R. E. Fitzner and R. H. Gray[1], Pacific Northwest Laboratory, P. O. Box 999, Richland, Washington 99352

Winter Diet and Weights of Barrow's and Common Goldeneye in Southcentral Washington

Abstract

Little data are available relative to diets and body weight dynamics of wintering Barrow's and common goldeneyes in freshwater habitats, and no data exist for subadults. Diets of these birds were studied on the Columbia and Yakima Rivers in southcentral Washington from October through May 1955-1956 and 1956-1957. Trichopteran larvae accounted for more than 67% of common goldeneye and 81% of Barrow's goldeneye food biomass. Mollusc and aquatic plant achenes were other important food items. Average weights of common goldeneye ranged from 599.3 ± 39.86 g for subadult females to 1060.2 ± 33.36 g for adult males. Average weights of Barrow's goldeneye ranged from 736.0 ± 44.73 g for subadult females to 1330.5 ± 18.69 g for adult males. Body-weight dynamics of birds may reflect resource availability, competition, and bioenergetics, all of which may influence winter distribution, differential migration and habitat use by sexes.

Introduction

The Hanford Reach of the Columbia River and a tributary, the Yakima River (Figure 1), are important wintering habitats for both Barrow's goldeneye (*Bucephala islandica*) and common goldeneye (*B. clangula*) (Yocom 1951, Fitzner and Rickard 1975). The mallard (*Anas playtyrhynchos*), northern pintail (*A. acuta*), American wigeon (*A. americana*), green-winged teal (*A. crecca*), ring-necked duck (*Aythya collaris*), canvasback (*A. valisineria*), redhead (*A. americana*), lesser scaup (*A. affinis*), greater scaup (*A. marila*), and bufflehead (*Bucephala albeola*) ducks share the Columbia River with goldeneyes.

The Columbia River remains open throughout the winter while the Yakima River sometimes freezes over. However, rapids on the Yakima River remain open even during the coldest periods, providing feeding areas for goldeneyes and other ducks. The Hanford Reach, a 90-km stretch, is currently the only remaining segment of the Columbia River in the United States not impounded by hydroelectric dams. Proposals to construct Ben Franklin Dam and build a barge shipping channel through the Hanford Reach have threatened to modify this segment of river. Demands have already been made on the waters of both rivers through irrigation withdrawal. In addition, return runoff contains agricultural chemicals that could alter the aquatic fauna of these rivers. A new proposal to classify the Hanford Reach as a wild and scenic river is now being reviewed. Currently, there is little information available to develop effective management plans or assess the effects of human activities on waterfowl wintering habitat along the Columbia and adjoining Yakima rivers.

Winter diets of common and Barrow's goldeneyes were studied from 1981 through 1988 to better understand the food requirements of these species during a stressful period of their annual cycle. This information is needed to effectively develop waterfowl management plans for the Columbia and Yakima rivers.

Methods

We collected 39 Barrow's goldeneye and 33 common goldeneye that were shot by hunters during October through May, 1955 through 1957. The esophagus and proventriculus were removed and their fresh contents separated, identified, and weighed to within 1 g (to within 0.1 g if less than 1 g) to determine percent wet weight and relative frequency of food items. Body weights were also recorded to the nearest gram. Plant food items were identified using Scheffer and Hotchkiss (1945).

Results and Discussion

Food Habits

All but one bird, a subadult female common goldeneye, contained food items. Aquatic insects composed 86% (wet weight) of the common goldeneye diet (Table 1). Two trichopteran larvae, *Brachycentrus* sp. and *Hydropsyche cocherelli*, accounted for

[1]To whom correspondence should be addressed: Environmental Protection, Battelle Pantex, P.O. Box 30020, Amarillo, TX 79177

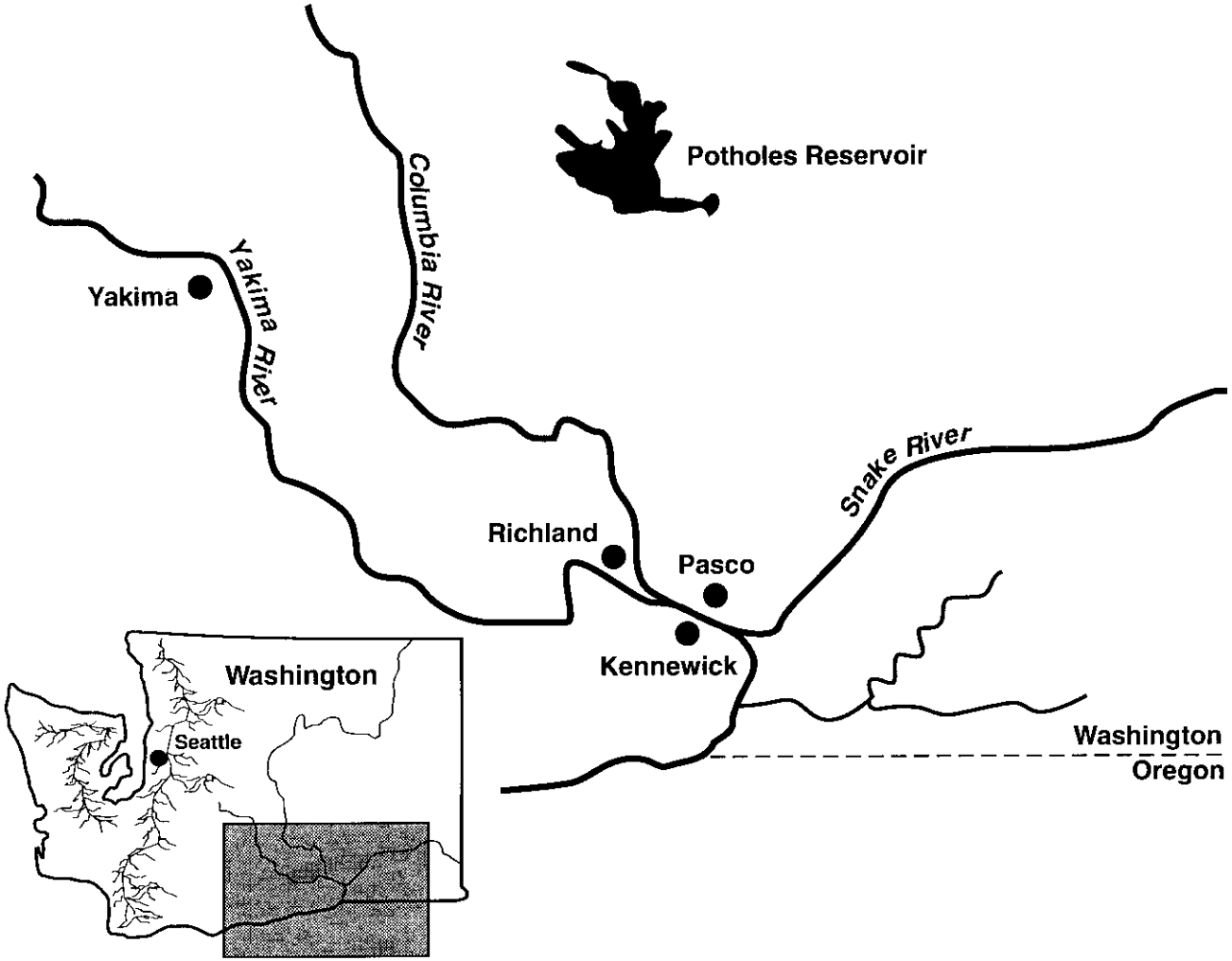

Figure 1. Columbia and Yakima rivers in southcentral Washington.

TABLE 1. Food items in common goldeneye collected on the Yakima and Columbia rivers, Southcentral Washington, 1955-1957

Taxa	Average Weight Per Bird	Total Wet Weight (g)	% Total
Plant Matter			
unidentified vegetation	0.7	24.0	1.00
Echinochloa crus-gali achenes	0.5	16.0	0.43
Potamogeton pectinatus achenes	0.3	11.0	0.30
P. foliosius achenes	0.1	2.0	0.05
Polygonum natans vegetation	0.3	10.0	0.27
P. hydropiper achenes	1.0	32.0	1.00
P. lapathifolium achenes	1.2	38.0	1.00
Scirpus acutus achenes	0.6	20.0	1.00
S. americanus achenes	0.2	7.0	0.19
S. paludosus achenes	0.03	1.0	0.03
S. nevadensis achenes	0.2	5.0	0.13
Eragrostsis megastocha achenes	0.1	3.0	0.08
Total Plant Matter	5.23	169.0	5.00
Animal Matter			
Crustacea			
Pacifastacus sp.	0.1	3.0	0.08
Insecta			
unidentified larvae	16.0	540.0	15.00
Coleoptrea adults	1.4	45.0	1.00
Corixidae adults	1.2	41.0	1.00
Notonectidae adults	0.03	1.0	0.03
Odonata naids	1.5	50.0	1.00
unidentified ephemeroptera naids	1.5	50.0	1.00
Brachycentrus occidentalis larvae	60.0	1981.0	53.00
Hydropsyche cocherelli larvae	14.0	464.0	12.00
Cheumatopsyche campyla larvae	1.4	46.0	1.00
Total Insecta	97.03	3218.0	86.00
Gastropoda			
Fisherola nuttalli	4.1	136.0	4.00
Fluminicola columbiana	1.1	149.0	4.00
Gyraulus spp.	0.1	4.0	0.11
Stagnicola apicina	1.1	37.0	1.10
unidentified snails	0.003	0.1	0.00
Total Gastropoda	6.4	326.1	1.00
Porifera			
Spongilla sp.	0.03	1	0.03
Osteichthyes			
unidentified fish	0.01	3	0.08
Other			
lead shot	0.03	1	0.03
Grand Total	113	3721.1	100.00

67% of insect biomass. The shortface lanx or limpet (*Fisherola nuttalli*) and Columbia pebblesnails (*Fluminicola* sp.) accounted for 8% of the common goldeneye diet. Plant matter, mostly achenes of pondweeds (*Potamogeton* spp.), smart weed (*Polygonum* sp.) and *Scirpus* spp. accounted for 5% of the biomass. Crayfish (*Pacifastacus* sp.) and unidentified minnows were recorded in trace amounts.

Elsewhere on the Detroit River, Michigan, Jones and Drobney (1986) found that common goldeneyes fed largely on plant matter, mostly wild celery (*Vallisneria americana*). Oligochaetes, small crustaceans, and minnows were also consumed. On the Mississippi River, Thompson (1973) reported that gastropods and pelecypods were important foods of common goldeneyes in the fall.

Studies of common goldeneye diets in marine waters generally document a similar preference for invertebrates and mollusks. However, while aquatic insect larvae are consumed in freshwater, crustaceans are consumed in marine waters. Cottam (1939) pooled marine and freshwater diets of common goldeneye and reported that they fed mostly on animal matter (crustaceans, aquatic insects, and mollusks), with 26% of the food being plant material (mostly *Potamogeton*). Nilsson (1972) found that common goldeneye along the Swedish coast ate mainly mussels and polychaetes. Olney and Mills (1963) and Olney (1965) found that common goldeneye fed primarily on crustaceans and shore crabs (*Carcinus* sp.). Vermeer and Levings (1977) reported that in Boundary Bay, British Columbia, the common goldeneye fed mostly on crustaceans, crabs (*Cancer* sp., *Telmessus* sp.), shrimp (*Upogebia*), and amphipods. Madsen (1954) found that crustaceans (shrimp, *Crangon* sp., prawns, *Palaemonetes*), and isopods, and to a lesser extent bivalves and gastropods (periwinkles, *Littorina* sp.) were consumed by common goldeneye in Denmark. In Puget Sound Washington, Hirsch (1980) reported that common goldeneye foraged predominantly on crustaceans, along with small amounts of fish and gastropods. Dominant prey items were shore crabs (*Hemigrapsus nudus*), crabs and shrimp (*Heptacarpus* sp.); *Lacuna unifasciata*, a small snail, was the dominant gastropod and blennies (*Apodichthys flavidus*) were also taken.

Barrow's goldeneye diets were generally similar to those of common goldeneye (Table 2). Aquatic trichopteran larvae accounted for 82% of the biomass; limpets (lanx) and snails accounted for 17%. However, Barrow's goldeneye diets contained less plant matter than did the diets of common goldeneye; only 1% consisted of *Potamogeton* and *Scirpus* achenes. Crayfish and unidentified minnows were recorded in trace amounts.

No other dietary studies have been reported for Barrow's goldeneye since 1939. Cottam (1939) reported on foods eaten by 71 adults, mostly from British Columbia, during 11 months of the year. Insects (odonata naiads, trichoptera larvae, midge larvae) constituted 36% of the diet by volume; mollusks (*Mytilus*) 19%, crustaceans (amphipods, isopods, crayfish) 18%, other animal foods 4%, and plant materials (*Potamogeton* and *Vallisneria*) 22%. Munro (1939), using some of Cottam's analysis, and additional samples, reported on the contents of 116 stomachs. Salmon eggs, mollusks, crustaceans, and marine algae were eaten by coastal-inhabiting birds. Inland-dwelling birds ate insects, mostly trichoptera larvae, odonata naiads, crustaceans (amphipods, crayfish) and plant materials.

In our studies, both goldeneye species fed on pebblesnails and shortface lanx. The distribution and abundance of these mollusk species are poorly known (Neitzel and Frest 1993). Columbia pebblesnail (*F. columbiana*) and shortface lanx are "Candidate Species" for potential listing as threatened or endangered by the U.S. Fish and Wildlife Service, and the State of Washington has placed them in their Special Animal Species list (WDG 1983). Considering the biomass of lanx and snails consumed by goldeneyes, both mollusk species must have occurred commonly enough to provide an important food source for these birds.

Weights

Weights of common and Barrow's goldeneyes (adults and subadults) are shown in Table 3. Nelson and Martin (1953) reported that weights of male common goldeneyes averaged 997 g, with a maximum of 1,406 g. Weights of female common goldeneyes averaged 815 g with a 1,133-g maximum. Subadult weights were not reported. Nelson and Martin (1953) also reported weights of Barrow's goldeneye: males averaged 1,087 g with a maximum of 1,314 g, while females averaged 725 g with a maximum of 861 g. Johnsgard (1975) reported an average weight for male Barrow's goldeneye at 1,162 g with a maximum of

TABLE 2. Food items in Barrow's goldeneye collected on the Yakima and Columbia rivers, 1955-1957

Taxa	Average Weight Per Bird	Total Wet Weight (g)	% Total
Plant Matter			
unidentified vegetation	0.3	10.0	0.18
Potamogeton pectinatus achenes	0.4	14.0	0.25
Polygonum hydropiper achenes	0.1	4.0	0.07
P. lapathifolium achenes	0.4	14.0	0.25
Scirpus acutus achenes	0.1	3.0	0.05
Total Plant Matter	1.3	45.0	1.00
Animal Matter			
Insecta			
unidentified larvae	1.1	41.0	1.00
Coleoptera adults	0.1	2.0	0.04
Corixidae adults	0.1	2.0	0.04
Odonata naids	0.1	2.0	0.04
Brachycentrus sp. larvae	86.5	3374.0	61.00
Hydropsyche cockerelli larvae	26.1	1019.0	18.00
Cheumatopsyche campyla larvae	1.8	70.0	1.00
unidentified ephemeropera naids	0.1	5.0	0.09
Total Insecta	116.9	4515.0	82.00
Gastropoda			
Fisherola nuttalli	19.0	756.0	14.00
Fluminicola columbiana	4.5	177.0	3.00
Gyraulus sp.	0.003	0.1	0.00
Stagnicola apicina	0.4	15.0	0.37
unidentified snails	0.03	1.0	0.02
Total Gastropoda	23.93	949.1	17.00
Porifera			
Spongilla sp.	0.03	1.0	0.02
Osteichthyes			
unidentified fish	0.06	0.2	0.00
Grand Total	142.22	5510.3	100.00

TABLE 3. Weights (g) of adult and subadult common and Barrow's goldeneyes from Southcentral Washington

	common goldeneye			Barrow's goldeneye		
Age/Sex	Range	Mean ± SE	N	Range	Mean ± SE	N
Adult						
Male	776-1246	1060.2 ± 33.36	14	980-1315	1130.5 ± 18.69	18
Female	505-833	720.2 ± 88.00	5	577-857	750.7 ± 21.33	10
Subadult						
Male	875-1025	986.0 ± 30.52	6	832-1113	977.8 ± 67.53	4
Female	397-736	599.3 ± 39.86	8	609-818	736.0 ± 44.73	5

SE = standard error. N = number of samples

1,219 g, while females ranged from 793.8 to 907.2 g. Yocom (1970) reported weights of Barrow's goldeneye collected in August; males averaged 1,020.6 g, while females averaged 595.4 g. These data were obtained when goldeneyes weighed the least because they were molting and females were still recovering from nesting and rearing young (Yocom 1970). Weights reported in our study are generally comparable to those reported by others. However, adult and subadult weights (Table 3) demonstrated age-related differences that should be considered in bioenergetic analyses. Body-weight dynamics may reflect resource availability and competition, which in turn may influence winter distribution, migration and habitat use by sexes.

Conclusions

This paper summarizes eight years of data on the winter diet and body-weight dynamics of Barrow's and common goldeneyes in a freshwater environment in the Pacific Northwest. Weights reported in our study were similar to those reported by others. On the Columbia and Yakima rivers, common and Barrow's goldeneye diets were generally similar and included large numbers of insects and mollusks. Common goldeneye ate more plant matter than Barrow's goldeneye. Mollusks were more important in the diet of Barrow's goldeneye. Few other data are available for Barrow's goldeneye. Comparison with other studies of common goldeneye show that while aquatic insect larvae are consumed in freshwater environs, crustaceans are consumed in marine habitats.

Acknowledgments

One June 3, 1992, Richard E. Fitzner was killed in an airplane crash while conducting wildlife surveys. He had studied bird and other wildlife populations in the mid-Columbia Basin for two decades. He will be sorely missed. We thank the many hunters who provided samples of goldeneye digestive systems. Jerry Davis was involved in collecting the specimens. We also thank Charles A. Brandt, Lisa E. Fitzner, Robert L. Newell, and William A. Radke for helpful suggestions in the preparation of this manuscript. This work was supported by the U.S. Department of Energy under Contract DE-AC06-76RLO 1830 with Battelle Memorial Institute.

Literature Cited

Cottam, C. 1939. Food habits of North American diving ducks. U.S. Dept. Agr. Tech. Bull. 643. 140 p.

Fitzner, R. E., and W. H. Rickard. 1975. Avifauna of waste ponds ERDA Hanford Reservation, Benton County, Washington. BNWL-1885, Battelle Pacific Northwest Laboratory, Richland, Washington. National Technical Information Service, Springfield, Virginia. 95 p.

Hirsch, K. V. 1980. Winter ecology of sea ducks in the inland marine waters of Washington. University of Washington, Seattle. M. S. Thesis.

Johnsgard, P. A. 1975. Waterfowl of North America. Indiana University Press, Bloomington. 575 p.

Jones, J. J., and R. D. Drobney. 1986. Winter feeding ecology of scaup and common goldeneye in Michigan. J. Wildl. Manage. 50:446-452.

Madsen, F. J. 1954. On the food habits of the diving ducks in Denmark. Dan. Rev. Game Biol. 2:157-266.

Munro, J. A. 1939. Studies of waterfowl in British Columbia. Barrow's golden-eye, American golden-eye. Trans. Royal Canadian Institute 22:259-318.

Neitzel, D. A., and T. J. Frest. 1993. Survey of Columbia River Basin streams for Columbia pebblesnail (*Fluminicola columbiana*) and shortface lanx (*Fisherola nuttalli*). PNL-8229. Rev. 1, Pacific Northwest Laboratory, Richland, Washington. National Technical Information Service, Springfield, Virginia. 29 p. plus appendix.

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Nelson, A. D., and A. C. Martin. 1953. Gamebird weights. J. Wildl. Manage. 17:36-42.

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

Olney, P. J. S., 1965. The autumn and winter feeding biology of certain sympatric ducks. Cong. Int. Un. Game Biol. 6:309-320.

Olney, P. J. S., and D. H. Mills. 1963. The food and feeding habits of goldeneye (*Bucephala clangula*) in Great Britain. Ibis 105:293-300.

Scheffer, T. H., and N. Hotchkiss. 1945. Plant-food resources for waterfowl in the pacific northwest. Washington State Dept. of Game. Biol. Bull. No. 7. 39 p.

Thompson, D. 1973. Feeding ecology of diving ducks on Keokuk Pool, Mississippi River. J. Wildl. Manage. 37:367-381.

Vermeer, K., and E. D. Levings. 1977. Populations, biomass and food habits of ducks on the Fraser Delta intertidal area, British Columbia. Wildfowl Trust Ann. Rep. 28:49-60.

WDG 1983. Washington State special animal species. Washington Dept. of Game, Olympia, Washington. 22 p.

Yocom, C. F. 1951. Waterfowl and their food plants in Washington. University of Washington Press, Seattle. 272 p.

_____. 1970. Weights of ten species of ducks captured at Ohtig Lake, Alaska. Murrelet 51:20-21.