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Depth and Littoral Habitat Association of Age-0 Yellow Perch in Two South Dakota Glacial Lakes

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DEPTH AND LITTORAL HABITAT ASSOCIATION OF AGE-0 YELLOW PERCH IN TWO SOUTH DAKOTA GLACIAL LAKES — Yellow perch (*Perca flavescens*) are a recreationally important species and represent a key ecological component of glacial lake littoral fish assemblages (Stone 1996, Blackwell et al. 1999). Research has shown a generalized pattern of juvenile (age-0) yellow perch spatial distribution wherein larvae hatch in near-shore areas, migrate to limnetic areas where they remain for approximately 40 d, and then return to demersal behaviors and within near-shore littoral habitats (Noble 1975, Whiteside et al. 1985). However, anomalous distribution and habitat use by age-0 yellow perch has been observed in South Dakota glacial lakes (Fisher and Willis 1997) and the spatial distribution and habitat association of post-larval (>25 mm) age-0 perch is largely unverified in northern Great Plains glacial lakes. Herein, we report the depth distribution and near-shore (0–2 m depth) habitat association of post-larval, age-0 yellow perch (hereafter referred to as age-0 yellow perch) in two northeastern South Dakota glacial lakes.

We sampled Pickerel Lake (Day County, South Dakota) and Clear Lake (Marshall County, South Dakota) in early August 2011. Pickerel Lake was mesotrophic (trophic state index [TSI; Carlson 1977] = 48.8), had a surface area of 397 ha, mean depth of 4.8 m, and shoreline development index of 2.2 (Stueven and Stewart 1996). Clear Lake was eutrophic (TSI = 52.6), had a surface area of 474 ha, mean depth of 3.8 m, and shoreline development index of 1.5 (Stueven and Stewart 1996). Pickerel Lake had a relatively steep basin morphometry compared to Clear Lake. Human shoreline development (e.g., cabins and docks) at both lakes had eliminated most natural riparian vegetation. Thus, there was a lack of submerged woody structure, and littoral habitat consists largely of bare rock and sand substrates interrupted by sparse submerged macrophytes. Submerged macrophytes in Pickerel and Clear lakes were predominantly sago pondweed (*Potamogeton pectinatus*) and coontail (*Ceratophyllum demersum*), with sparse emergent stands of bulrushes (*Scirpus* spp.) and cattails (*Typha* spp.) in shallow, protected, and undeveloped areas of the lakes (Kaufman et al. 2008).

To evaluate the depth distribution of age-0 yellow perch, we selected three sample areas at each lake. We identified and selected sample areas to match standardized annual larval yellow perch trawling sites. We stratified each sample area into three strata based on depth contours (0–2 m, 2–4 m, and >4 m). We estimated relative abundance of age-0 yellow perch at each sample area in each depth stratum using a bottom trawl and a surface trawl. We towed the bottom trawl (3.75-m head rope; 3-mm bar mesh; 1.1 m^2 mouth) 30 m behind a boat traveling approximately 1–2 m s^{-1} for a target of 100 m in each depth stratum at each sample area. We towed a surface trawl with 1-m diameter mouth and 3-mm bar mesh concurrently with the bottom trawl. We computed the volume of water sampled with each trawl as the distance trawled multiplied by the surface area of the mouth of each respective trawl. We reported catch rates of age-0 yellow perch as the number of age-0 perch per cubic meter.

Habitat use of age-0 fishes, particularly yellow perch, is often heterogeneous and complex (Whiteside et al. 1985, Fisher et al. 1999, Paradis et al. 2008). Because littoral habitat in the study lakes consisted largely of bare rock and sand substrates or submerged macrophytes and preliminary gear testing indicated that age-0 yellow perch were mostly within the littoral zone. We restricted our habitat association evaluation to near-shore vegetated and non-vegetated areas. We selected one vegetated site and one non-vegetated site at each lake. Vegetated sites consisted of areas of submerged sago pondweed and coontail; no measures of macrophytic density were taken. We collected age-0 yellow perch with four different gears (push trawl, benthic sled, beach seine, and drop net). The push trawl consisted of a dead-end 3-m bottom trawl (3.75-m head rope; 3-mm bar mesh; 1.1 m^2 mouth), and the benthic sled consisted of 3-mm bar mesh netting attached to a rigid, galvanized steel frame (1.2 × 0.9 m) fastened to two 1.2-m galvanized steel skis. We fastened the push trawl and benthic sled to booms extending outward from the bow of the boat and pushed along each transect. The beach seine was an 27.4 × 1.8 m bag seine (3-mm bar mesh) and the drop net consisted of a cast net (6.2-m diameter; 5-mm bar mesh) suspended from a floating polyvinyl chloride (PVC) frame.

We sampled three transects with the push trawl, benthic sled, and beach seine in each habitat. Additionally, we sampled four locations with the drop net. We collected additional samples with the drop net to equalize the volume of water sampled with each gear. We computed the volume of water sampled by the push trawl and benthic sled as the distance trawled multiplied by the surface area of the mouth of each respective net. We computed the volume of water sampled by the drop net as the surface area of the drop net multiplied by mean depth of the water column directly below the net. Moreover, we computed the volume of water sampled by the beach seine as the area of a theoretical circle enclosed by the net multiplied by mean depth within the circle. We reported catch rates of age-0 yellow perch as the number of age-0 perch per cubic meter.

Although parametric analyses of variance and post-hoc multiple comparisons are relatively robust to deviations from normality (Brenden et al. 2003), small sample size and the presence of many zeros in our data set warranted use of non-parametric alternatives. Thus, we used the Kruskal-Wallis test to evaluate potential differences in age-0 yellow perch relative abundance among depth strata. Because overall significant differences among depth strata were detected, we made post-hoc comparisons with non-parametric Wilcoxon rank-sum tests. We also compared catch rates of age-0 yellow perch in vegetated and non-vegetated areas in each lake with each gear using Wilcoxon rank-sum tests. All comparisons were assessed for statistical significance at α = 0.05.

Depth distribution of age-0 yellow perch was similar in both study lakes. We captured no age-0 yellow perch in the surface trawls in either lake. Catches of age-0 yellow perch collected with a bottom trawl in the 0–2 m and 2–4 m strata were similar and always greater than those in the >4 m stratum (Table 1). We detected significant differences in bottom trawl catches of age-0 yellow perch among depth strata at Pickerel (χ^2_2 = 6.81, *P* = 0.03) and Clear lakes (χ^2_2 = 12.35, *P* = 0.002). We detected no differences in age-0 yellow perch catches between the 0–2 m and 2–4 m strata at Pickerel Lake (*P* = 0.30) or Clear Lake (*P* = 0.23). However, we detected significant differences in age-0 yellow perch densities between the 0–2 m and >4 m strata at Pickerel Lake (*P* = 0.03) and Clear Lake (*P* = 0.02), and the 2–4 m and >4 m strata in Pickerel Lake (*P* = 0.03) and Clear Lake (*P* = 0.02). In Pickerel Lake, 50% of age-0 yellow perch collected were within the 0–2 m stratum and 50% were within the 2–4 m stratum; none were collected within the >4 m stratum. In Clear Lake, approximately 45% of age-0 yellow perch collected were within the 0–2 m stratum, 54% within the 2–4 m stratum, and 1% within the >4 m stratum.

Table 1. Mean abundance (number/m^3) of age-0 yellow perch collected with a bottom trawl across depth strata in Pickerel and Clear lakes, South Dakota, during August 2011. Numbers in parentheses represent one standard error of the mean. For each lake, means with the same letter are not significantly different at α = 0.05.

Depth strata (m)	Pickerel Lake	Clear Lake
0–2	0.05 (0.02)[a]	0.16 (0.03)[a]
2–4	0.03 (0.01)[a]	0.14 (0.06)[a]
>4	0.00[b]	0.01 (0.003)[b]

[a, b] Means with the same letter are not significantly different (α = 0.05).

Observed patterns of age-0 yellow perch near-shore habitat association also were similar in both study lakes. Catches of age-0 yellow perch were greater (*P* < 0.05) in vegetated habitats than in non-vegetated habitats. We collected no age-0 yellow perch from many of the non-vegetated habitat samples (Table 2). However, the one notable exception occurred when comparing catches obtained with the drop net in Clear Lake. We collected a greater abundance of age-0 yellow perch with the drop net in vegetated habitats compared to non-vegetated habitats, but the difference was not statistically significant (*P* = 0.11).

Table 2. Mean abundance (number/m^3) of age-0 yellow perch collected with four different gears in vegetated and non-vegetated habitats in Pickerel and Clear lakes, South Dakota, during August 2011. Catches of age-0 yellow perch collected with all gears were greater (P < 0.05) in the vegetated habitat than in the non-vegetated habitat, except for those collected with the drop net at Clear Lake (denoted with an asterisk). Numbers in parentheses represent one standard error of the mean.

Lake	Habitat	Benthic sled	Push trawl	Beach seine	Drop net
Pickerel	Vegetated	0.07 (0.03)	0.09 (0.06)	3.04 (0.93)	1.04 (0.63)
Pickerel	Non-vegetated	0.00	0.00	0.00	0.00
Clear	Vegetated	0.65 (0.39)	1.64 (0.82)	4.10 (0.71)	0.07 (0.05)*
Clear	Non-vegetated	0.01 (0.01)	0.04 (0.05)	0.03 (0.02)	0.04 (0.01)*

Results indicate that age-0 yellow perch in these two northeastern South Dakota glacial lakes are distributed unevenly in littoral areas around patches of submerged macrophytes and maintain a mostly demersal existence. Similar results were found in studies of juvenile fish (e.g., yellow perch and bluegill [*Lepomis macrochirus*]) distribution and habitat use in glacial lakes in Iowa (Bryan and Scarnecchia 1992) and Ontario (Post and McQueen 1988). However, Fisher et al. (1999) found contrasting results that no differences in juvenile yellow perch catch rates were observed between sites with and without submerged macrophytes in Pelican Lake, South Dakota.

Pelican Lake has a relatively simple basin morphometry and limited submerged and emergent aquatic vegetation, which could result in a more random distribution of age-0 yellow perch compared to a more patchy distribution in lakes with relatively complex basin characteristics (e.g., Pickerel Lake and Clear Lake; Fisher et al. 1999).

Development of sampling protocols for age-0 yellow perch in glacial lakes has proven difficult (Fisher et al. 1999). However, results of the present study will aid in fishery management considerations when selecting sample sites and gear used to sample age-0 yellow perch. When targeting age-0 yellow perch in northern Great Plains glacial lakes, sampling stratification based upon macrophyte presence and depth contours should be considered. Specifically, sampling should occur in near-shore (< 4 m), vegetated habitats using demersal sampling gears. Research is currently underway to determine the most efficient gear for sampling age-0 yellow perch in northern Great Plains glacial lakes.

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