Integrating basic and applied research in determining whether competition exists between two top-level predators in South Dakota Missouri River reservoirs

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Walleye, *Sander vitreus*, are native to the Missouri River reservoirs in South Dakota and are the most popular sport fish among anglers in the state (Stone 1996). Smallmouth bass, *Micropterus dolomieu*, were introduced into these reservoirs in the early 1980s and their popularity among anglers continues to increase. Both species are top-level predators throughout their range, and walleye anglers perceive that introductions of smallmouth bass may negatively affect walleye growth and abundance through competitive interactions. We integrated results from a field-based study with those of an experimental approach to assess competition between these two predators.

Potential for competition between walleye and smallmouth bass was assessed using a diet study of both predators on the lower end of Lake Sharpe from May through October 2006. Lake Sharpe is a 23,000-ha reservoir impounded by Oahe Dam on the upper end and Big Bend Dam on the lower end (Figure 1). Fish were collected using a combination of short-term (i.e., < 4 hours) and overnight gill net sets and nighttime electrofishing during the last two weeks of every month. All fish were sacrificed for stomach dissection and otolith extraction. The target sample size was 20 stomachs containing food per length category per month. Food habits were recorded for four walleye length groups (<300, 300-380, 381-450, >450 mm) and four smallmouth bass length groups (<250, 250-330, 331-410, >410 mm). Frequency of occurrence was calculated to determine the importance of food items to the diet (Bowen 1996). Diet overlap among the predators was assessed using Pianka's index (1973).

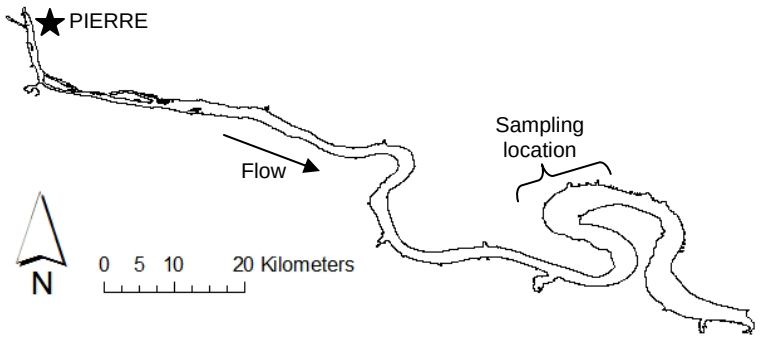

Figure 1. Map of Lake Sharpe, South Dakota, the location of diet study of walleye and smallmouth bass in 2006. Fish sampling was completed on the lower end of the lake where spatial overlap between the two species is highest.

Diets of walleye and smallmouth bass were similar from May through August (Figure 2). Analyses will be completed for September and October. Both predators consumed primarily ephemeropterans during May and June, but shifted exclusively to gizzard shad, *Dorosoma cepedianum*, in July and August. As a result of these similarities, diet overlap was high for all months (Table 1).

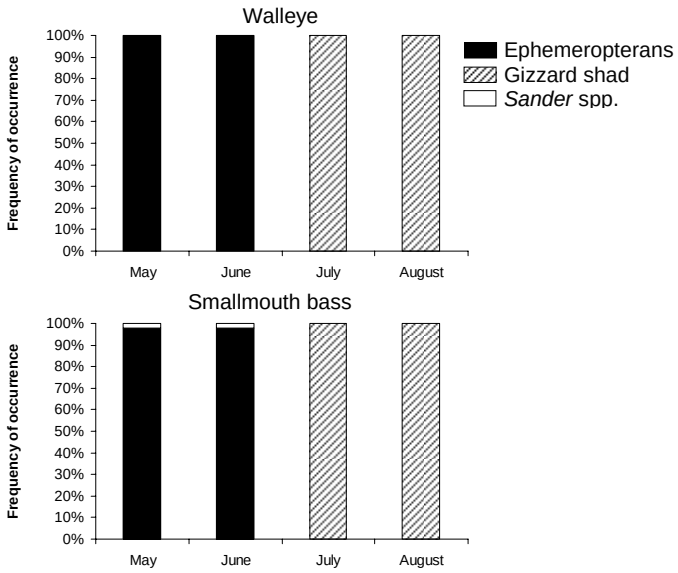

Figure 2. Frequency of occurrence of diet items for both walleye and smallmouth bass by month.

Table 1. Pianka's index of diet overlap between walleye and smallmouth bass by month. Numbers in parentheses represent one standard deviation derived from a cross-validation method. Pianka values $\geq$ 0.7 indicate high diet overlap.

Month			
May	June	July	August
0.71 (0.01)	0.76 (0.01)	1.00 (0.01)	1.00 (0.01)

The potential for competition exists for these two predators, given the high diet overlap. To quantify competition, we conducted laboratory experiments to measure the growth response of walleye and smallmouth bass, both individually (allopatry) and together (sympatry), for a 43 d feeding period. All treatments were fed a maintenance ration (estimated from the bioenergetics model) of fathead minnows, *Pimephales promelas*, every three days for 30 days. This ration was decreased by 30% after Day 30. Growth was calculated between Days 0 and 30 and between Days 30 and 43. We also quantified feeding behaviors (attack rates and capture efficiency) of walleye and smallmouth bass in allopatry and sympatry to determine the type of competition occurring (interference vs. resource).

Under maintenance ration conditions, smallmouth bass gained more weight than walleye across all treatments, but walleye gained similar weight between treatments indicating prey were not limited, a prerequisite for competition (Figure 3). When feeding rations were decreased, the response of smallmouth bass was more pronounced, indicating smallmouth bass may outcompete walleye when prey resources are scarce.

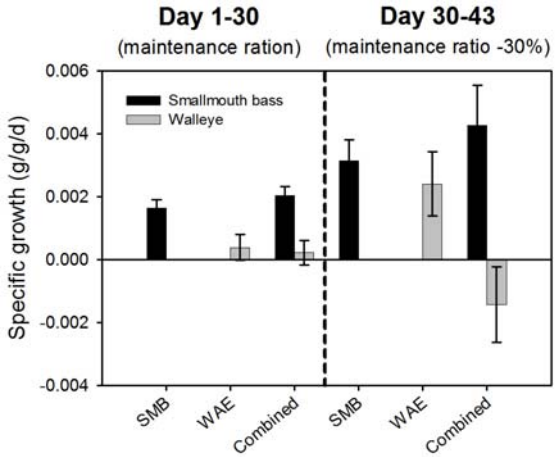

Figure 3. Growth response of walleye and smallmouth bass in allopatry and sympatry under maintenance feeding ration and a more limited feeding ration.

Increased attack rates for smallmouth bass indicate that they may outcompete walleye via resource competition (Figure 4). However, foraging behaviors were variable among both predators.

Thus, determining whether smallmouth bass exploit prey at a greater rate than walleye was difficult. While smallmouth bass may be more aggressive than walleye, the capture efficiency of smallmouth bass appeared to be more variable than that for walleye. Therefore, walleye foraging efficiency remained high in the presence of smallmouth bass, and interference competition between walleye and smallmouth bass does not likely occur.

Results from experiments indicated that competition between walleye and smallmouth bass occurred under limited prey conditions. However, anecdotal field evidence (the number of gizzard shad consumed by predators, the low rate of empty stomachs in July and August) suggest that prey were not limited in Lake Sharpe once gizzard shad entered the food web. Thus, to prevent negative effects of competition, Lake Sharpe should be managed for the sustained or increased production of gizzard shad.

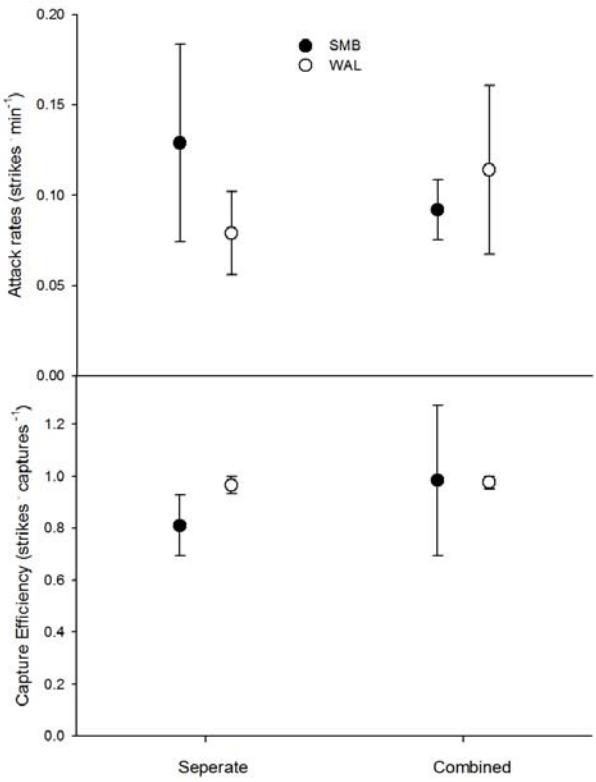

Figure 4. Attack rates and capture efficiency of walleye and smallmouth bass in allopatry and sympatry.

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