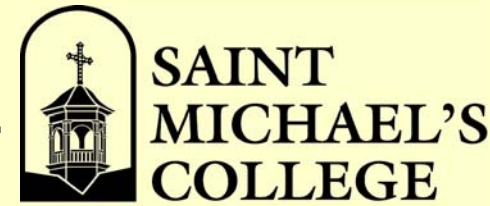


DIET OVERLAP BETWEEN NATIVE YELLOW PERCH (*PERCA FLAVESCENS*) AND INVASIVE WHITE PERCH (*MORONE AMERICANA*) IN MISSISQUOI BAY, LAKE CHAMPLAIN, VERMONT.

Jeffrey D. White (jwhite3@smcvt.edu) and Douglas E. Facey (dfacey@smcvt.edu)

Department of Biology, Saint Michael's College, Colchester, Vermont, USA (www.smcvt.edu)



Summary

White perch (*Morone americana*, Fig 1) are invasive to Lake Champlain. They apparently entered the southern lake in the mid 1980s, and have become abundant in Missisquoi Bay since the late 1990s. White perch are efficient opportunist feeders, potentially competing for food with native fishes such as yellow perch (*Perca flavescens*, Fig 2). Goals of this study were to determine if significant diet overlap between these two fishes exists in Missisquoi Bay, and to observe any shifts in their diets over the course of the summer. Fishes were angled biweekly from late May through early October, 2006, euthanized by cranial concussion, and dissected to identify and determine percent diet composition of food items. Diet overlap was quantified using Schoener's Index of Proportional Overlap. Generally, yellow perch ate benthic invertebrates from late May to mid June, eggs and benthic invertebrates from mid June to mid July, and fish, chironomids, and flatworms in August. White perch consumed mainly zooplankton from mid June to early August, when their diet shifted to fish and chironomids. Diet overlap was significant on 9 August (0.64) and 7 September (0.73), but not significant for the five other samples.



Figure 1. White perch (*Morone americana*) is invasive to the Lake Champlain Basin.

Figure 2. Yellow perch (*Perca flavescens*) is native to the Lake Champlain Basin.

Purpose of the Study

Effects of White Perch Introductions

- White perch invasions may be detrimental to native fishes such as yellow perch. Studies conducted on the Laurentian Great Lakes have found that white perch:
 - Undergo similar ontogenetic shifts in diet that cause diet overlap with yellow perch (Parrish and Margraf 1991; Sierszen *et al.* 1996; Truemper and Lauer 2005).
 - Experience similar temporal shifts in diet as yellow perch, which maintain diet overlap (Danahy *et al.* 1991).
 - May have led to resource partitioning among native fishes such as yellow perch due to possible past competition or ontogenetic shifts (Parrish and Margraf 1994).
 - Might affect recruitment of native fishes through egg consumption or competition with juveniles (Schaeffer and Margraf 1986; Sierszen *et al.* 1996).
 - Through efficient and voracious feeding, might prevent optimal foraging by yellow perch, causing a reduction in yellow perch growth (Parrish and Margraf 1990; O'Gorman and Burnett 2001).

Study Site

Missisquoi Bay is the northeasternmost region of Lake Champlain (Fig 3). The warm, shallow waters are a local recreation and tourism asset, and the bay includes a national wildlife refuge with extensive wetlands. Eutrophication in recent years has raised concerns from ecological and economic standpoints. Former clear, sandy areas are now turbid, muddy, and choked by weeds, and cyanobacterial blooms have resulted in beach closures (LCRC 2005, Fig 4). As a result, Missisquoi Bay has attracted more research attention, including exploring the role of invasive white perch in the ecosystem.

Objectives

- Assess diet overlap between white and yellow perch in Missisquoi Bay throughout the summer.
- Document eating habits of the white perch, which might have the potential to alter the food web.
- Document current food use by these fishes, which may change in the future due to recent introduction of alewife (*Alosa pseudoharengus*) in Missisquoi Bay.



Figure 3. Lake Champlain and enlargement of Missisquoi Bay, indicating the research sampling site within the red dotted line.

Figure 4. (right) Missisquoi Bay before and after cyanobacterial blooms, summer 2006.

Methods

In the Field

- We sampled for fishes by angling on an approximately biweekly basis.
- Fishes were immediately killed by cranial concussion.
- Fishes were stored in ice to slow digestion.

In the Laboratory

- We sorted fishes by species and date of sample, and measured total and standard lengths (TL and SL, cm) and weight (g).
- Stomachs were dissected and food items were identified to the lowest taxonomic group possible, then enumerated.
- We calculated percent diet composition for each food item in each stomach, averaged those values for each sample, and used the Schoener Index of Proportional Overlap (Schoener 1970) to statistically quantify diet overlap; values range from 0 (no overlap) to 1 (perfect overlap) with an accepted significance value of 0.60.

$$C_{xy} = 1 - 0.5 \left(\sum |P_{ix} - P_{iy}| \right)$$

Results

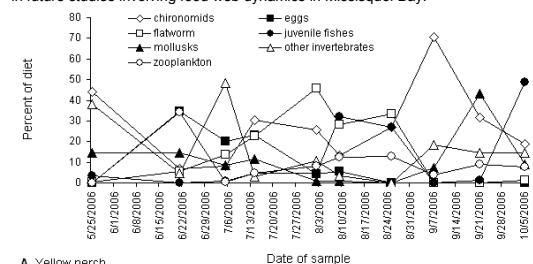
- Yellow perch were captured in all samples; white perch were absent from late May and early-mid June samples, and were scarce on 21 September and 10 October.
- Total sample size: 145 yellow perch (mean SL = 14.7 cm ± 2.37 SD); 66 white perch (mean SL = 17.7 cm ± 3.19 SD).
- Generally, yellow perch ate benthic invertebrates from late May to mid June, eggs and benthic invertebrates from mid June to mid July, and fish, chironomids, and flatworms in August (Fig 5A).
- White perch consumed mainly zooplankton from mid June to early August, dominated by *Leptodora kindtii* on 21 June, *Diaphanosoma birgei* on 5 July, *Holopedium gibberum* on 14 July, and *L. kindtii* again on 2 August. By August 10 their diet shifted to fishes, including juvenile yellow perch, and chironomids (Fig 5B).
- Significant overlap (Schoener Index ≥ 0.60) occurred in two samples, 9 August and 7 September (Table 1).

Table 1. Summary of Schoener Index values by sample. Red indicates significant overlap.

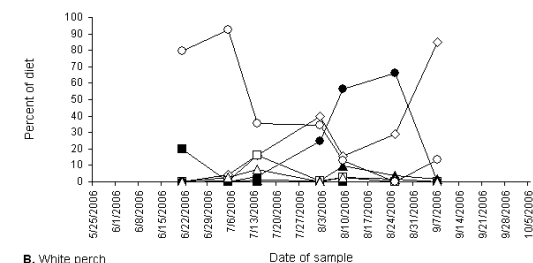
Sample Date	June 21-22	July 5-6	July 14	Aug. 2	Aug. 9	Aug. 25	Sept. 7
Schoener Overlap Index	0.32	0.065	0.42	0.34	0.64	0.40	0.73
n = yellow perch	18	25	50	20	16	9	7
n = white perch	5	3	12	11	18	5	12

Discussion and Conclusions

- There was some redundancy in organisms consumed by white perch and yellow perch, but diet overlap was often not significant (Table 1).
- Significant overlap occurred when both species focused on juvenile fishes on 9 August and chironomids on 7 September (Fig 5).
- Data are consistent with opportunist feeding, as diets shifted regularly over time (Fig 5).
- Zooplankton constituted a large portion (35-92%) of white perch diets prior to cyanobacteria blooms on Missisquoi Bay in early August. Could there be a link?
- In summary,
 - Diets of invasive white perch overlapped significantly with native yellow perch diets in two of seven sampling periods (9 August and 7 September).
 - This suggests the degree of overlap among adults is related to similar temporal shifts in diet by both species. This finding is consistent with the literature.
 - Information collected regarding food use by both of these species might prove useful in future studies involving food web dynamics in Missisquoi Bay.



A. Yellow perch



B. White perch

Figure 5. Temporal shifts in food use by yellow perch (A) and white perch (B), late May-early October, 2006. Absences in white perch data reflect occasional inability to catch white perch.

Acknowledgments

This research was made possible by the support of the Department of Biology and the John C. Hartnett Endowment at Saint Michael's College, and the Lake Champlain Research Consortium.

References

- Danahy, R.J., N.H. Ringler & J.E. Gannon. 1991. Influence of nearshore structure on growth and diet of yellow perch (*Perca flavescens*) and white perch (*Morone americana*) in Mexico Bay, Lake Ontario. *J. Gl. Lakes Res.* 17:155-193.
- [LCRC] Lake Champlain Research Consortium. 2005. PRIME - Partnership for Research and Investigations in the Missisquoi Ecosystem. <http://academic.smcvt.edu/cprime/PRIME%20Directory.htm>. Accessed 23 Feb. 2007.
- O'Gorman, R., & J.A.O. Burnett. 2001. Fish community dynamics in north-eastern Lake Ontario with emphasis on the growth and reproductive success of yellow perch (*Perca flavescens*) and white perch (*Morone americana*). 1978 to 1997. *J. Gl. Lakes Res.* 27(3): 367-383.
- Parrish, D.L. & F.J. Margraf. 1990. Interactions between white perch (*Morone americana*) and yellow perch (*Perca flavescens*) in Lake Erie as determined from feeding and growth. *Can. J. Fish. Aquat. Sci.* 47: 1779-1787.
- Parrish, D.L. & F.J. Margraf. 1991. Prey selectivity by age 0 white perch (*Morone americana*) and yellow perch (*Perca flavescens*) in laboratory experiments. *Can. J. Fish. Aquat. Sci.* 48: 807-810.
- Parrish, D.L. & F.J. Margraf. 1994. Spatial and temporal patterns of food use by white perch and yellow perch in Lake Erie. *J. Freshw. Ecol.* 9(1): 29-35.
- Schoener, T.W. 1970. Nonsynchronous spatial overlap of lizard and patchy habitats. *Ecology* 51(3): 406-418.
- Sierszen, M.E., J.R. Keough & C.A. Hickey. 1996. Trophic analysis of ruffe (*Gymnogenus cernuus*) and white perch (*Morone americana*) in a Lake Superior coastal food web, using stable isotope techniques. *J. Gl. Lakes Res.* 22(2): 436-443.
- Truemper, H.A. & T.E. Lauer. 2005. Gape limitation and piscine prey-selection by yellow perch in the extreme southern area of Lake Michigan, with emphasis on two exotic prey items. *J. Fish Biol.* 66: 135-149.