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Tools and Technology

Capture Efficiency of Torrent Ducks by the Active Mist-Net Method

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ABSTRACT We report on the use and efficiency of an active mist-net method for capturing 3 subspecies of torrent ducks (*Merganetta armata*), a territorial and specialized South American waterfowl, in fast-moving rivers of the Andes Mountains. As an active process, the execution of this methodology required the presence of a well-trained, 3-person team. During the austral winter and spring between 2010 and 2014, we captured 372 torrent ducks in 410 capture events on 8 different rivers in Colombia ($n = 1$), Peru ($n = 5$), and Argentina ($n = 2$). Each captured torrent duck was banded and 38 opportunistic recaptures events were obtained using the same methodology in the same territories. We deployed the mist nets across fast-moving deep rivers, along elevational gradients (680–4,200 m). Males were more easily captured than females, because of their greater tendency to fly. Our data validated this capture method for torrent ducks, as we succeeded in capturing individuals of the 3 subspecies in different habitats at different elevations and latitudes. To avoid animal mortality, we recommend application of this method only when 3 minimal conditions are met: 1) each field crew has ≥3 people; 2) all of the crew members have hand-radios to enable continuous communication; and 3) each crew member has received prior training (e.g., installation, inspection, manipulation, and removal of the mist net, bird extraction, and familiarity with the behavior of the torrent ducks).

KEY WORDS Andes, capture, diving duck, *Merganetta armata*, mist net, rivers, torrent duck, waterfowl.

Studies in wildlife management and biology that require the capture of a habitat-specialized waterfowl species (e.g., riverine, diving, and sea specialists) require the development and refinement of specific techniques different from the methodologies applied to terrestrial species (Brodeur et al. 2008, Ware et al. 2013, Smith et al. 2015). Waterfowl, as an abundant and cosmopolitan group of birds have been the focus of numerous studies and object of several different capture techniques (used mostly for migratory Northern Hemisphere waterfowl; see Bub 1991, Batt et al. 1992). However, for river-specialist waterfowl species, with many species distributed in the tropics, refined and validated capture techniques are still absent (Kear 2005).

Riverine-specialist birds are those that live exclusively along streams or rivers (Buckton and Ormerod 2002). In South America, 3 subspecies of the torrent duck (*Merganetta armata*) inhabit many of the rivers in the west and the east slopes along the Andes Mountains from northwestern Venezuela to southern Chile and Argentina (Conover 1943). These ducks are small-bodied diving ducks (350–550 g) that feed primarily on benthic macro-invertebrates (Johnson 1963, Alvarez et al. 2014) and nest in cliffs, rocks, and tree cavities adjacent to the rivers (Conover 1943, Johnson 1963, Moffet 1970). Torrent ducks are one of the most difficult species to capture alive for study purposes because of their avoidance behavior and the torrential rivers they inhabit (Johnsgard 1966, Cardona and Kattan 2010). They are always alert and constantly monitoring the presence of intruders in their territory and capable of disappearing and

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hiding easily because of their capacity to dive, thus avoiding any threats. Their natural environment consists mostly of fast-flowing water, which may be extremely difficult to cross, and in some areas, delimited by inaccessible thick riverine vegetation. However, strong territorial and philopatric behaviors throughout their elevational and latitudinal distribution facilitate the capture and recapture of individuals (Johnson 1963, Johnsgard 1966).

Torrent ducks offer an ideal opportunity to demonstrate the efficacy of an active mist-net method deployed across rivers in the Andes Mountains. Mist nets across rivers have previously been proven as an effective method to capture all 5 riverine waterfowl species (harlequin ducks [*Histrionicus histrionicus*], Bengtson 1972; African black ducks [*Anas sparsa*], Ball et al. 1978; blue ducks [*Hymenolaimus malacorhynchos*], Williams 1988; Salvadori's duck [*Salvadorina waigiuensis*], Straus 2006; and torrent ducks, Cardona and Kattan 2010). However, the repeatability of methods used to capture riverine ducks had been reported only in a few papers (Ball et al. 1978, Smith et al. 2015). Coincidently, the mist-net technique we developed is relatively similar to that deployed by Smith et al. (2015) for harlequin ducks, thus corroborating that the same technique can be used on different species in different environments. Thereby, our objectives were to demonstrate the effectiveness of capturing large numbers of torrent ducks, with repeatability across 8 different torrential white-water rivers in the Andes, varying in both elevation and latitude.

STUDY AREA

We captured torrent ducks with mist nets at 8 different Andean rivers inhabited by populations of 3 subspecies of *Merganetta armata*: *M. a. colombiana* in Río Quindío in Colombia; *M. a. leucogenis* in 5 rivers in Peru (Río Huaura, Río Chancay-Huaral, Río Chillón, Río Santa Eulalia, Río Pachachaca); and *M. a. armata* in 2 rivers in Argentina (Arroyo Grande, Río Malargüe), during the austral summers and springs from 2010 to 2014 (Table 1). All of these rivers had seasonal water fluctuation and, in some cases, their water flow was controlled by irrigation projects. Along most of the rivers, there were agricultural fields and small towns. These towns were connected by dirt or paved roads, which frequently ran parallel to major sections of the rivers. This generally facilitated access to the rivers and capture of torrent ducks.

METHODS

Equipment

We typically used 12-m, and 9-m × 3-m mist nets (120-mm mesh), but we also used an 18-m net on the wider rivers or a 6-m net on narrower streams (2 sets of nets of each of the 4 sizes were available during each field season). On account of the strong current in fast-moving rivers, we reinforced all the mist nets in the bottom trammel line with a 5-mm nylon rope. We used 2 strong and flexible wooden poles (young *Eucalyptus* trees, purchased in the local market) of >3-m length × <4-cm diameter to brace each mist net on either side of the river. Occasionally, when 2 of the longest nets (12-m and 18-m) were joined to cover the entire span of a wide river, 3 wooden poles were required. We used nylon ropes of 5-mm diameter and approximately 30-m length to pull and stretch the net across wide and uncrossable rivers and approximately 3-m-long rope to support the poles. We affixed the poles with the 3-m ropes to 2 or 3 fixed points on the ground, such as the base of plants or rocks (Fig. 1).

Table 1. Mist-net capture information and Catch Per Unit Effort (CPUE) for 410 torrent ducks at 8 rivers in the Andes Mountains, South America, from 2010 to 2014.

Country	River (No. field teams) Latitude, elevation[c]	Capture events (F, M, juv, Deaths)	Field hours (hr)	River length[a] (km)	CPUE[b]	Recapture events (F, M)	Survey yr
Colombia	Quindío (1) 4.6°N, 1,500–2,100 m	24 (8, 15, 0, 1 *juv*)	84	18	0.016		2012
Peru	Huaura (1) 10°S, 820–4,150 m	51 (9, 41, 0, 1 *F*)	100	58	0.009	3 (0, 3)	2013–2014
	Chancay-Huaral (1) 11.2°S, 680–4,200 m	48 (10, 38, 0, *0*)	128	44	0.009	1 (0, 1)	2013–2014
	Chillón (1–2) 11.5°S, 1,000–4,000 m	163 (30, 129, 1, 1 *F*, 1 *M*, 1 *juv*)	248	42	0.010	33 (1, 32)	2011–2013
	Santa Eulalia (1) 11.6°S, 2,700–3,100 m	4 (3, 1, 0, *0*)	8	17	0.029		2012
	Pachachaca (1) 13.5°S, 2,200–3,600 m	54 (21, 30, 2, 1 *juv*)	100	76	0.007	1 (0, 1)	2010
Argentina	Arroyo Grande (1) 33.5°S, 1,800–3,200 m	46 (16, 30, 0, *0*)	32	22	0.065		2011
	Malargüe (1) 35.5°S, 1,600–1,900 m	20 (7, 13, 0, *0*)	24	26	0.032		2011
	Total	410 (104, 297, 3, *6*)	724	303		38 (1, 37)	

[a] Length of the section of the river that was evaluated.
[b] CPUE is estimated as ducks/field team/hr/km.
[c] Elevation range as meters above sea level.

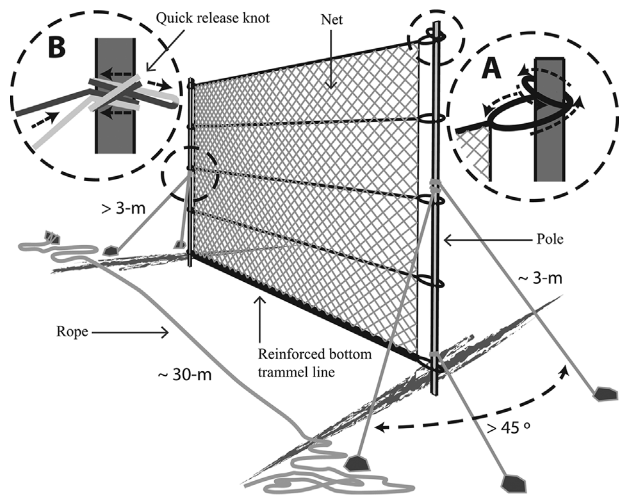

Figure 1. Schematic of the structure, components, and deployment of the active mist-net method for capturing torrent ducks, which we used at 8 rivers in the Andes Mountains, South America, from 2010 to 2014.

Site Selection

We chose capture sites after we had identified the presence and locations of torrent ducks in the river and assessed accessibility of both river banks. We investigated these possible sites while moving downstream or upstream, driving on the closest dirt or paved road, or by walking alongside the river. After identifying a pair or group of ducks, the crew tried to remain undetected by the birds by hiding themselves and avoiding excessive movement. We usually deployed the mist net downstream and away from the ducks' visual range to avoid scaring them; however, adult torrent ducks can be chased into the mist net from either direction. Some of the sites we chose were located close to towns, and many had features that contributed to the success of the method we deployed. Features included a stretch of shallow crossings that allowed us to submerge the mist net or structures to cross the river such as bridges or manual cable cars.

Net Deployment

Each field crew required a minimum of 3 people at each capture site and everyone in the field crew had a radio for communication, along with mesh bags to hold and transport captured ducks. To deploy the net, one crew member crossed the river (carrying one net pole and sometimes the ~30-m rope), either by wading (in shallow or weak current) or using bridges or a manual cable car closest to the capture site (in fast-moving deep rivers). In situations in which the crew member crossed the river without the 30-m rope, we then threw the rope across the river with the aid of a weight, usually a rock. We used the 30-m rope to pull the net, which we had tied to a set of trammel loops, across the river (Fig. 1).

After the net was extended across the river, we raised it. On each side of the river, one person verified the order of the trammel loops to place the net correctly on each net pole. We wrapped the top trammel loop twice around the pole to provide greater stability to the extension of the net on the poles (see Fig. 1A). Meanwhile, the crew member on each side of the river located 2 or 3 strong fixing points (e.g., trees, shrubs, rocks) to which they tied the shortest ropes (~3-m), and then attached the free ends of the ropes at or above the midpoint of the net pole, usually somewhat below the middle trammel loop. The angle of the rope at the net pole from the 2 fixed points on at least one of the sides was $\geq 45^\circ$; this was sufficient to stabilize the entire net. We always fixed the base of the net pole under water, and usually placed it between large rocks. However, in situations where the current was extremely strong, we added a third fixed point, usually close to the base of the net pole (Fig. 1). In the cases where we used 2 fixed points to attach the net pole, we tied a double-strand rope to the net pole with a clove-hitch knot (see Fig. 1B) with end-off in a quick release knot. We then tied the 2 ends of the rope to each fixed point with either a clove hitch or a few half-hitch knots ending in a quick release as well. We completed the set-up of the net by verifying that the net was spread evenly and completely open, with the poles in a fully vertical position, making sure each mesh pocket was formed in the middle of the net. Finally, we placed the bottom trammel line above the water in fast-moving deep rivers, or under water fixed to the riverbed with rocks in shallow rivers and streams.

Operations

Before we moved (i.e., "drove") the ducks toward the net, we double-checked the stability of the net on both sides of the river, where each person in the crew occupied his respective assigned position to capture the ducks. On the capture site, usually downstream of the target ducks, one person was located on one side of the mist net, with a second member on the opposite side of the river positioned upstream to chase ducks downstream, and the last crew member positioned downstream to chase ducks back upstream into the mist net if ducks first evaded the mist net. The person next to the net hid near the net (e.g., behind a boulder, shrub, or other available natural cover) while the other 2 crew members (called the "chasers") walked upstream or downstream depending on the accessibility of the landscape on each side, and also depending upon the current location of the target birds. Each crew member maintained a constant communication by radio regarding the number, sex, and age of the ducks, as well as the details of their position and movements toward the mist net.

We next chased the target ducks toward and into the net. By monitoring their location continuously, we knew the last location where ducks had been sighted; at times, we maintained an additional person watching the ducks while the chaser moved beyond (upstream or downstream) the target ducks (>500 m from the net) to direct them toward the net. Whenever possible, chasers waded in the river on the side opposite the net to keep visual contact with the target birds and ensure that they did not hide on the river bank before they reached the net. If the river was too deep to wade safely or the border vegetation was so dense as to block access and views along the river, chasers maintained a recurrent presence into the shoreline making their way through the vegetation at as many points as possible. Flying adult torrent ducks were readily caught, but swimming birds were caught only if the net was completely submerged across the river; we noted that such a net disposition was difficult to set when the current was fast and strong, and there was a possibility of drowning birds.

When a crew member visually confirmed contact with the net by a duck, they alerted other crew members via radio. During bird extraction, crews kept the net in constant tension to avoid contact of the duck and net with water. Usually extraction of the captured ducks involved one crew member wading into the river, but only when the river was shallow and with easy access (Fig. 2). When the river was too fast or deep to safely wade, we closed the net with the duck and removed it entirely from the shore closest to the captured bird, similar to the technique applied by Smith et al. (2015).

Once we removed the duck or ducks from the net, a short survey was made to determine whether more ducks were in the river, in which case we again set up the net across the river. It was common to find pairs of ducks—male and female—in the river; occasionally, we encountered small groups of mostly male ducks in agonistic interactions. Moreover, because these ducks are territorial during the reproductive season, there was always a significant chance of success in the second capture attempt at the same capture site. Once we completed capture operations, we removed the mist net, cleaned it of plant material carried by the river, and stowed it in a storage bag. The Institutional Animal Care and Use Committee (IACUC) approval number for this research was 152985—University of Alaska Fairbanks.

RESULTS

We captured 372 individual torrent ducks (103 F, 260 M, 3 juv, and 6 mortalities) in 410 total capture events (104 F, 297 M, 3 juv, 6 mortalities; Table 1). Among these, only 6 deaths occurred (1 juv in 2010, 2 juv and 1 M in 2012, 1 F in 2013, and 1 F in 2014) in different rivers and years (Table 1). We recaptured 32 of 366 ducks (372 minus 6 mortalities) previously banded and released in 38 opportunistic recaptured events, principally on the Río Chillón (Table 1). We used the same capture method at different elevations in 8 rivers (724 hr for 303 km of river; Table 1).

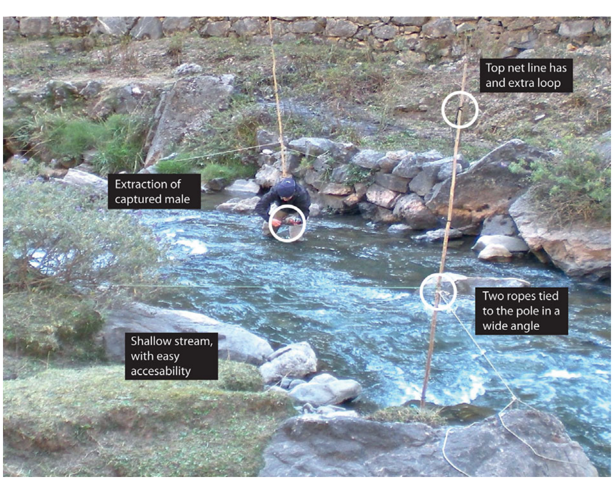

Figure 2. Captured torrent duck in a mist net being removed on the Río Chancay-Huaral, Andes Mountains, South America, at 3,729 m, Peru, 3 August 2015.

The Argentine rivers yielded on average the greatest capture events per unit effort (ducks/field team/hr/km; CPUE), which was fourfold greater than the Peruvian and Colombian rivers (Table 1). Additionally, the average sex ratio of ducks captured (males:females) was greater in Peru (2.9) as compared with Argentina (1.9) and Colombia (1.7; Table 1). We expected the adult sex ratio would be 1:1 by territory during the reproductive season.

The sex and age of ducks captured were associated with displacement behavior of the individuals within the territory of the rivers. We captured more than twice as many adult males (297) as adult females (104; Table 1). We located and captured ducks along different habitats and steepness of the rivers from a minimum elevation of 680 m to a maximum elevation of 4,200 m.

The maximum number of ducks captured in one event or using one net deployment at one specific location was 5 (Arroyo Grande, Mendoza, Argentina). Capture attempts with zero yields occurred with highly evasive ducks 43 times, apart from the 410 successful captured events. Nontarget species captured included speckled teal (*Anas flavirostris*), white-capped dipper (*Cinclus leucocephalus*), buff-winged cinclodes (*Cinclodes fuscus*), black-crowned night heron (*Nycticorax nycticorax*), and spotted sandpiper (*Actitis macularius*), which we released on site.

DISCUSSION

We demonstrated that the active mist-net method is an effective technique for capturing torrent ducks in fast-flowing rivers of the Andes Mountains. The 3 geographically distinct subspecies of torrent ducks were captured with the same method multiple times at different elevations and latitudes, despite evasive behaviors of the species and associated risks and challenges of working in torrential rivers. Among rivers, the Argentine rivers yielded the greatest CPUEs because of the greatest observed torrent duck aggregations. By contrast, the low CPUEs in the Peruvian rivers could be explained by larger territories, captures during the incubation period (May–Jul of 2013–2014) when females usually are absent from the river, and excess capture effort. Therefore, one option to increase the CPUEs would be to conduct captures after the hatching period when females and offspring are more present in the river.

Other conditions facilitated the use and efficiency of this active capture method. Low water levels (dry season transitions) in the Andean rivers during the study favored capture of ducks in many cases because the deployment of mist nets and extraction of netted ducks were easier. In addition, territorial and philopatric behaviors of torrent ducks increased the probability of capturing $\geq$1 adult male duck/territory (Johnsgard 1966). Also, with the mist net not fixed to the bottom of the river, we were more effective capturing males than females because males typically fly more often than females; males fly quickly but low over the water, rarely higher than 6 m (20 feet), and methodically follow twists and turns of the river (Johnsgard 2010). For example, in 2015, during a subsequent project with torrent ducks, we caught approximately 90% of adult males while they were flying and 100% of adult females while they were swimming.

The method that we developed to capture torrent ducks is similar in concept and practice as previously reported active methods used to capture other species of riverine ducks (Bengtson 1972, Ball et al. 1978, Williams 1988, Straus 2006, Cardona and Kattan 2010). The required effort in difficult parts of the river is probably the reason that our methodology is similar to that applied by Smith et al. (2015) to capture harlequin ducks. Even though Smith et al. (2015) worked in a different ecosystem and on a nonterritorial species, our results validated theirs with 3 different subspecies of torrent ducks.

The method described herein effectively captured torrent ducks throughout their elevational distribution. However, a necessary condition for success is being extremely careful to remain unobserved by the birds during the site selection and deployment of the net. In open areas, it was a challenge for crew members to remain hidden because vegetation around the rivers is largely grassland at higher elevations (>4,000 m) of the Andes Mountains and therefore, does not provide much shelter from observation by the ducks. We highly recommend that only 1 person walk upstream or downstream either chasing, or looking for, the ducks in these habitats. On occasions that we failed to capture torrent ducks, individual birds hid in waterfalls and behind rocks after we attempted unsuccessfully to chase them into the mist net, or birds repeatedly failed to fly and avoided the net by diving under it when the bottom trammel line was above the water surface. These behaviors were more common in females and juveniles than males and usually occurred when the ducks detected our presence prior to the netting operation. By contrast, successful capture of >3 individuals usually occurred when ducks were engaged in agonistic behavior on the border of territories and levels of disturbance within the river itself was greater, pushing pairs of ducks into other territories (a situation that occurred in Arroyo Grande, Argentina). These multiple simultaneous captures were never a risk situation as long as each crew had $\geq$3 crew members, with one person always attending the net. When we captured nontarget birds, we stopped the entire operation to remove these birds from the net. Constant radio communication during the operation allowed us to determine the most appropriate moment to start or stop the work.

Mortality due to this method occurred by drowning when individual ducks tried to dive under the net while the bottom trammel line was fixed to the bottom in rapid sections of the river. A previous study in Colombia did not report mortality in captures of torrent ducks because the captures were done specifically in calm and shallow parts of the river and only for a small number of attempts (Cardona and Kattan 2010; 7 ducks). From our experience and previous observations (Johnsgard 1966), female and juvenile torrent ducks have greater tendency to dive compared with males. In the rapid river sections, detectability of ducks diving into the river was reduced and current strength reduced the swimming capacities of the net-captured birds. Therefore, we highly recommend that if there is not a better location to deploy the mist net other than a rapid section of the river, then always deploy the mist net with the bottom trammel line above the river surface to avoid drowning events, especially by females and juveniles.

Safety of the field crew was the most important consideration when choosing a capture site. The crew avoided crossing rivers in sections where the water level was higher than the waist (~1 m). Additionally, we visually evaluated any dangerous features of the river and avoided wading into parts with fast-moving water with rapids; therefore, we always searched for safe parts of the river to reach the opposite bank.

Finally, it is important to consider that in studies deploying active capture techniques for habitat-specialized species such as torrent ducks, modifications in the procedures of the capture method will be necessary (i.e., knowledge and experience of the crew, equipment); as well as flexibility in the work decisions to adjust protocols to changing field conditions (i.e., field work schedule, crew size). Achieving these requirements will allow for maximizing the number of individual ducks captured, minimizing stress (e.g., abandonment of territory or nest), and reducing the risk of mortality at the time of the capture, while also creating a safe work environment for the crew.

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