (Hogan 1985) or quickly become wary of nets or traps (Benson and Suryan 1999). Padded leg-hold traps require that a bird trigger the trap itself (King *et al.* 2000), precluding selective capture. Mortality risk can be associated with the use of net guns (Herring *et al.* 2008). Widespread disturbance to a breeding colony can result from the use of noose-carpets during the day or spotlighting at night (D. D. Roby, pers. obs.). Additionally, with these techniques it is difficult to target specific individuals, and there is often a time lag between bird entrapment and sample collection. Catching birds singly, when multiple birds are needed, can be problematic because other birds in the area grow alert to and wary of the presence of a capture device.

Several traditional techniques have been used to capture ground-nesting Double-crested Cormorants (*Phalacrocorax auritus*; hereafter, cormorant). At the large breeding colony of cormorants on East Sand Island, Oregon, prior to 2008 most birds were caught using a night-lighting technique (Anderson *et al.* 2004), which involved entering the colony at night with large landing nets. Constraints of a study initiated in 2008

(Courtot *et al.* 2012) required that we develop a new capture technique. Our objectives were to develop a technique that would: 1) minimize colony-wide disturbance to cormorants to reduce nest predation by nearby nesting and roosting Glaucous-winged x Western gull hybrids (*Larus glaucescens* x *L. occidentalis*); 2) minimize or eliminate disturbance to California Brown Pelicans (*Pelecanus occidentalis californicus*) that roost near the cormorant colony and were protected under the United States Endangered Species Act at the time (U.S. Fish and Wildlife Service 2009); and 3) allow capture of a large number of birds while minimizing the holding time for each individual, optimally catching birds singly or in small groups. Here, we describe a low-disturbance, precise, rapid, and safe technique that employs habitat enhancement to lure cormorants to nest adjacent to an above-ground tunnel customized for capture of birds by hand.

METHODS

Double-crested Cormorants are large waterbirds (> 1,500 g) that nest colonially on a variety of substrates, including trees, bare ground, rocky areas, and man-made structures. At East Sand Island, Oregon, USA, in the Columbia River estuary (46° 15' 36.00" N, 123° 58' 12.00" W), nearly the entire colony of more than 12,000 breeding pairs builds their nests on the ground. Beginning in 2000, approximately 2-4 weeks before nest building was initiated, we constructed or repaired an above-ground tunnel system through which researchers accessed observation blinds within the cormorant colony from off-colony entrance points (Fig. 1). Cormorants began to nest adjacent to portions of the tunnel system after it had been present in the colony for five consecutive breeding seasons. During 2008 and 2009, we captured adult cormorants nesting adjacent to the tunnel system to deploy satellite tracking devices (Courtot *et al.* 2012).

Above-ground Tunnel Design

We constructed the tunnel system by connecting and covering a series of lumber A-frames (Fig. 2), a design similar to that described by Cairns *et al.* (1987). We covered the wood tunnel structure with a durable

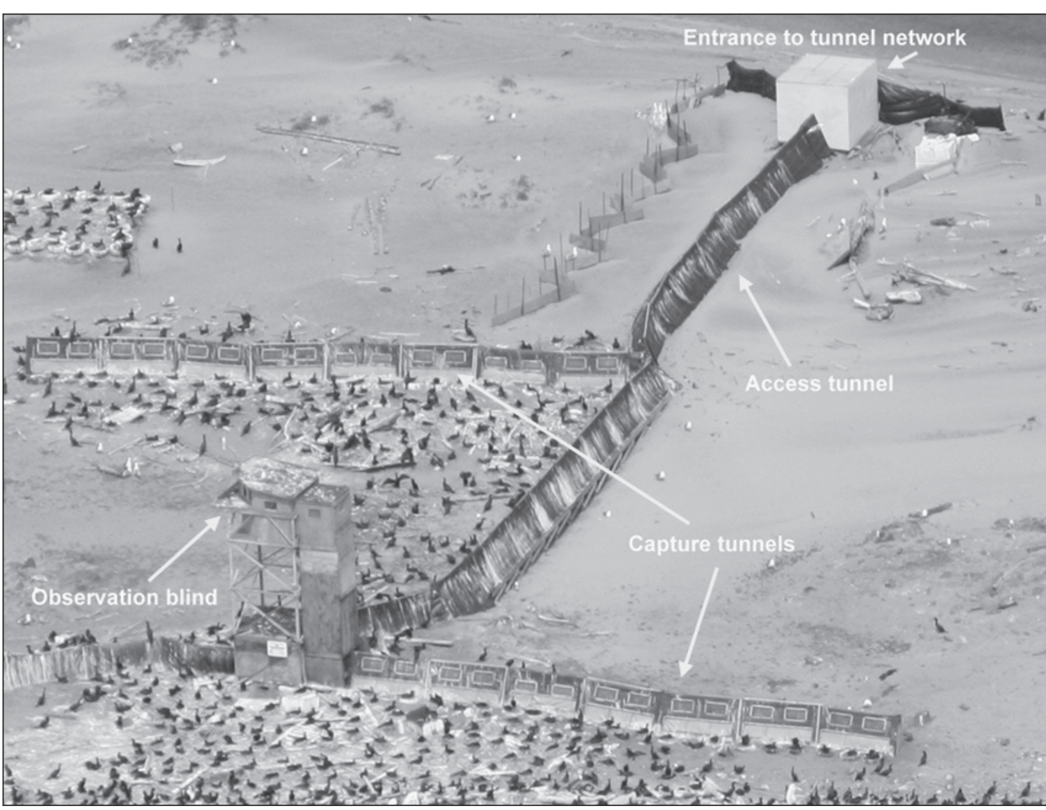

Figure 1. The above-ground tunnel system constructed in the Double-crested Cormorant colony at East Sand Island, Oregon.

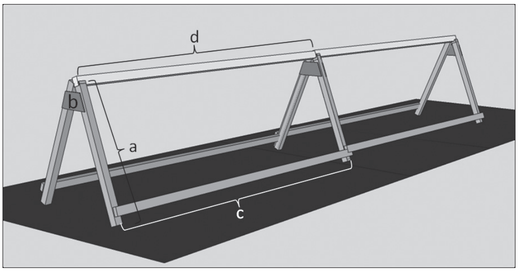

Figure 2. Detail of the above-ground tunnel structure prior to the attachment of the plywood sheets. A-frames were constructed with (a) 1.2-m sections of 50.8 x 50.8-mm lumber joined at the top with (b) a cut piece of 9.5-mm thick plywood. We connected consecutive A-frames with (c) 2.4-m lengths of 25.4 x 50.8-mm lumber approximately 76 mm from the bottom and (d) 50.8 x 50.8-mm lumber at the top.

polypropylene-based landscaping fabric (DeWitt Sunbelt woven ground cover, 3.7-m width), and buried extra cloth in a trench dug along the tunnel to improve structural support. We achieved a long-lasting weather-resistant attachment by screwing wood slats on top of the cloth along the tunnel frame (Fig. 3).

We built tunnel sections extending into areas of the colony where cormorant nesting had occurred in the previous year. We modified the tunnel structure by attaching a 1.2 x 2.4-m sheet of 9.5-mm plywood with two observation windows and one capture opening (Fig. 3) to each side of the A-frame before covering with landscaping cloth. We cut away the landscaping cloth from the openings and, from within the tunnel, covered the observation windows with camouflage netting (Camo Systems) stapled to the plywood. We pinned burlap cloth on top of the netting with large tacks, which provided complete concealment in daylight and allowed removal of the burlap to improve visibility in low light conditions. We covered the ground-level capture openings with three pieces of vinyl fabric (to prevent guano absorption) stapled along the bottom edge, and with a loop of elastic chord tied through a grommet in the upper corners of the vinyl we hooked the chord to a nail in the tunnel wall.

Nesting Habitat Enhancement

To encourage cormorants to nest within arms' reach of the capture tunnels, we enhanced nesting habitat immediately adjacent to the tunnels by using previously successful techniques (Suzuki *et al.* 2015). We placed 381-432 mm radius tires along the length of the tunnels, filled them almost completely with sand, and placed old cormorant nests and woody debris inside. We placed three tires in front of each 2.4-m tunnel section, spaced so the distances between the tire centers were similar to the distances between naturally constructed nests (about 0.8 m). During 2008 and 2009, we prepared a total of 140 tires as nest sites.

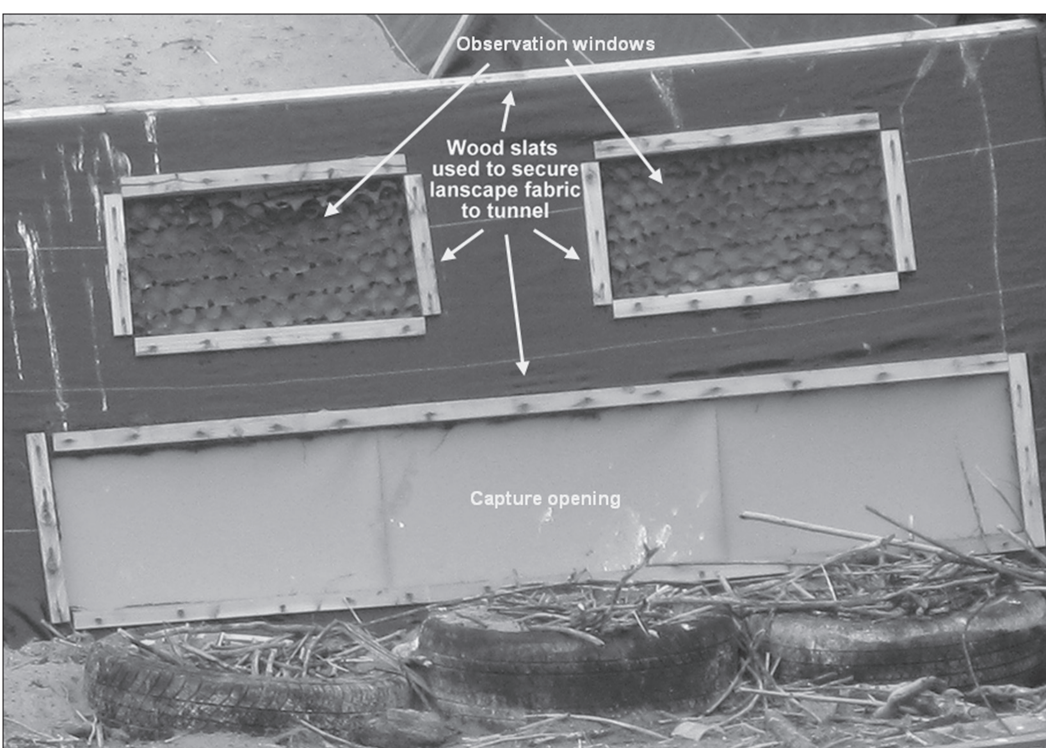

Figure 3. Detail of the completed above-ground tunnel.

Capture Technique

We captured cormorants by reaching through the lower opening of the tunnel, grabbing the bird (usually around the neck near the head), and pulling the bird into the tunnel. We positioned ourselves in the tunnel adjacent to a target bird, held the vinyl in place while we unfastened the chord from the tunnel wall, then dropped the vinyl panel to capture the target bird.

Once under control, we placed the cormorant in a cotton bag for transport through the tunnel to an enclosed work area. To conceal subsequent activity in the tunnel, we immediately reattached the vinyl fabric. Although captures could have been conducted by a single researcher, a second person to assist made the process faster and safer for birds and researchers. Researchers wore protective gear including gloves, thick-sleeved shirts, and safety glasses during captures. After birds were processed, they were released adjacent to the colony to minimize disturbance to other nesting birds.

We captured adults at the nest during late-incubation or the post-guard chick-rearing phase (> 7 days post-hatch) under a wide range of light levels (i.e., daylight, new moon, and full moon). We used headlamps with dim red lights when additional light was necessary. We avoided capturing adults during early incubation when a lack of investment might have increased the chance of nest abandonment (D. D. Roby, pers. obs.). We also avoided capturing adults brooding young chicks to reduce the risk of nestling mortality from exposure or gull predation, if the nest was left unattended following capture (D. D. Roby, pers. obs.).

RESULTS

During the 2008 and 2009 breeding seasons, we captured 87 breeding adult cormorants and recaptured 53% (n = 30) of targeted individuals. All original captures were successfully completed at night during late incubation or early post-guard. Recaptures were completed both day and night during late chick-rearing. Cormorants nested in 77% of the prepared tire nest sites (n = 140).

No adult cormorants were injured during capture, and no non-target species or individuals were captured. As a direct result of capture activities, we observed one chick displaced from a nest, one egg broken, and four eggs displaced from a single nest. Disturbance as a result of capture-related activities was minimal and localized. Under all capture conditions, captured birds were completely within the tunnel and out of view of neighboring birds in less than 30 sec. A brief period (15-30 sec) of vocalization and increased alertness by birds within 5 m of the capture nest was the most common response to capture activity. The greatest apparent disturbance occurred during daytime captures when nearby adults attending nests (< 2 m from the capture nest or no more than 10 nearby nests) briefly left their nests (< 2 min). Daytime captures occurred when there were no nests with eggs in the area. Nighttime captures resulted in such little disturbance that in most cases individuals on nests immediately adjacent to that of the captured bird (< 1 m away) did not leave their nests. On occasions when both parents were present at a nest prior to capture, the mate of the captured bird assumed nest attendance responsibilities soon after capture (typically in < 1 min). All captured birds were observed attending their nests following capture. Nearby roosting and nesting gulls often became alert and vocalized briefly (< 2 min) during and following captures; we did not observe any disturbance to roosting California Brown Pelicans or nesting Brandt's Cormorants (*P. penicillatus*).

DISCUSSION

Capture of ground-nesting adult cormorants by hand from above-ground tunnels within a nesting colony was a precise, rapid, and safe means of capturing individuals and resulted in minimal disturbance to other birds. Above-ground tunnels have previously been used by researchers to minimize disturbance to colonial-nesting bird species, including Double-crested Cormorants (Shugart *et al.* 1981; Cairns *et al.* 1987; Kuiken *et al.* 1997). Additionally, similar capture approaches have been used where colonial birds have nested on existing manmade structures (Gill and Hatch 2002), and nesting habitat enhancement has been used to lure many bird species to nest in potential capture locations (Blums *et al.* 1983; Mock *et al.* 1999; Gill and Hatch 2002). However, to the best of our knowledge, this is the first time that such a technique has been described for capturing ground-nesting colonial birds by hand.

Unlike many alternative capture techniques feasible under these conditions, only the arms and hands of researchers were in view during capture, and captured birds were only briefly visible to nearby nesting birds. To minimize the holding time of an individual, the capture rate (captures per hr) was determined by the time required to process individuals, rather than the time required to capture individuals.

The extremely brief and localized disturbance resulting from this capture technique is a tremendous advantage when capturing multiple birds consecutively, when target or non-target birds are sensitive to disturbance, or when regulations require minimal disturbance (e.g., working with protected species). We caution that the tunnel structures may serve as a perch for aerial predators, allowing access to nest contents even during small disturbances to the nesting colony. When warranted, we suggest conducting captures at a time when nest depredation is not a risk (e.g., at night when gulls are least active) or applying roosting deterrents to the tunnel to discourage their use as a perch.

The above-ground tunnel capture technique is unique because it allows researchers to rapidly control captured birds and position them for sampling, in addition to permitting the capture and recapture of specific individuals. These features are invaluable when studies require: 1) sampling before stress-induced changes in metabolic rates and/or hormone levels occur; 2) the recovery of expensive tracking devices; or 3) data downloads from logging devices. Our customized tunnel system design also allows for easy access to nest contents and could provide a low-disturbance method for sampling or collecting eggs or chicks.

To maximize the chance of capturing the targeted number of individuals, it is beneficial to design the tunnels to accommodate more nests than are required. The option to select specific nests was advantageous, as capture opportunities varied with nest location within the tire and the position of the bird on the nest. Lower recapture success observed in this study is largely attributable to attempting recaptures late in the nestling stage when adult nest attendance becomes less frequent and when adults are typically positioned adjacent to, not on, the nest. Additionally, some recapture attempts were conducted during daylight because identification of specific individuals was difficult in darkness. Our success at recaptures under these suboptimal conditions (53%) demonstrates the versatility of our approach as we are unaware of other studies where individual adult cormorants have been captured twice within a breeding season. Based on our observations, we believe that we would have had high recapture success when adults were more committed to attending the nest (i.e., prior to the late post-guard stage). Since completing our 2008-2009 study, we have successfully repeated this capture technique.

In addition to being a potentially useful approach for capturing adults and accessing nest contents at other cormorant breeding sites, this approach could be adapted for other species of ground-nesting colonial birds. Our success with this approach was dependent on the willingness of cormorants to nest immediately adjacent to a structure that researchers could occupy, and our ability to attract cormorants to nest in this area using nesting habitat enhancement. Our tunnel design could be modified to encourage a particular study species to habituate to the structure and to provide the most appropriate nesting habitat adjacent to the structure. In field conditions where this capture approach is feasible, we believe that it provides significant advantages over previous techniques.

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Fish and Wildlife (Salem, Oregon). All animal handling protocols were approved by the Oregon State University Institutional Animal Care and Use Committee. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government. We thank D. Craig and two anonymous reviewers for insightful comments that improved an earlier draft of this manuscript.

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