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FOOD HABITS OF FALL-COLLECTED AGE-0 WALLEYES IN EASTERN SOUTH DAKOTA GLA- CIAL LAKES

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FOOD HABITS OF FALL-COLLECTED AGE-0 WALLEYES IN EASTERN SOUTH DAKOTA GLACIAL LAKES— Food habits of age-0 fishes can influence their growth and survival prior to the first winter (Hoxmeier et al. 2006, Shoup and Wahl 2011). Ontogenetic diet shifts in juvenile piscivorous fishes result in a transition in consumption from zooplankton to macroinvertebrates and eventually fish throughout development (Mittelbach and Persson 1998). Certain food items may be more energetically beneficial to fishes than others as consumption of prey fishes may lead to faster growth rates of predators, decreased overwinter starvation, avoidance of competition, and reduced predation risk (Werner and Gilliam 1984). By the time age-0 walleyes (*Sander vitreus*) have reached lengths of 60–80 mm total length (TL), their diets are predominantly composed of fish (Priegel 1969, Quist et al. 2002, Galarowicz and Wahl 2005). Previous studies have examined age-0 walleye food habits in South Dakota in a limited number of waters at various times and the majority of fall diets were composed of fish (Beck et al. 1998, Blackwell et al. 1999). Fathead minnows (*Pimephales promelas*), rainbow smelt (*Osmerus mordax*), yellow perch (*Perca flavescens*), darters (*Etheostoma* spp.), and gizzard shad (*Dorosoma cepedianum*) have all been documented as regionally important prey fish species for juvenile walleyes (Jackson et al. 1992, Beck et al. 1998, Blackwell et al. 1999, Pelham et al. 2001, Uphoff 2012). Although generalized feeding ecology of walleye during early life stages has been investigated, previous studies have only examined food habits in either a controlled setting or limited number of waters, thereby potentially overlooking spatial differences in feeding ecology. Therefore, this study examined food habits of age-0 walleye collected during fall across a range of eastern South Dakota glacial lakes.

Age-0 walleyes were collected during South Dakota Department of Game, Fish and Parks (SDGFP) standardized fall electrofishing surveys at 10 eastern South Dakota glacial lakes in September and October 2013. Age-0 walleyes were collected from Bitter (Day County; 6,075 ha), Brant (Lake County; 420 ha), Clear (Marshall County; 474 ha), Enemy Swim (Day County; 869 ha), Kampeska (Codington County; 2125 ha), Madison (Lake County; 1069 ha), Opitz (Day and Marshall counties; 581 ha), Roy (Marshall County; 831 ha), Sinai (Brookings County; 735 ha) and Twin (Minnehaha County; 116 ha) lakes. We validated ages for all walleyes sampled using the length ranges of confirmed age-0 walleyes obtained from the 2013 South Dakota regional fall walleye recruitment sampling reports for each lake (B. Blackwell and D. Lucchesi, unpublished data). We placed age-0 walleyes on ice after collection for transport back to the laboratory. In the laboratory, we thawed the fish, measured for TL (mm), weighed (g), and excised whole stomachs and stored them in 90% ethyl alcohol. We analyzed twenty age-0 walleye stomachs for each lake except Bitter Lake, where 19 stomachs were collected. We enumerated diet items and measured for wet weight (g). We identified fish prey items to species when possible, and invertebrates were identified to order. However, we grouped etheostomid, centrarchid, and invertebrate species into larger prey type categories for analysis. We characterized food habits by calculating percent composition by number and wet weight for all prey types for each individual lake (Bowen 1996).

Mean TL of age-0 walleyes examined ranged between 134 and 197 mm, and the percent of empty stomachs observed ranged from 0 to 65% for all lakes (Table 1). Fish composed the largest proportion of food items by number and wet weight for each lake, but the primary prey fish species differed across lakes (Fig. 1). Diets of age-0 walleyes in Twin and Opitz lakes were almost exclusively fathead minnows (Fig. 1). Etheostomids composed a substantial portion of age-0 walleye diets by both number and wet weight at Bitter, Clear, Enemy Swim, Madison, Kampeska, and Roy lakes (Fig. 1). Centrarchids, specifically black crappie (*Pomoxis nigromaculatus*), were among the most abundant food items by number and weight in Brant, Enemy Swim, Madison, and Sinai lakes. Yellow perch were only found in age-0 walleye stomachs in Enemy Swim Lake, and white sucker (*Catostomus commersonii*) were only found in Lake Madison (Fig. 1). Only six individual invertebrates (i.e., Hemipterans and Hirundineans) were found among all of the stomachs collected in this study, and five of these individuals were recorded from Twin Lakes (Fig. 1).

A high degree of piscivory by age-0 walleyes was documented across all lakes in this study, likely related to the TL of fish we collected. Fish were more numerous in age-0 walleye diets in Lake Poinsett, South Dakota, as TL exceeded 119 mm (Beck et al. 1998); the smallest fish sampled in our study was 117 mm. Previous studies have suggested that juvenile piscivores will select fish when available in order to maximize energy profitability (Galarowicz et al. 2006). Juvenile fish that are piscivorous tend to have faster growth rates when compared to fish in the same cohort that prey on invertebrates (Keast and Eadie 1985, Buijse and Houthuijzen 1992, Graeb et al. 2005). Consumption of fish prey would likely increase lengths of age-0 walleyes, body condition, overwinter survival, and subsequent recruitment to the fishery (Chevalier 1973).

Results of our study support previous studies that indicate that age-0 walleyes are opportunistic predators (Ney 1978, Ryder and Kerr 1978, Blackwell et al. 1999). Other studies have found that age-0 walleyes selectively feed on specific prey items (Knight and Vondracek 1993); however, we found no consistent pattern in food habits of age-0 walleyes collected during the fall. Relative abundance of prey fishes and habitat overlap with age-0 walleyes may contribute to the age-0 walleye food habits we observed. For instance, Johnny darters (*E. nigrum*), which were relatively abundant in the food habits documented in some of our study lakes, often select for sandy substrates with little to no cobble (Leidy 1992).

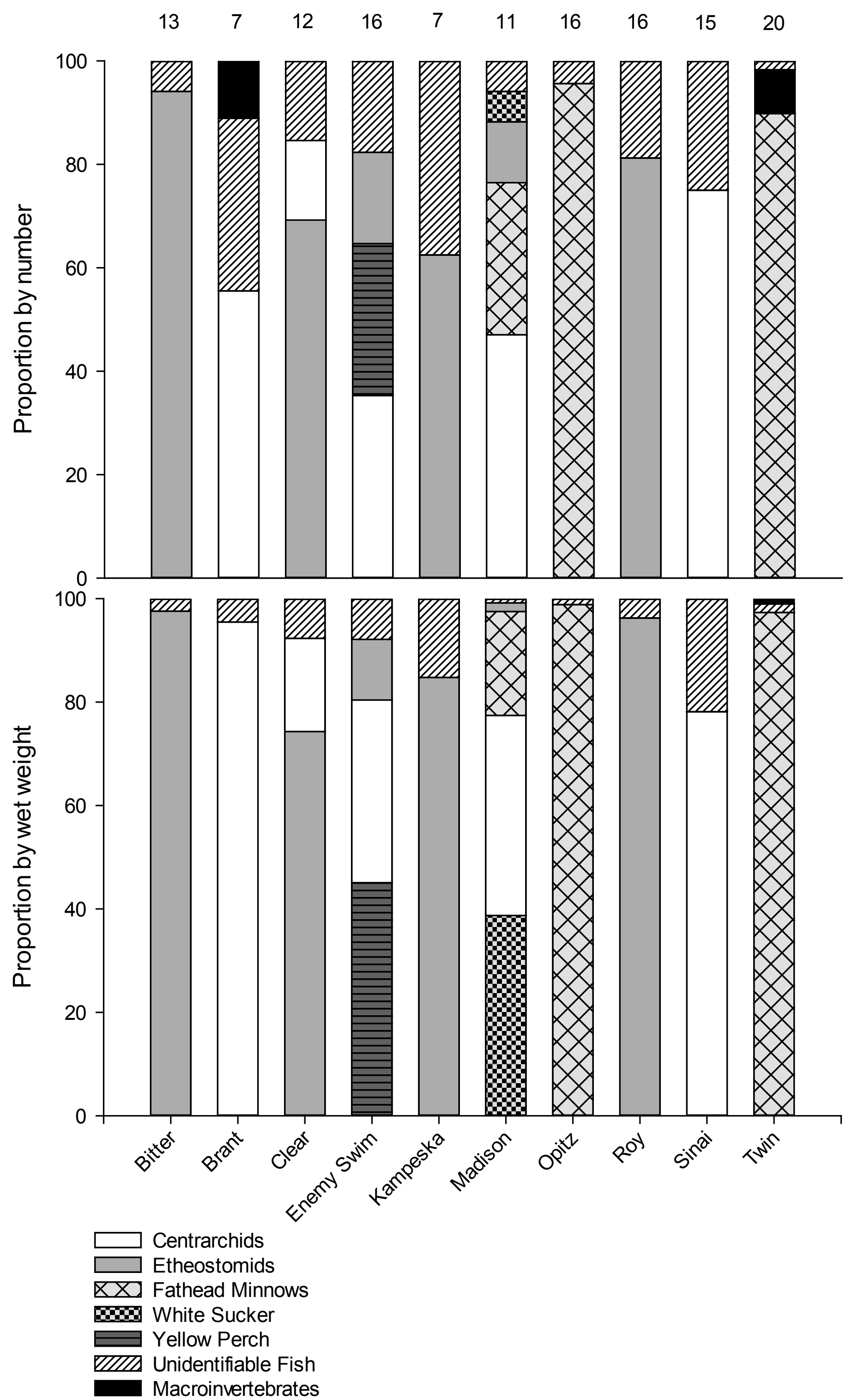

Figure 1. Percent prey composition by number (upper panel) and weight (lower panel) for age-0 walleye collected from 10 eastern South Dakota glacial lakes, fall 2013. Numbers above each column represent number of walleyes with prey items in their stomachs used for diet analyses.

Table 1. Mean total length (TL), total number of diets examined per lake (*N*), total length range, and the percent (%) of empty stomachs for age-0 walleye collected from 10 eastern South Dakota glacial lakes, 2013. Numbers in parentheses represent one standard error.

Lake	*N*	Mean TL (mm)	TL range (mm)	% empty
Bitter	19	148 (3.1)	123–165	32
Brant	20	166 (2.2)	144–181	65
Clear	20	142 (1.5)	130–153	40
Enemy Swim	20	134 (2.7)	117–154	20
Kampeska	20	142 (1.6)	126–155	65
Madison	20	148 (4.2)	125–185	45
Opitz	20	197 (2.8)	171–225	20
Roy	20	139 (2.5)	120–155	20
Sinai	20	193 (2.4)	176–211	25
Twin	20	173 (1.8)	161–191	0

Similarly, age-0 walleyes have been shown to prefer sand and gravel substrates (Johnson 1969, Johnson et al. 1988), and SDGFP electrofishing sites that target age-0 walleye generally occur over sand substrates (B. Blackwell, SDGFP, personal communication). Further study of the relative abundance of prey and habitat use by both age-0 walleyes and their prey is needed to provide a better understanding of the role these factors have in influencing age-0 walleye food habits.

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LITERATURE CITED

Beck, H. D., A. B. Starostka, and D. W. Willis. 1998. Diet overlap of age-0 walleye and white bass in Lake Poinsett, South Dakota. Journal of Freshwater Ecology 13:425–431.

Blackwell, B. G., C. A. Soupir, and M. L. Brown. 1999. Seasonal diets of walleye and diet overlap with other top-level predators in two South Dakota lakes. South Dakota Game, Fish and Parks, Fisheries Division Report 99-23, Pierre, USA.

Bowen, S. H. 1996. Quantitative description of the diet. Pages 513–532 *in* B. R. Murphy, and D. W. Willis, editors. Fisheries techniques, Second edition. American Fisheries Society, Bethesda, Maryland, USA.

Buijse, A. D., and R. P. Houthuijzen. 1992. Piscivory, growth, and size-selective mortality of age-0 pikeperch (*Stizostedion lucioperca*). Canadian Journal of Fisheries and Aquatic Sciences 49:894–902.

Chevalier, J. R. 1973. Cannibalism as a factor in first year survival of walleye in Oneida Lake. Transactions of the American Fisheries Society 102:739–744.

Galarowicz, T. L., J. A. Adams, and D. H. Wahl. 2006. The influence of prey availability on ontogenetic diet shifts of a juvenile piscivore. Canadian Journal of Fisheries and Aquatic Sciences 63:1722–1733.

Galarowicz, T. L., and D. H. Wahl. 2005. Ontogenetic foraging patterns of a young-of-year piscivore: the role of individual prey types and densities. Canadian Journal of Fisheries and Aquatic Sciences 62:2330–2342.

Graeb, B. D. S., T. Galarowicz, D. H. Wahl, J. M. Dettmers, and M. J. Simpson. 2005. Foraging behavior, morphology, and life history variation determine the ontogeny of piscivory in two closely related predators. Canadian Journal of Fisheries and Aquatic Sciences 62:2010–2020.

Hoxmeier, R. J. H., D. H. Wahl, R. C. Brooks, and R. C. Heidinger. 2006. Growth and survival of age-0 walleye (*Sander vitreus*): interactions among walleye size, prey availability, predation, and abiotic factors. Canadian Journal of Fisheries and Aquatic Sciences 63:2173–2182.

Jackson, J. J., D. W. Willis, and D. G. Fielder. 1992. Food habits of young-of-the-year walleye in Okobojo Bay of Lake Oahe, South Dakota. Journal of Freshwater Ecology 7:329–341.

Johnson, B. L., D. L. Smith, and R. F. Carline. 1988. Habitat preferences, survival, growth, foods, and harvests of walleyes and walleye × sauger hybrids. North American Journal of Fisheries Management 8:292–304.

Johnson, F. H. 1969. Environmental and species associations of the walleye in Lake Winnibigoshish and connected waters, including observations and food habits and predator-prey relationships. Minnesota Fisheries Investigation 5:5–36.

Keast, A., and J. M. Eadie. 1985. Growth depensation in year-0 largemouth bass: the influence of diet. Transactions of the American Fisheries Society 114:204–213.

Knight, R. L., and B. Vondracek. 1993. Changes in prey fish populations in western Lake Erie, 1969-88, as related to walleye, *Stizostedion vitreum*, predation. Canadian Journal of Fisheries and Aquatic Sciences 50:1289–1298.

Leidy, R. A. 1992. Microhabitat selection by the Johnny darter, *Etheostoma nigrum* Rafinesque, in a Wyoming stream. Great Basin Naturalist 52:68–74.

Mittleback, G. G., and L. Persson. 1998. The ontogeny of piscivory and its ecological consequences. Canadian Journal of Fisheries and Aquatic Sciences 55:1454–1465.

Ney, J. J. 1978. A synoptic review of yellow perch and walleye biology. Pages 1–12 *in* R. L. Kendall, editor. Selected coolwater fishes of North America. Special Publication 11, American Fisheries Society, Bethesda, Maryland, USA.

Pelham, M. E., C. L. Pierce, and J. G. Larscheid. 2001. Diet dynamics of the juvenile piscivorous fish community in Spirit Lake, Iowa, USA, 1997–1998. Ecology of Freshwater Fish 10:198–211.

Priegel, G. R. 1969. Food and growth of young walleyes in Lake Winnebago, Wisconsin. Transactions of the American Fisheries Society 98:121–124.

Quist, M. C., C. S. Guy, R. J. Bernot, and J. L. Stephen. 2002. Seasonal variation in condition, growth and food habits of walleye in a Great Plains reservoir and simulated effects of an altered thermal regime. Journal of Fish Biology 61:1329–1344.

Ryder, R. A., and S. R. Kerr. 1978. The adult walleye in the percid community - a niche definition based on feeding behaviour and food specificity. American Fisheries Society Special Publication 11:39–51.

Shoup, D. E., and D. H. Wahl. 2011. Body size, food, and temperature affect overwinter survival of age-0 bluegills. Transactions of the American Fisheries Society 140:1298–1304.

Uphoff, C. S. 2012. Seasonal food habits and variability in length of age-0 walleye in Harlan County Reservoir, NE. Thesis, University of Nebraska Kearney, Kearney, USA.

Werner, E. E., and J. F. Gilliam. 1984. The ontogenetic niche and species interactions in size-structured populations. Annual Review of Ecology and Systematics 15:393–425.

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