GARRETT, K. AND J. DUNN. 1981. Birds of southern California: status and distribution. Los Angeles County Audubon Society, Los Angeles, CA.

LARRISON, E. J. AND E. N. FRANCQ. 1962. Field guide to the birds of Washington state. Seattle Audubon Society, Seattle, WA.

LINSDALE, J. M. 1936. The birds of Nevada. Pacific Coast Avifauna No. 23.

MCQUEEN, L. 1979. The Grasshopper Sparrows of the Willamette Valley. Oregon Birds 5:32-35.

MONSON, G. AND A. R. PHILLIPS. 1964. A checklist of the birds of Arizona. University of Arizona Press, Tucson, AZ.

MUNRO, J. A. AND I. M. COWAN. 1947. A review of the bird fauna of British Columbia. British Columbia Prov. Mus. Dept. of Educ. Spec. Publ. No. 2.

SMITH, R. L. 1963. Some ecological notes on the Grasshopper Sparrow. Wilson Bull. 75:159-165.

WHITMORE, R. C. 1981. Structural characteristics of Grasshopper Sparrow habitat. J. Wildl. Manage. 45:811-814.

WIENS, J. A. 1969. An approach to the study of ecological relationships among grassland birds. Ornith. Monogr. No. 8.

WIENS, J. A. 1973. Interterritorial habitat variation in Grasshopper and Savannah Sparrows. Ecology 54:877-884.

WIENS, J. A. AND M. I. DYER. 1975. Rangeland avifaunas: their composition, energetics, and role in the ecosystem, pp. 146-181. *In:* D. R. Smith (ed.), Proceedings of the symposium on management of forest and range habitats for nongame birds (May 6-9, 1975, Tucson, Ariz.). USDA For. Serv. Gen. Tech. Rep. WO-1.

Department of Biology, University of California, Los Angeles, CA 90024. Received 19 January 1982, accepted 1 March 1983.

DIET OF THE HARLEQUIN DUCK IN THE STRAIT OF GEORGIA, BRITISH COLUMBIA

KEES VERMEER

The Harlequin Duck (*Histrionicus histrionicus*) has a disjunct, nearctic distribution with large numbers of birds concentrated in the northern Pacific and smaller populations occurring in Iceland, southern Greenland and northeast North America (Voous 1960, Bellrose 1976, Palmer 1976). The Harlequin Duck's diet in Icelandic rivers consists chiefly of insects (Bengtson and Ulfstrand 1971, Gudmundsson 1971). Cottam (1939) reported that crustaceans made up 57% and molluscs 25% of 63 Harlequin Duck stomach contents from Alaska, British Columbia, Quebec, Wyoming, Alberta, and California from January to September. However, Cottam provided little information on the diet of Harlequin Ducks on the British Columbia coast, recording only that the crab *Hemigrapsus* was the most important food item taken by those ducks at Comox, Vancouver Island. For the

TABLE 1. Percentage wet weight and occurrence of principal food categories found in esophagi and gizzards of 54 Harlequin Ducks from the Strait of Georgia, 1977-1978. (Unidentified and digested food and grit excluded.)

Food categories	Wet weight	Occurrence
Snails and limpets	29.3	90.0
Fish and fish eggs	21.9	18.5
Crabs	15.9	66.7
Chitons	13.2	44.4
Algae	9.2	14.8
Bivalves	8.5	11.1
Amphipods	0.9	1.9
Shrimp	0.4	7.4
Echinoderms	0.4	3.7
Barnacles	0.3	7.4

TABLE 2. Percentage wet weight and occurrence of food items and grit in esophagi and gizzards of 54 Harlequin Ducks from Cortes and Saltspring Islands, Strait of Georgia in 1977 and 1978.

	Cortes Island				Saltspring Island			
	March 1977		Nov. 1977		Nov. 1977		Oct. 1978	
Food items and grit	Weight	Occ.	Weight	Occ.	Weight	Occ.	Weight	Occ.
Snails								
Amphissa versicolor	0.4	4.8	0.5	21.4	—	—	—	—
Bittium estrechtii	—	—	Trace	14.3	—	—	—	—
Calliostoma ligatum	—	—	—	—	—	—	Trace	11.1
Lacuna marmorata	—	—	—	—	0.5	40.0	8.2	55.6
L. porecta	—	—	—	—	2.0	30.0	—	—
L. vincta	Trace	4.8	—	—	—	—	—	—
Lirularia lirulata	1.1	19.0	—	—	—	—	—	—
Littorina planaxis	—	—	—	—	—	—	Trace	11.1
L. scutulata	19.8	52.4	5.7	50.0	11.9	60.0	1.3	77.8
L. sitkana	1.0	28.6	1.8	28.6	0.8	10.0	3.8	55.6
Margarites costalis	—	—	—	—	—	—	Trace	11.1
M. lirulates	—	—	—	—	Trace	40.0	0.3	33.3
M. pupillus	—	—	—	—	Trace	10.0	0.6	22.2
M. succinctes	—	—	Trace	7.1	2.1	20.0	—	—
Mitrella carinata	0.4	4.8	—	—	—	—	—	—
M. gouldii	Trace	4.8	—	—	Trace	10.0	—	—
Nassarius mendicus	—	—	—	—	—	—	0.2	11.1
Odostomia sp.	—	—	Trace	7.1	Trace	10.0	Trace	11.1
Thais canaliculata	—	—	—	—	0.6	10.0	—	—
T. lamellosa	—	—	0.2	7.1	—	—	—	—
T. lima	—	—	Trace	7.1	—	—	—	—
Thais egg sacs	—	—	3.5	14.3	—	—	—	—
Unid. snail fragments	—	—	—	—	2.0	20.0	2.4	44.4
Limpets								
Collisella digitalis	—	—	—	—	1.3	30.0	—	—
C. pelta	3.1	28.6	1.5	21.4	—	—	—	—
Notoacmaea persona	1.3	14.3	3.1	28.6	2.2	20.0	Trace	11.1
N. scutum	1.5	14.3	13.4	92.9	Trace	20.0	Trace	11.1
Fishes								
Gunnel (Pholidae)	0.3	4.8	2.1	14.3	—	—	—	—
Sculpin (Cottidae)	—	—	6.7	7.1	—	—	—	—
Fish spawn	1.1	4.8	—	—	9.1	10.9	54.5	44.4

TABLE 2. Continued.

Food items and grit	Cortes Island				Saltspring Island			
	March 1977		Nov. 1977		Nov. 1977		Oct. 1978	
	Weight	Occ.	Weight	Occ.	Weight	Occ.	Weight	Occ.
Crabs								
Cancer sp.	—	—	—	—	8.4	40.0	—	—
Hemigrapsus oregonensis	0.6	4.8	9.1	5.7	—	—	0.4	11.1
Pagurus sp.	0.8	9.5	4.0	19.3	0.2	10.0	Trace	11.1
Pagurus in *Littorina* shells	1.1	9.5	10.2	92.6	5.1	40.0	—	—
Crab fragments	1.5	42.9	11.8	64.3	2.8	40.0	Trace	22.2
Chitons								
Tonicella lineata	1.3	14.3	—	—	8.1	70.0	7.8	77.8
Mopalia sp.	—	—	6.7	7.1	25.8	60.0	0.1	33.3
Algae								
Enteromorpha sp.	—	—	—	—	—	—	3.4	11.1
Ulva sp.	—	—	—	—	14.6	10.0	8.7	33.3
Digested algae	6.1	14.3	—	—	—	—	—	—
Bivalves								
Mytilus edulis	26.0	23.8	Trace	7.1	—	—	—	—
Amphipods (unidentified)	—	—	—	—	—	—	2.9	11.1
Shrimp								
Heptocarpus sp.	—	—	1.6	28.6	—	—	—	—
Echinoderms								
Pisaster brevispines	—	—	1.4	7.1	—	—	—	—
Ophiolis sp.	—	—	Trace	7.1	—	—	—	—
Barnacles (*Balanus* sp.)	—	—	—	—	1.2	40.0	—	—
Digested animal matter and broken shells	17.6	57.1	12.5	50.0	—	—	4.0	22.2
Grit	15.0	90.4	4.2	78.6	1.3	60.0	1.4	77.8
No. stomachs	21		14		10		9	
Wet weight (g)	166		150		126		156	

purpose of obtaining more detailed information on the Harlequin Duck's diet in British Columbia's coastal waters, I examined the contents of esophagi and gizzards of 54 Harlequin Ducks taken in the Strait of Georgia in 1977 and 1978.

Harlequin Ducks were collected in March and November 1977 along the south coast of Cortes Island (50°00'N, 125°00'W) in the northern Strait of Georgia and in November 1977 and October 1978 along the south coast of Saltspring Island (48°45'N, 123°20'W) in the southwestern portion of the Strait. Esophagi and gizzards were dissected within one hour of collection and the food contents were weighed to the nearest 0.1 g and stored in 10% formaldehyde.

The principal food categories of 54 Harlequin Ducks analyzed from the Strait of Georgia are shown in Table 1. The main foods eaten by those ducks were snails, limpets, fish eggs, crabs, chitons, algae, and bivalves. Snails were a major food source at both Cortes and Saltspring Islands at all sampling times (Table 2). At Cortes Island, bivalves were important prey items in March 1977, and crabs and limpets were important in November of that year. Chitons constituted the principal food in November 1977 and fish eggs in October 1978 at Saltspring Island.

Littorina scutulata was the principal snail species taken. Many of the *Littorina* snails may have been taken by Harlequin Ducks because 10–80% of the shells contained hermit crabs (*Pagurus* sp.). The limpets *Notoacmaea persona* and *N. scutum* occurred at all sampling times (Table 2). Twenty *N. scutum* averaged 1.1 cm long (range 0.5–1.8 cm). Fish commonly occurred in the diet, while fish spawn formed the principal food of those ducks at Saltspring Island in October 1978. Munro and Clemens (1931) counted nearly 9000 herring eggs in one Harlequin Duck stomach from the British Columbia coast. *Hemigrapsus oregonensis* and *Pagurus* sp. were the most frequent crabs taken. Not many ducks eat chitons, but Harlequin Ducks apparently are an exception. *Tonicella lineata* and *Mopalis* sp. were preyed upon. *Ulva* spp. were the most abundant algae in Harlequin Duck stomachs. *Mytilus edulis* was the only bivalve prey encountered. Bent (1925) stated that *Mytilus edulis* forms one of the main foods of Harlequin Ducks on the New England coast.

Harlequin Ducks foraged close to boulder-strewn shores over rocky and to some extent gravel substrates and in kelp beds, where their feeding habits are varied and presumably opportunistic. For example 70% of the identified prey species in Table 2 chiefly occur on rock substrate and 22% on a gravel substrate (based on description in Smith and Carlton 1975 and Morris et al. 1980).

Acknowledgements.—The author would like to thank L. Cullen and M. Galbraith for assistance with the food analyses of Harlequin Ducks. The study was financed by the Canadian Wildlife Service. R. Ydenberg made useful comments on an earlier manuscript.

LITERATURE CITED

BELLROSE, R. C. 1976. Ducks, geese and swans of North America. Stackpole Books, Harrisburg, PA.

BENGTSON, S. A. AND S. ULFSTRAND. 1971. Food resources and breeding frequency of the Harlequin Duck, *Histrionicus histrionicus* in Iceland. Oikos 22:235–239.

BENT, A. C. 1925. Life histories of North American waterfowl. Part II. U.S. Nat. Mus. Bull. 130. Washington, DC. 396 pp.

COTTAM, C. 1939. Food habits of North American diving ducks. U.S. Dept. Agric. Tech. Bull. 643. 140 pp.

GUDMUNDSSON, F. 1971. Straumendur (*Histrionicus histrionicus*) a Island; Fyrri hluti. Natturu-fraedingurinn 41:1–28. Reykjavic.

MORRIS, R., D. P. ABBOTT, AND E. C. HADERLE. 1980. Intertidal invertebrates of California. Stanford Univ. Press, Los Angeles. 690 pp.

MUNRO, J. A. AND W. A. CLEMENS. 1931. Waterfowl in relation to the spawning of herring, British Columbia. Biol. Brd. Canada Bull. 17:1–46.

PALMER, R. S. 1976. Handbook of North American birds, Vol. 3. Waterfowl (Part 2). Yale Univ. Press, New Haven and London.

SMITH, R. I. AND J. T. CARLTON. 1975. Light's manual: intertidal invertebrates of the central California coast, 3rd ed. Univ. California Press, Berkeley. 716 pp.

VOOUS, K. H. 1960. Atlas van de Europese Vogels. Elsevier, Amsterdam.

Canadian Wildlife Service, P.O. Box 340, Delta, British Columbia V4K 3Y3. *Received 20 January 1983, accepted 1 March 1983.*