Short Communications

The Wilson Journal of Ornithology 120(3):594–599, 2008

Use of Legs and Feet for Control by Scoters during Aerial Courtship

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ABSTRACT.—Scoters (*Melanitta* spp.) exhibit extraordinary maneuvers during courtship flight, attitudes which are not commonly seen in flight. Scoters drop their legs and spread webbed feet during these maneuvers. There appears to be a correlation between how the feet of scoters meet the airflow and the maneuver in progress. *Received 25 April 2007. Accepted 5 August 2007.*

Block Island Sound, New York/Rhode Island, USA supports large populations of scoters (*Melanitta* spp.) in late winter and early spring. Groups of each species of scoter form courting parties at this time, comprised of a single hen with an entourage of drakes (Gunn 1927, McKinney 1959). Airborne courting parties in late winter exhibit uncommon flight patterns which include steep climbs (Wilson 1980), abrupt turns, and slow fluttering flight. Often during these maneuvers the birds drop their legs so the spread webbed feet can engage the airflow.

I spent weekends through the 1970s photographing scoters during late winter and early spring near Montauk, New York (41° 03′ N, 72° 00′ W) at the eastern end of Long Island, where the Montauk Lighthouse faces the southern terminus of Block Island Sound and the adjoining Atlantic Ocean. The objective of this paper is to describe how the feet of scoters are used in aerial maneuvers during this early courtship period. Six figures are discussed that support these descriptions.

OBSERVATIONS

A Surf Scoter (*Melanitta perspicillata*) courting party transitions from straight ahead flight to an abrupt turn because the lone hen (Fig. 1, arrow 1) departs the formation. In this sequence the highest drake brakes with both feet prior to turning. Just below him a drake (Fig. 1, arrow 2) rotates his extended right leg in a counter-clockwise direction about the roll axis to a position that, rather than below, is beside his body (Fig. 2). His open (braking) foot, being perpendicular to the incident airflow, is subject to only the force of drag. This force is proportional to the square of the airflow velocity (Videler 2005:7) and, acting in the same direction as airflow and coupling to the bird's body by the extended leg, produces clockwise rotational force about the yaw axis that is part of the mechanics of the turn.

Similarly, the feet of at least two of the descending Black Scoter (*M. nigra*) (Fig. 3B, arrows 1 and 2) are presented to the headwind to produce only drag. The descending courting party is depicted (Fig. 3A) in varied transient attitudes, all with deployed webbed feet. The formation flutters to the water with a yawing motion resembling a falling leaf. Supporting this maneuver is a headwind that, judging from the white-caps on Block Island Sound, is a sea state that appears more rough than moderate, indicating a fresh breeze (Beaufort Scale #5) and wind velocity approximated at 30–39 km/hr. The wings of scoters 1 and 2 are configured in a negative dihedral that minimizes control, while their feet are rotated about their roll axis. They shift centers of force that produce the oscillating yawing motion and the strong headwind enhances this control. The birds' large angle of attack is needed to counteract the resulting rotational force the feet produce about the pitch axis.

In contrast, the feet of a Black Scoter courting party (Fig. 4A) are swept back in execution of an abrupt turn. The hen (Fig. 4A, arrow 1) is initially seen in a large angle of attack and braking prior to following a drake (Fig. 4A, arrow 2) out of formation. This drake is executing a banking turn with his swept back feet astride the spread tail. The feet are held at roughly right angles to each other, rather than parallel, and the surface of the right foot is held vertically. Similarly, the hen (Fig. 4B) is making her turn and also holds her right foot vertically (Fig. 5). In

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FIG. 1. Members of a Surf Scoter courting party execute an abrupt turn to follow the departing hen (arrow 1). A rarely seen turning technique is exhibited by the drake (arrow 2) with the extended foot.

aviation terminology, is this right foot functioning as a vertical stabilizer or a rudder? It is noteworthy the right foot is outboard of the turn, giving it a greater distance from the center of the turn and, thus, a greater angular velocity.

The side-slipping Black Scoter (Fig. 3B, arrow 3) appears almost totally devoid of pitch control due to the vertical attitude of the wings and tail. Control of pitch normally results from the horizontal movement of the

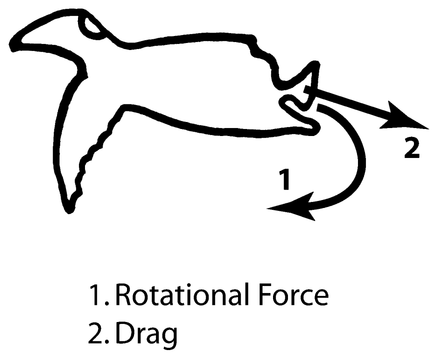

FIG. 2. As the stationary paddle turns a canoe, so too does the force of drag acting on this outstretched foot create rotational force.

wing (Brown 1961:301, Pennycuick 1975:52). The tail's primary use is for pitch (Brown 1961:302). However, the legs and swept back, spread-webbed feet must have significance, if only by default.

A courting party of White-winged Scoter (*M. fusca*, Fig. 6), when heading into the wind, executes a steep climb. A ''slight'' sea state (Fig. 6) allows approximating the wind speed at 7–19 km/hr, a light to gentle breeze on the Beaufort Scale (#s 2–3). Typically, during this maneuver, the legs deploy the spread webs of the feet astride the tail. The lead drake is at the peak of the climb. The near vertical attitude of the feet in this terminal attitude eliminates increased lift as a reason for their deployment. Their exact function, however, remains unclear.

DISCUSSION

The literature is gradually reflecting that legs and webbed feet of water birds are used for attitude control and maneuver. Brown (1951) suggested it is generally accepted that birds' legs do not contribute to flight, while Barlee (1964:303) believed the feet can produce unbalanced forces. Aymar (1935:32) and Pennycuick (1975:55) both suggest the auk's (*Alcidae*) small tail necessitates control and lift augmentation by the feet. Videler (2005:27) advocates that, in many species, every aspect of the body is related to flight and, in addition, that legs and feet can alter the center of gravity (Videler 2005:47).

FIG. 3. A descending Black Scoter courting party uses the strong headwind to perform this less than synchronized maneuver. The enlargement (B) better reveals foot positioning and use.

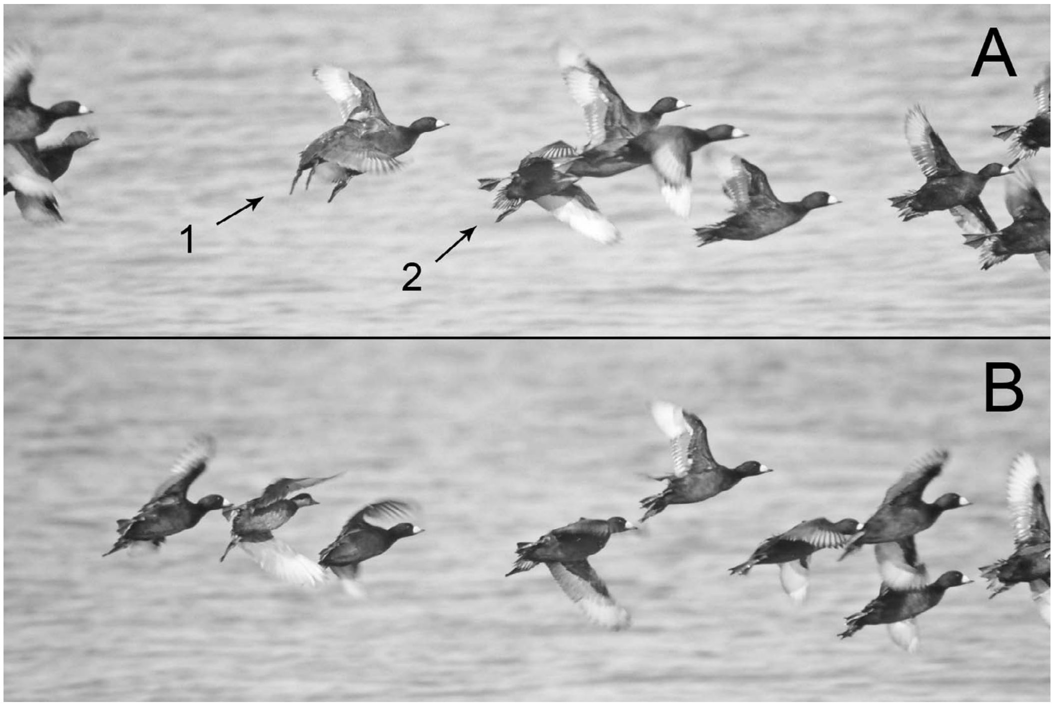

FIG. 4. A two-frame sequence of ~1 sec duration depicts a Black Scoter courting party executing an abrupt turn. Other than the hen in frame A (arrow 1) using her feet to brake, the entire formation has feet swept back.

It is reasonable to assume there is an aerodynamic reason why scoters deploy their legs and spread webbed feet in flight. An extended webbed foot clearly can exert a rotational force about the bird's center of gravity depending on how it interfaces with airflow. This rotational force is exerted upon the airborne body and is either balanced for a trim attitude, or the bird uses the imbalance to change attitude. The reason for the extended foot is elusive in some instances. This is not so for some scoters (Fig. 1, arrow 2; Fig. 3B, arrows 1 and 2). The force of drag acting on the foot with its resulting rotational force is obviously part of an ongoing maneuver; the use of the foot as a control surface is unambiguous.

It is only when the foot, from the extended leg, is swept back that conclusions cannot be absolute. The vertically-held right foot (Fig. 4) is part of the maneuver but its function is open to speculation. The higher airflow velocity over the right foot allows it to generate a greater reactive force, suggesting its use as a control surface.

The side-slipping Black Scoter (Fig. 3B, arrow 3) is using his swept back feet. At that instant his only maneuver is descent. That the surfaces of the feet are oriented perpendicular to one another suggests attitude control.

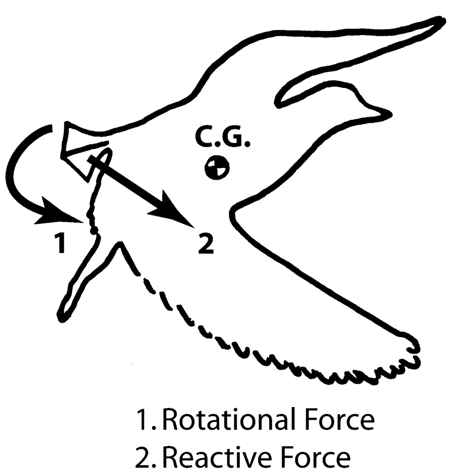

FIG. 5. Is the swept back right foot a vertical stabilizer, or is it a rudder? Any deflection of the airflow by the foot will result in a reactive force that pivots on the center of gravity, resulting in rotational force.

FIG. 6. Gravity surmounts thrust at the peak of a steep climb by White-winged Scoters.

If the lead White-winged Scoter (Fig. 6) was a fixed-wing aircraft, its thrust spent and in a large angle of attack, it would be devoid of control and prone to falling into a spin with possible catastrophic results. However, birds do not spin out. The drake (Fig. 6) maintains a delicate balance prior to the dive that must follow. In pondering how this is done, it is applicable to recall Videler's (2005:27) previously referenced observation, ''Not only the wings and the tail but also the head, neck, the body and the hind limbs have features directly related to flight in many species.''

ACKNOWLEDGMENTS

I thank P. A. Johnsgard (University of Nebraska–Lincoln), V. A. Tucker (Duke University), and two anonymous reviewers for commenting some thirty years ago on early drafts of this subject. I am grateful for the helpful comments made by the reviewers of this current manuscript. I am indebted to Lindsey Rohrbach (South Fork Natural History Museum) for organizing the digital imagery. Finally, I must acknowledge the literate comments, research, and editing by my wife Janice on whom my dependency is absolute. The original photographs are contained on 35 mm Kodachrome transparencies.

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The Wilson Journal of Ornithology 120(3):599–602, 2008

Bill Entanglement in Subcutaneously-anchored Radio Transmitters on Harlequin Ducks

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ABSTRACT.—We report two incidences of Harlequin Ducks (*Histrionicus histrionicus*) entangling their bills in subcutaneously-attached anchor transmitters. We suggest caution should be exercised when using these transmitters. *Received 19 May 2007. Accepted 1 November 2007.*

Radio telemetry is an important tool for wildlife research that can reveal valuable information about wild birds that would otherwise be difficult to obtain, such as movements, home ranges, survival, and nest site attributes. However, methods of radio transmitter attachment vary and researchers must choose an attachment that provides adequate retention time, and minimizes detrimental effects. Attachment methods on waterfowl have included backpack harnesses (Dwyer 1972), glue (Perry et al. 1981), tail-mount (Giroux et al. 1990), suture and glue (Wheeler 1991), anchor-suture (Mauser and Jarvis 1991, Pietz et al. 1995), interscapular implants (Korschgen et al. 1996a), and intra-abdominal implants

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(Korschgen et al. 1996b). Some evaluations of radio transmitters have revealed deleterious effects such as feather wear, lower survival, reduced reproductive effort, behavioral changes, and mass loss (Paquette et al. 1997, Guyn and Clark 1999, Ackerman et al. 2004), whereas other studies have found no significant consequences of transmitters (Houston and Greenwood 1993, Esler et al. 2000, Hepp et al. 2002, Hupp et al. 2006, Iverson et al. 2006). Entanglement is an issue, with potential direct effects on survival, that has been reported for harness transmitters (Keedwell 2001, Duriez et al. 2005), but less frequently with other attachment methods (Conway and Garcia 2005). We report two incidences in which the bills of Harlequin Ducks (*Histrionicus histrionicus*) became entangled with subcutaneously-anchored radio transmitters. This information is important from both ethical and scientific perspectives and informs researchers of potential complications when using these transmitters.

METHODS

We investigated Harlequin Duck breeding and nesting attributes in southern British Columbia during summer in 2003 and 2004. We used transmitters attached by a subcutaneous anchor (Pietz et al. 1995) to adult females to follow them through the breeding season. The transmitters, made by Holohil Systems Ltd. (model RI-2B, Carp, ON, Canada), were a 6-g model with a mortality switch and a life span from 3 to 9 months. They were circular, measured 2 cm in diameter, and had a maximum height of 0.8 cm. We glued stainless steel anchors (Advanced Telemetry Systems, Isanti, MN, USA) to the transmitters opposite the antennae with marine-grade epoxy (Fig. 1).

Each transmitter was attached in the small depression between the scapulae, dorsal to the approximate junction of the cervical and thoracic vertebrae. The feathers were parted using isopropyl alcohol and the site was prepared with Betadine solution (Purdue Frederick Co., Stamford, CT, USA). This attachment site was naturally void of contour feathers and only downy feathers needed to be removed. The transmitter anchor also was cleaned with Betadine solution. The skin was pinched and lifted at the attachment site, and a sterile 18-gauge hypodermic needle was used to puncture a small hole in the skin without contacting the underlying muscle, nerves or blood vessels. No local anesthetic was used because the incision was small and there is believed to be little enervation in this area (Altman 1981, Pietz et al. 1995). The anchor of the transmitter was inserted into the hole, curled end first, and manipulated until the anchor had the head of the arrow pointing forward and resting flat on the bird's back. A quick-drying, veterinary-grade adhesive (Vetbond, 3M, St. Paul, MN, USA) was used around the insertion site to seal the opening, and to glue the top and bottom of the transmitter to the feathers. The females were released immediately after the adhesive dried. These transmitters are normally shed after a period of weeks to months (Iverson et al. 2006).

OBSERVATIONS

We radio-marked 34 female Harlequin Ducks and monitored them from their arrival in breeding areas (late Apr) until the majority of females had departed for wintering areas (early Aug). We had two females (one each year) hook their bills on part of the anchor of the radio transmitter as it began to extrude during the shedding process. The females did not have their bills caught on the transmitter attachment in the same way. The bill of the first female was caught on the curled end of the anchor (Fig. 1), which was slightly open and pierced through the lower mandible of her bill while the looped side of the anchor was still attached subcutaneously to her back. The bill of the second female was caught when her lower mandible became wedged into the loop side of the anchor while the curled end was still attached to her back. The result for both birds was that their heads were held to their backs and, although they were still able to move about, they were likely unable to acquire food during this time. We recaptured both of these females and removed the transmitters. However, if this complication had occurred after we had completed monitoring, these females may have died from starvation or been highly vulnerable to predation.

DISCUSSION

No other study has reported this type of complication from using anchor transmitters.

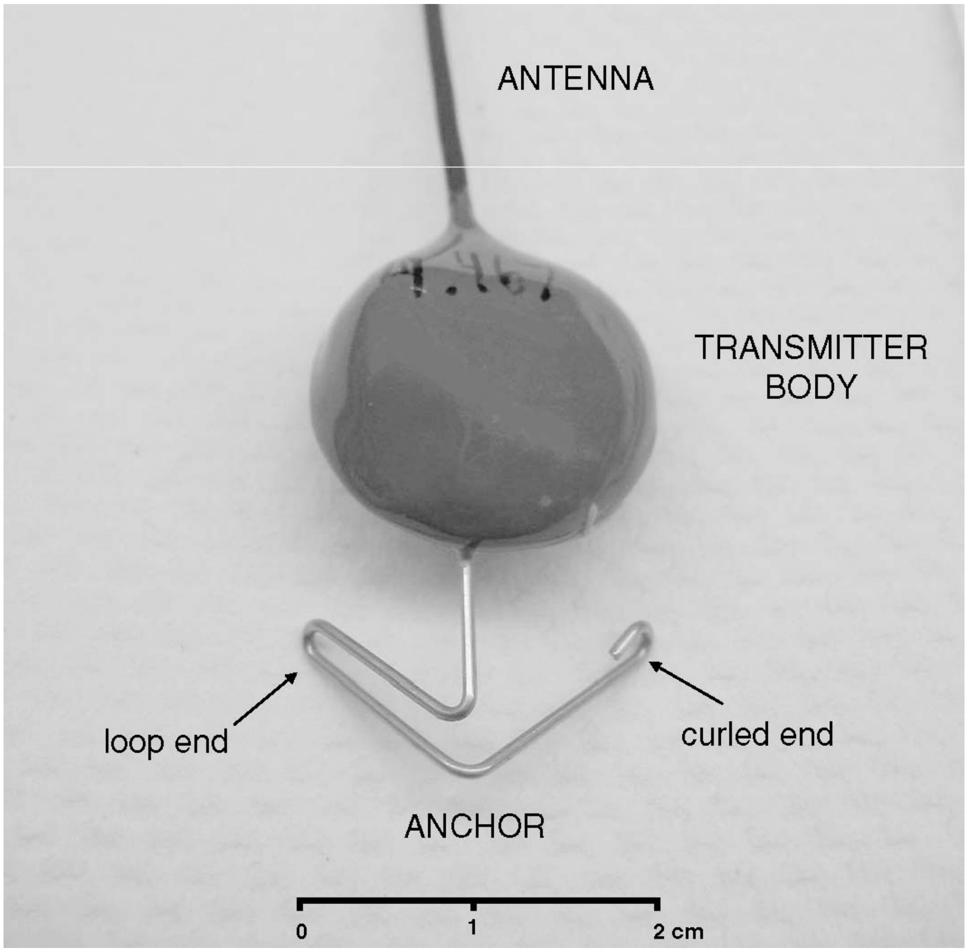

FIG. 1. Illustration of subcutaneously-anchored radio transmitter.

We surmise that Harlequin Ducks are particularly susceptible to this problem because of their small bill size. Pietz et al. (1995) found this type of attachment was retained on some birds for over a year and, in these cases, could lead to feather wear and some abrasion. However, they reported no incidences of the transmitter anchors catching the bills of Mallards (*Anas platyrhynchos*) or Gadwalls (*A. strepera*). Paquette et al. (1997) reported negative effects of anchor transmitters on reproduction and survival of Mallards and suggested this resulted from additional energetic costs associated with increased mass and drag, as well as increased preening. Overall there have been few reports of negative effects from this type of transmitter attachment and many researchers have advocated their use, especially for shorter-term studies (Hepp et al. 2002, Fleskes 2003, Iverson et al. 2006). This attachment method is less surgically invasive than interscapular subcutaneous or intra-abdominal transmitters, and retention times are often appropriate for the battery life of the transmitters. We do not conclude that anchor attachments should be avoided when it is appropriate for the study design, but suggest that potential problems should be considered. Precautionary measures such as using a smaller anchor size, ensuring the curled end is tightly closed, and narrowing the loop end could prevent complications with using this radio attachment method. We advocate that researchers involved in radio telemetry studies make efforts to evaluate, and subsequently report in the primary literature, the effects of radio transmitters, given their widespread use and potential risks to individual animals and results of studies.

ACKNOWLEDGMENTS

Funding was provided by BC Hydro Bridge Coastal Fish and Wildlife Restoration Program. The Centre for Wildlife Ecology at Simon Fraser University provided logistical support. Chester Alec and Sam Copeland were valuable field technicians, and Sam Iverson, Sunny LeBourdais, Ken Wright, Sean Boyd, and Bobby Vinnie assisted with captures.

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