FOODS OF SPECTACLED EIDERS *SOMATERIA FISCHERI* IN THE BERING SEA, ALASKA

MARGARET R PETERSEN[1], JOHN F PIATT[1] and KIMBERLY A TRUST[2]

[1] U.S. Geological Survey, Biological Resources Division, Alaska Biological Science Center, 1011 E. Tudor Road, Anchorage, Alaska 99503 (e-mail: margaret_petersen@usgs.gov, john_piatt@usgs.gov)

[2] U.S. Fish and Wildlife Service, Ecological Services-Anchorage Field Office, 605 West 4th Ave., Room G62, Anchorage, Alaska 99501 (e-mail: kim_trust@mail.fws.gov)

The winter diet of Spectacled Eiders living in marine habitats is known only from two individuals described by Cottam (1939). Here we examine marine diets from 36 stomachs collected near St. Lawrence Island, Bering Sea, Alaska, during May-June in 1987 and 1992. All Spectacled Eiders ate Mollusca, including Gastropoda (snails; frequency of occurrence 20.0%; sole taxon 0.0%) and Bivalvia (bivalves; 80.0%; 48.0%), and Crustacea (barnacles, amphipods and crabs; 30.6%; 0.0%). One bird ate a cod. The predominant species group eaten was Macoma Clams (72.0%; 36.0%). Prey species of Spectacled Eiders occur predominantly in waters 25-60 m deep in the Bering Sea. To obtain these prey, especially the bivalves, on the winter area Spectacled Eiders must forage in waters exceeding 40 m. We speculate that Spectacled Eiders regularly forage at depths of 45-70 m throughout winter.

Keywords: Spectacled Eider, Bering Sea, Winter Diet, Feeding Behaviour

Except where birds winter relatively close to shore (eg Nilsson 1972, Goudie & Ankney 1986, Bustnes & Erikstad 1988, Beauchamp, *et al.* 1992, Guillemette *et al.* 1993, Metzner 1993, Bustnes & Lønne 1997) the food habits and feeding areas of eiders at-sea are unknown. Food habit information of Spectacled Eiders when in marine environments is limited to two birds shot in January before 1939 (Cottam 1939). Spectacled Eiders spend 8-11 months each year at-sea and feed on marine resources. Thus, non-breeding diet choice and habitat selection is critical to overwinter survival, recruitment of juveniles, and accumulating resources for breeding. As a result of the dramatic declines of Spectacled Eiders nesting on the Yukon-Kuskokwim Delta (61°30'N, 165°30W), Alaska, from the 1970s to 1992 (Stehn *et al.* 1993, Ely *et al.* 1994), the species was listed as threatened in 1993 under the U.S. Endangered Species Act (U.S. Federal Register 58(88):27474-27480). Potential causes for decline and obstacles to recovery could include impacts occurring at-sea that result in changes in the food base (U.S. Fish and Wildlife Service 1996).

Here we describe the foods of Spectacled Eiders in the Bering Sea during May-June. From these samples, we predict the foraging behaviour and diets of this species when at-sea during winter (October to March).

Study area

Most of the Bering Sea continental shelf and slope is relatively shallow (<140 m), dropping off to depths exceeding 200 m only at its western and southern edges. This extremely rich sea has supported commercial whaling, sealing and fishing of at least eight nations over the past 200 years (National Research Council 1996). Parts of this area have an extensive macrofauna which may exceed 30 g C/m^2 at some locations (Grebmeier & Cooper 1995).

© The Wildfowl & Wetlands Trust

Winter surveys (Stoker 1973) show an extreme patchiness of the fauna and variability of samples. It also is a rich nursery and feeding area for bottom feeding Pacific Walrus *Odobenus rosmarus* and Grey Whales *Eschrichtius robustus* (National Research Council 1996). A major feature in the region is St. Lawrence Island (63°46'N, 171°44'W), located in the northern half of the Bering Sea shelf. Waters adjacent to the island quickly drop to 20 m or more in depth.

Methods

Stomach samples were collected as part of a study on the food habits of marine birds in the Bering Sea during 1987 and 1992. At St. Lawrence Island, field workers collected digestive tracts of birds brought into the village by local hunters. An additional 20 male Spectacled Eiders were collected for contaminant analysis near Gambell, St. Lawrence Island, in May 1995. In all years, digestive tracts were frozen intact for later food habits analysis which included identifying all prey items to the lowest possible taxon and, when possible, examining the number and size of food items.

Identification of food items was based on prey remains rather than whole animals in many samples. Thus, the importance of various taxa as determined by their relative abundance and volume was not possible for all samples. Following Madsen (1954) and Swanson *et al.* (1974) we provide the frequency of occurrence of each taxon and its frequency as the sole food item in the stomach. Not enough whole samples of major bivalves were available to determine size of individuals by hinge size as was done by Nehls (1991).

Results

Spectacled Eiders ate a variety of species of Mollusca, including Gastropoda (snails) and Bivalvia (clams) and Crustacea (barnacles, amphipods, and crab) (**Table 1**). Macoma Clams *Macoma spp.* were eaten by 72.0% of individuals suggesting that some of these species, particularly Aleutian Macoma *Macoma lama*, Chalky Macoma *M. calcarea*, and Brota Macoma *M. brota*, are important prey items. Of the Crustacea taken by eiders, amphipods and crab were eaten, but this occurred relatively infrequently (**Table 1**). Amphipods were taken almost exclusively by one individual who ate 94 Lacinessid Amphipods and one Yoldias Clam *Yoldia spp.*

Most food items were bottom dwelling animals that live either below, on, or within a few cm of the substrate. Individual eiders consumed a variety of species; however, some individuals ate exclusively Bivalvia or Crustacea (**Table 1**). One bird probably ate one fish and no individuals ate vegetative material.

Intact bivalves (Aleutian Macoma and Chalky Macoma) averaged 18.6 ± 1.08 mm (n=9, range 8 mm) and 35.4 ± 5.57 mm (n=9, range 23 mm) respectively, in length. Few items were sufficiently whole to measure length and volume of individuals. The numbers of identifiable individuals among all stomachs was six Gastropoda, 131 Bivalvia, 118 Crustacea, and one fish. The single fish was identified from a very worn otolith and could not be identified to species nor was a size estimate possible. It is also unclear that the bird ate a whole fish or ingested the otolith while feeding on other organisms.

Discussion

The high proportion of bivalves in the diet of Spectacled Eiders is not surprising. Common *Somateria mollissima*, King S. *spectabilis*, and Steller's *Polysticta stelleri* Eiders also eat Mollusca when at-sea. Food items of two Spectacled Eiders reported by Cottam (1939) included unidentified amphipods and other species (including Blue Mussels *Mytilus edulis*) commonly found in shallower waters. The eiders in our sample probably foraged in deeper waters where Blue Mussels were not dominant or not present. It is possible that Spectacled Eiders, as with Common Eiders (Guillemette *et al.* 1993), take different prey when feeding at different depths in response to changes in benthic communities and prey densities. Spectacled Eiders may also prefer different foods during different times of the

Table 1. Food items eaten by 36 Spectacled Eiders in the Bering Sea, Alaska. Mollusca includes 11 stomachs in which items could only be identified as Mollusca. Other calculations for Mollusca are based on the 25 samples in which more precise identification was possible.

	Frequency (%)	
Food item	of occurrence	as sole taxon
Phylum Mollusca	**100.0**	**88.9**
Class Gastropoda	**20.0**	**0.0**
Trichotropis spp. (Hairy-shell Snail)	12.0	0.0
Naticidae (Moon Snail)	8.0	0.0
Class Bivalvia	**80.0**	**48.0**
Yoldia spp. (Yoldias)	16.0	0.0
Yoldia traciaeformis (Broad Yoldia)	4.0	0.0
Liocyma fluctuosa (Wavy Liocyma)	4.0	0.0
Macoma spp. (Macomas)	12.0	36.0 [a]
M. brota (Brota Macoma)	40.0	12.0
M. calcarea (Chalky Macoma)	40.0	8.0
M. lama (Aleutian Macoma)	16.0	0.0
Panomya spp. (Roughmyas)	4.0	0.0
Phylum Arthropoda		
Class Crustacea	**30.6**	**11.1**
Ampeliscidae (Ampeliscid Amphipod)	5.6	0.0
Lysianassidae (Lysianassid Amphipod)	8.3	0.0
Majidae (Crab)	5.6	0.0
Hyas spp. (Lyre crabs)	2.8	0.0
Chionocetes spp. (Tanner Crab)	19.4	11.1
Dermaturus mandtii (Wrinkled Crab)	2.8	0.0
Suborder Balonomorpha (Barnacle)	8.3	0.0
Phylum Cordata		
Gadidae (Cod)	2.8	0.0

[a] Includes all members of the Genus *Macoma*.

year, as has been found in Steller's Eiders (eg Petersen 1981) and King Eiders (eg Frimer 1995, Bustnes & Lønne 1997).

Spectacled Eiders winter in an area south and southwest of St. Lawrence Island (Petersen, *et al.* 1995). Mean densities of invertebrates (primarily bivalves and polychaetes) can exceed 2,100 individuals/m^2 (>450 g wet wt./ m^2) in the general area in summer (Grebmeier & Cooper 1995) and 4,414 individuals/m^2 (157.3g wet wt./m^2) in mid-winter (Stoker 1973). Major prey species taken by birds in our study are similar to the dominant benthic species found by Stoker (1973) in winter in waters 45-70 m.

The limited evidence provided here suggests that Spectacled Eiders at-sea eat benthic prey almost exclusively, and feed in deeper waters than those reported for other eiders and sea ducks. Long-tailed Ducks *Clangula hyemalis* have been reported to regularly forage to depths of 22 m (Nilsson 1972) or greater (eg Cottam 1939). Common Eiders feed primarily in waters <10 m deep (Bustnes & Lønne 1997, Nilsson 1972, Guillemette *et al.* 1993) and King Eiders in waters >20 m deep (Frimer 1994, Bustnes & Lønne 1997). We believe that Spectacled Eiders regularly feed in winter at depths >40 m because Chalky Macoma and Brota Macoma occur in those and deeper depths south and southwest (Stoker 1973, Grebmeier & Cooper 1995) of the wintering area in the Bering Sea.

Stoker (1973) noted a trend toward extreme patchiness of Chalky Macoma in mid-winter, a primary food eaten by birds in this study. Eiders feed on benthic invertebrates by diving simultaneously in compact flocks (Ydenberg & Guillemette 1991, Guillemette *et al.* 1993, Frimer 1994). We suspect that Spectacled Eiders behave in a similar manner if, as suggested by Guillemette *et al.* (1993), feeding in large flocks enhances food finding. During late winter Spectacled Eiders may aggregate in areas with superabundant food and, like scoters (Durinck *et al.* 1993), females may accumulate fat reserves necessary for breeding in spring. Many aspects of the ecology of Spectacled Eiders in winter are speculative. Systematic sampling of foraging habitats and foods in the areas used by birds when at-sea is needed to gain a more thorough understanding of how Spectacled Eiders use Bering Sea resources.

Additional studies of distribution and abundance of Spectacled Eiders have shown that the population as a whole is in excess of 400,000 birds (Petersen, *et al.* in press). Marked declines in breeding populations appear to be limited to the Yukon-Kuskokwim Delta, Alaska, breeding area (Stehn *et al.* 1993, Ely *et al.* 1994). Studies of the breeding biology of birds in that region have shown that the marked decline of breeding birds is linked to lead poisoning (Grand *et al.* 1998). Thus there is no evidence to suggest that over the long-term winter conditions (foods, competition, ice conditions etc.) have contributed to any discernable population decline of Spectacled Eiders.

We thank Wayne Lidster and Darlene Apangalook for collecting stomach samples from hunter killed birds at St. Lawrence Island during 1987 and 1992. Daniel Mulcahy and Conrad and Carson Oozeva assisted with samples collected for contaminant analysis in 1995. Food items were identified by K. Turco and A. Springer of FALCO, Fairbanks, Alaska. We thank Dirk V. Derksen, USGS, Alaska Biological Science Center, Anchorage, Alaska, for providing funds for analysis of these data. We appreciated comments on the manuscript by Jan Ove Bustnes, Dirk V. Derksen, and J. Barry Grand.

References

Beauchamp, G., Guillemette, M. & Ydenberg, R. 1992. Prey selection while diving by Common Eiders, *Somateria mollissima. Anim. Behav.* 44:417-426.

Bustnes, J.O. & Erikstad, K.E. 1988. The diets of sympatric wintering populations of Common Eider *Somateria mollissima* and King Eider *S. spectabilis* in Northern Norway. *Ornis Fennica* 65:163-168.

Bustnes, J.O. & Lønne, O.J. 1997. Habitat partitioning among sympatric wintering Common Eiders *Somateria mollissima* and King Eiders *Somateria spectabilis. Ibis* 139:549-554.

Cottam, C. 1939. Food habits of North American diving ducks. *US Dept. Ag., Washington, D. C., Technical Bulletin* 643.

Durinck, J., Christensen, K.D., Skov, H. & Danielsen, F. Diet of the Common Scoter *Melanitta nigra* and Velvet Scoter *Melanitta fusca* wintering in the North Sea. *Ornis Fennica* 70:215-218.

Ely, C.R., Dau, C.P. & Babcock, C.A. 1994. Decline in a population of Spectacled Eiders nesting on the Yukon-Kuskokwim Delta, Alaska. *Northwestern Naturalist* 75:81-87.

Frimer, O. 1994. The behaviour of moulting King Eiders *Somateria spectabilis*. *Wildfowl* 45:176-187.

Frimer, O. 1995. Comparative behaviour of sympatric moulting populations of Common Eider *Somateria molissima* and King Eider *S. spectabilis* in central West Greenland. *Wildfowl* 46:129-139.

Grand, J. B., Flint, P. L., Petersen, M. R. & Moran, C. L. 1998. Effect of lead poisoning on Spectacled Eider survival rates. *J. Wildl. Manage.* 62:1103-1109.

Grebmeier, J. M. & Cooper, L.W. 1995. Influence of the St. Lawrence Island polynya upon the Bering Sea benthos. *J. Geophysical Research* 100:4439-4460.

Goudie, R. I. & Ankney, C. D. 1986. Body size, activity budgets, and diets of sea ducks wintering in Newfoundland. *Ecology* 67:1475-1482.

Guillemette, M., Himmelman, J.H., Barette, C. & Reed, A. 1993. Habitat selection by Common Eiders in winter and its interaction with flock size. *Can. J. Zool.* 71:1259-1266.

Madsen, F. J. 1954. On the food habits of the diving ducks in Denmark. *Dan. Rev. Game Biol. No.* 2:157-266.

Metzner, K.A. 1993. *Ecological strategies of wintering Steller's Eiders on Izembek Lagoon and Cold Bay, Alaska.* M.Sc. Thesis, Univ. Missouri - Columbia. 193 pp.

National Research Council. 1996. *The Bering Sea ecosystem.* National Academy Press. Washington, DC.

Nehls, G. 1992. Bestand, Jahresrhythmus und Nahrungsökologie der Eiderente, *Somateria mollissima,* L. 1758, im Schleswig. Holsteinischen Wattermerr. *National park Schleswig-Holsteinisches Wattermeer. Schriftenreihe Heft 3.* (German with English summary)

Nilsson, L. 1972. Habitat selection, food choice, and feeding habits of diving ducks in coastal waters of south Sweden during the non-breeding season. *Ornis. Scand.* 3:55-78.

Petersen, M.R. 1981. Populations, feeding ecology and molt of Steller's Eiders. *Condor* 83:256-262.

Petersen, M.R., Douglas, D.C. & Mulcahy, D. M. 1995. Use of implanted satellite transmitters to locate Spectacled Eiders at-sea. *Condor* 97:276-278.

Petersen, M.R., Larned, W.W. & Douglas, D. C. 1999. At-sea distribution of Spectacled Eiders (*Somateria fischeri*): A 120 year-old mystery resolved. *Auk* 116:in press.

Stehn, R. A., Dau, C.P., Conant, B. & Butler, W.I. Jr. 1993. Decline of Spectacled Eiders nesting in western Alaska. *Arctic* 46:264-277.

Stoker, W. W. 1973. *Winter studies of under-ice benthos on the continental shelf of the northeastern Bering Sea.* M.Sc. Thesis, University of Alaska, College. 67pp.

Swanson, G.A., Krapu, G.L., Bartonek, J.C., Serie, J.R. & Johnson, D.H. 1974. Advantages of mathematically weighting waterfowl food habits data. *J. Wildl. Manage.* 38:302-307.

U.S. Fish & Wildlife Service. 1996. *Spectacled Eider recovery plan.* Anchorage, Alaska, USA 157 pp.

Ydenberg, R. & Guillemette, M. 1991. Diving and foraging in the Common Eider. *Ornis Scandinavica* 22:349-352.