Predation rates, timing, and predator composition for Scoters (Melanitta spp.) in marine habitats

Eric M. Anderson, Daniel Esler, W. Sean Boyd, Joseph R. Evenson,
David R. Nysewander, David H. Ward, Rian D. Dickson, Brian D. Uher-Koch,
Corey S. VanStratt, and Jerry W. Hupp

7 Studies of declining populations of sea ducks have focused mainly on bottom–up processes with little emphasis on the role of predation. We identified 11 potential predators of White-winged Scoters (*M* (L., 1758)) and Surf Scoters (*M* (L., 1758)) in North American marine habitats. However, of 596 Scoters marked with VHF transmitters along the Pacific coast, mortalities were recovered in association with just two identifiable categories of predators: in southeast Alaska recoveries occurred mainly near mustelid feeding areas, while those in southern British Columbia and Washington occurred mainly near feeding areas of Bald Eagles (*H* (L., 1766)). Determining whether marked Scoters had been depredated versus scavenged was often not possible, but mortalities occurred more frequently during winter than during wing molt (13.1% versus 0.7% of both species combined, excluding Scoters that died within a postrelease adjustment period). In two sites heavily used by Scoters, diurnal observations revealed no predation attempts and low rates of predator disturbances that altered Scoter behavior (≤0.22/h). These and other results suggest that predation by Bald Eagles occurs mainly at sites and times where densities of Scoters are low, while most predation by mustelids probably occurs when Scoters are energetically compromised.

m Les études des populations en déclin de canards marins se sont intéressées surtout aux processus ascendants avec peu d’emphase sur le rôle de la prédation. Nous avons identifié 11 prédateurs potentiels de la macreuse brune (*M* (L., 1758)) et de la macreuse à front blanc (*M* (L., 1758)) dans des habitats marins nord-américains. Cependant, chez 596 macreuses porteuses d’émetteur VHF le long de la côte du Pacifique, nous avons noté des mortalités associées à seulement deux catégories identifiables de prédateurs : dans le sud-est de l’Alaska, les émetteurs ont été récupérés principalement près des aires d’alimentation des Mustelidae, alors que ceux du sud de la Colombie-Britannique et du Washington ont été retrouvés surtout près des aires d’alimentation des pygargues à tête blanche (*H* - (L., 1766)). Il est souvent impossible de déterminer si les macreuses marquées ont été victimes de prédation ou consommées comme charognes, mais les mortalités ont lieu plus fréquemment pendant l’hiver que durant la mue

lation recoveries to concurrent declines in many taxa of marine birds is unclear. Human impacts have likely modified predator–prey relationships not only by affecting predator

1. Locations and periods of observation for White-winged Scoters (*M*) and Surf Scoters (*M*) marked with VHF transmitters, as well as years of study, number of transmitters deployed for all years combined (nos. deployed), the number of transmitters for which a mortality signal was observed by fate category, and the observed percentage of marked Scoters that were depredated or scavenged.

				No. of transmitters displaying mortality signal by fate category			
	Period	Years	Nos. deployed*	Bald Eagle	Mustelid	Other	Observed % depredated or scavenged†
i - i 7							
Puget Sound, Washington							
Forbes Point	Molt (Aug.–Sept.)	2009	8	0 (0)	0 (0)	0 (0)	0.0
Strait of Georgia, B.C.							
Baynes Sound	Winter (Dec.–Apr.)	2001–2002, 2002–2003, 2003–2004	128	2 (0)	1 (1)	14 (9)	13.3
Fraser Delta	Molt (Aug.–Sept.)	2008, 2009	10	0 (0)	0 (0)	0 (0)	0.0
Southeast Alaska							
Juneau	Molt (Aug.–Sept.)	2008, 2009	37	0 (0)	0 (0)	0 (0)	0.0
7							
Puget Sound, Washington							
Multiple sites	Winter (Dec.–Apr.)	2003–2004, 2004–2005, 2005–2006					

All transmitters included mortality switches that doubled the pulse rate if the transmitter remained motionless for >12 h. For each transmitter that displayed a mortality signal, we documented circumstantial evidence of the marked individual's fate and placed it into one of the following five fate categories: (1) transmitter recovered near an obvious feeding area of a predator (with subcategories for each identifiable type of predator); (2) Scoter killed by hunter; (3) Scoter mortality confirmed or likely but cause unknown; (4) transmitter may have been dislodged with possible survival of Scoter; or (5) Scoter mortality could not be confirmed. When a possible cause of mortality was unclear, transmitters were included in category 3 if they were abdominal implants, or if they were subcutaneously implanted or externally mounted and were recovered in or reliably biangulated to upland sites (mortality likely because Scoters use upland habitats only during breeding) or to intertidal sites with Scoter remains. Category 4 included externally mounted and subcutaneously implanted transmitters that were recovered in the intertidal zone without Scoter remains; we assumed that abdominal implants could not be dislodged within the relatively short observation periods. Category 5 included externally mounted and subcutaneously implanted transmitters that we could not recover or reliably locate.

Scoter remains were often inadequate for forensic analyses, and thus we do not report the fraction of Scoters that were likely depredated versus those that died of other causes and were then scavenged. However, we consider only those Scoters that survived a postrelease adjustment period. Specifically, as in Iverson et al. (2006), we assumed that recovery from handling effects and acclimation to transmitters would be complete after 14 d for implanted transmitters and after 7 d for external transmitters. Beyond these adjustment periods even the relatively invasive abdominally implanted transmitters likely had minimal impacts on Scoter survival (Mulcahy and Esler 1999). Mortalities of Scoters that occurred after these adjustment periods are more likely due to natural causes, rather than to handling effects that might have reduced survivorship. As a summary measure, we report the percentage of all marked Scoters that appeared to have been depredated or scavenged (i.e., those in categories 1 and 3 above). We did not statistically analyze the fates of marked Scoters because our ability to confirm mortalities and assess probable causes of death varied among sites and seasonal periods because of differences in local conditions and logistical support. Thus, we qualitatively compared species, seasonal periods, and sites with respect to differences in apparent predators and rates of predation or scavenging.

[illegible]

Field methods

We conducted 5 min focal observations of Scoters from shore with a 20×–

not be confirmed was greater in B.C. sites (9.8%) than in all other sites combined (3.7%). Of cases in which species of mustelid could be identified, remains of two wintering Surf Scoters in southeast Alaska were associated with river otters (*L*) and remains of nine wintering Surf Scoters in southeast Alaska and two wintering White-winged Scoters in Baynes Sound, B.C., were associated with American mink (*N*). As indicated by appreciable quantities of blood observed with recovered transmitters, at least one mink and two unknown mustelid species preyed on live Surf Scoters during winter in southeast Alaska. Remains of other marked Scoters were insufficient to distinguish whether they had been depredated or scavenged.

Smaller numbers of transmitters for which mortality signals were observed occurred in three additional fate categories. Numbers of Scoters harvested by hunters during winter included one Surf Scoter in Puget Sound and one Surf Scoter in Juneau. Numbers of Scoters that may have shed transmitters included three White-winged Scoters and four Surf Scoters in Baynes Sound, two Surf Scoters in Malaspina Inlet, and five Surf Scoters in Juneau during winter. Mortality could not be confirmed for one White-winged Scoter in Baynes Sound and four Surf Scoters in Juneau during winter.

In Baynes Sound, the single site in which both Scoter species were marked during winter, the fraction of individuals that were depredated or scavenged was nearly 50% greater for Surf Scoters compared with White-winged Scoters. However, results from the four sites in which Surf Scoters were marked during winter suggest that rates of predation vary by area. Of all marked Scoters that were likely depredated or scavenged, mortality signals of nearly half (51 out of 111) were observed within the postrelease adjustment period. The rate of apparent transmitter dislodgement was greater during winter (3.1%) compared with wing molt (0.0%), and was slightly greater for Surf Scoters (2.7%) compared with White-winged Scoters (1.6%; Table 1). The fraction of marked Scoters for which mortality could not be confirmed was low for each Scoter species (<1.0% in each location).

[illegible]

In Penn Cove and Birch Bay in Puget Sound during 2003–2005, we did not observe any predation attempts on White-winged Scoters or Surf Scoters in 2961 five minute observations or in opportunistic observations of nonfocal individuals

3. Predators of Scoters in marine habitats, including animals observed feeding on (predation) or pursuing (chase) live Scoters, or with Scoter remains found in gut contents or near feeding areas (prey remains).

	White-winged Scoter (*M*)	Surf Scoter (*M*)	Unidentified Scoter (or Black Scoter, *M* (L., 1758))
Bald Eagle, *H* (L., 1766)	Predation, ^{b,*} prey remains ,,,	Predation, , prey remains ,,,	Predation (Black Scoter), prey remains
Gyrfalcon, *F*			

peared low by predators other than Bald Eagles and mustelid species (including mainly American mink), the only predators identified in our study of 596 marked Scoters. However, this conclusion about predator composition for Scoters requires several qualifications. First, individuals within a predator species may display strong specialization on a specific prey type, even for prey that may be atypical for the species. For instance, some individual river and sea otters appear to prey heavily on marine birds (Stenson et al. 1984; Riedman and Estes 1988). Second, White-winged Scoters are >50% larger than Surf Scoters, meaning that White-winged Scoters are probably a less manageable prey type for many of the avian and mustelid predators that we identified. Indeed, Bald Eagles may not be able to lift some White-winged Scoters off the water (B. Troutman, WDFW, personal communication). Third, direct observations needed to clearly distinguish predation from scavenging are under-represented for species that feed nocturnally (Snowy Owl (*B b*), American

human impacts to marine ecosystems. Pacific herring and Pacific salmon are important foods for Bald Eagles, and together form a prey base that spans the majority of the seasonal period when Bald Eagles are particularly abundant in coastal ecosystems (Fig. 2). However, Pacific herring and Pacific salmon have declined at the same time that numbers of Bald Eagles have increased (Fig. 1); declines in these traditional foods are especially pronounced south of Alaska where Bald Eagles may be the most common predator of Scoters (Nehlsen et al. 1991; Willson and Womble 2006). In Washington, <50% of stocks of Pacific herring and Pacific salmon are considered healthy (Stick 2005; Stinson et al. 2007). Declines in fish that are important prey for Bald Eagles, American mink, and many other marine predators may have shifted some predation risk to already diminished numbers of marine birds. Such a shift is perhaps most likely of predators such as Bald Eagles for which marine birds were probably a traditional dietary item (Erlandson et al. 2007). It is less certain whether predation of marine birds has increased by other mainly piscivorous predators for which predation of marine birds has been documented less often, such as mustelid species and harbor seals (*P*) (Stenson et al. 1984; Tallman and Sullivan 2004).

Acknowledgements

Field assistance was provided by J. Barrett, B. Bartzen, T. Bowman, J. Brown, S. Coulter, D. Cushing, A. DuBour, L. Heisler, S. Iverson, M. Kirk, L. Koloski, D. Lacroix, P. Levesque, T. Lewis, R. Lis, R. MacDonald, M. McAdie, A. McLean, A. Pagano, L. Parker, A. Patterson, K. Pontius, J. Ray, J. Reed, J. Reynolds, V. Richard, J. Whissel, and many others. With much volunteer support, Bird Studies Canada supplied B.C. Coastal Waterbirds Survey data. This study was funded by the NOAA National Estuarine Research Reserve System (fellowship to E.M.A.), the Sea Duck Joint Venture, the USFWS Western Washington Fish and Wildlife Office, the SeaDoc Society, Ducks Unlimited Canada, the Natural Sciences and Engineering Research Council of Canada, the Province of British Columbia through the Ministry of Advanced Education (funding for C.S.V.), the Department of Biology at Simon Fraser University, the USGS Alaska Science Center, and the Washington Brant Foundation. Logistical support was provided by the Centre for Wildlife Ecology, the Canadian Wildlife Service, Auke Bay Laboratories, the Ted Stevens Marine Research Institute, the USFWS Juneau Office, and the USDA Forest Service Juneau Ranger District.

References

Anderson, E.M., and Lovvorn, J.R. 2011. Contrasts in energy status and marine foraging strategies of White-winged Scoters (*M*) and Surf Scoters (*M.*). Auk, **12** (2): 248–257. doi:10.1525/auk.2011.10088.

Anderson, E.M., Lovvorn, J.R., Esler, D., Boyd, W.S., and Stick, K.C. 2009. Using predator distributions, diet, and condition to evaluate seasonal foraging sites: sea ducks and herring spawn. Mar. Ecol. Prog. Ser. **3 6**(1): 287–302. doi:10.3354/meps08048.

Bayer, R.D. 1987. Winter observations of bald eagles at Yaquina Estuary, Oregon. Murrelet, **6** (2): 39–44. doi:10.2307/3535690.

Béchet, A., Giroux, J.-F., and Gauthier, G. 2004. The effects of disturbance on behaviour, habitat use and energy of spring staging snow geese. J. Appl. Ecol. **41**(4): 689–700. doi:10.1111/j.0021-8901.2004.00928.x.

Bird Studies Canada. 2010. British Columbia Coastal Waterbirds Survey. Available from: http://www.naturecounts.ca/ [accessed 7 June 2010].

Brooks, A. 1922. Notes on the abundance and habits of the Bald Eagle in British Columbia. Auk, **3** (4): 556–559.

Brown, P.W., and Fredrickson, L.H. 1997. White-winged Scoter (*M*). *I* The birds of North America. No. 274. *E* *b* A. Poole and F. Gill. The Birds of North America, Inc., Philadelphia, Pa. pp. 1–27.

Campbell, R.W., and MacColl, M.D. 1978. Winter foods of snowy owls in southwestern British Columbia. J. Wildl. Manage. **42**(1): 190–192. doi:10.2307/3800714.

Dekker, D. 1995. Prey capture by peregrine falcons wintering on southern Vancouver Island, British Columbia. J. Raptor Res. **2** (1): 26–29.

Dickson, D.L., and Gilchrist, H.G. 2002. Status of marine birds of the southeastern Beaufort Sea. Arctic, **55**(Suppl. 1): 46–58.

Erlandson, J.M., Rick, T.C., Collins, P.W., and Guthrie, D.A. 2007. Archaeological implications of a bald eagle nesting site at Ferrelo Point, San Miguel Island, California. J. Archaeol. Sci. **34**(2): 255–271. doi:10.1016/j.jas.2006.05.002.

Ford, J.K.B., Ellis, G.M., Barrett-Lennard, L.G., Morton, A.B., Palm, R.S., and Balcomb, K.C., III. 1998. Dietary specialization in two sympatric populations of killer whales (*O*) in coastal British Columbia and adjacent waters. Can. J. Zool. **76**(8): 1456–1471.

Goudie, R.I.., Brault, S., Conant, B., Knodratyev, A.V., Petersen, M.R., and Vermeer, K.. 1994. The status of sea ducks in the north Pacific Rim: toward their conservation and management. Trans. North Am. Wildl. Nat. Resour. Conf. **5** (1): 27–49.

Iverson, S.A., Smith, B.D., and Cooke, F. 2004. Age and sex distributions of wintering Surf Scoters: implications for the use of age ratios as an index of recruitment. Condor, **106**(2): 252–262. doi:10.1650/7386.

Iverson, S.A., Boyd, W.S., Esler, D., Mulcahy, D.M., and Bowman, T.D. 2006. Comparison of the effects and performance of four radiotransmitter types for use with scoters. Wildl. Soc. Bull. **34**(3): 656–663. doi:10.2193/0091-7648(20int.4(.)-42.3(D(Reed)5tt-LeC-,ch)-89(Sta)114(