SUMMER HABITAT ASSOCIATIONS OF RARE FISHES IN SOUTH DAKOTA TRIBUTARIES TO THE MINNESOTA RIVER

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ABSTRACT

Four fish species found in western tributaries to the Minnesota River are listed as rare in South Dakota. We found only two northern redbelly dace *(Phoxinus eos),* but sample size of other species was sufficient to examine relationships between fish abundance and habitat with correlation and regression analyses. Relative abundance of hornyhead chub *(Nocomis biguttatus)* and blackside darter *(Percina maculata)* was related to mean stream width (+) and water temperature (-). Relative abundance of rosyface shiner *(Notropis rubellus)* was related to the amount of riffle habitat (-). These fish-habitat associations identify habitat conditions that might be important for managing habitat for these species.

INTRODUCTION

A small part of the upper Mississippi River basin is in South Dakota as watersheds of the Whetstone, Yellowbank, and Lac Qui Parle rivers, which are tributaries to the Minnesota River. The fish communities in these rivers vary from 13 to 22 species for a total of 27 species (Dieterman and Berry 1994). Dominant species are cyprinids such as fathead minnow *(Pimephales promelas),* blacknose dace *(Rhinichthys atratulus),* creek chub *(Semotilus atromaculatus),* and common shiner *(Luxilus cornutus).*

Four species are present that are considered rare in South Dakota but are more common in Minnesota (Wilcox et al. 1978, Underhill 1989, Kavanaugh 1993): northern redbelly dace *(Phoxinus eos),* hornyhead chub *(Nocomis biguttatus),* blackside darter *(Percina maculata),* and rosyface shiner *(Notropis rubellus).* These species are examples of fish that are common elsewhere in the Mississippi River basin but occur as relict populations in streams of the semi-arid prairie on the western edge of their range (Cross and Moss 1987). Our objective was to determine habitat associations of these rare species.

STUDY SITE

The Minnesota River is the largest tributary of the Mississippi River in Minnesota, crossing the state from its headwaters on the Coteau des Prairies in South Dakota to its confluence with the Mississippi river (Fasching 1983, Kavanaugh 1993). About 2% of the catchment is composed of the sub-basins of the Whetstone, Yellowbank, and Lac Qui Parle rivers in South Dakota. These rivers originate as swift creeks on the highlands of the Coteau in South Dakota, meander across low plains, and then plunge through ravines into the Minnesota River (Waters 1977).

The streams flow through the Prairie Coteau Escarpment ecoregion, which is a distinctive ecosystem rising 100-300 m from the Minnesota River Valley to the brow of the Coteau. The streams are distinctive for prairie streams because they are relatively natural, high-gradient, cool, and forested. In South Dakota we sampled five tributaries to the Lac Qui Parle River in Deuel County (Monighan Creek, Cobb or Florida Creek, Lost Creek, Crow-Timber Creek, Crow Creek), and the North and South Forks of the Yellowbank and Whetstone rivers in Grant County.

METHODS

One reach was selected at the top, middle, and base of the Coteau on each stream. An exception was the North Fork Whetstone River, which was sampled only at the base. Each reach was about 100 m long and encompassed pool, riffle, and run habitats. Habitat data were collected within each reach using line-transect methods similar to those proposed by Simonson et al. (1994).

Transects were set across the middle of each pool, riffle, and run, and at the transition points between. Depth, substrate, and cover type were recorded at quarter points along each transect. Substrates were classified as boulder, rubble/cobble, gravel, sand, silt, clay, (Gordon et al. 1992) or as muck (fine materials with substantial organic matter), or detritus (plant fragments). Percent substrate and cover type were calculated as the number of points where a substrate or cover type was found divided by the total number of points multiplied by 100. We measured dissolved oxygen (mg/L), temperature (°C), pH, conductivity (uS/cm), turbidity (JTUs), and water velocity (m/s) once in the center of each pool, riffle, and run. The length of each pool, riffle, and run was divided by the total reach length to determine the percentage of each.

Fishes were collected by electrofishing between block nets (for details see Dieterman and Berry 1994). Relative abundance of each species in each reach was expressed as the number collected per hour of electrofishing. Relationships between fish relative abundance and habitat characteristics were explored using correlation and regression techniques.

Habitat variables (N = 29) were assessed for correlations with fish relative abundance. Significant correlations ($P \leq 0.10$) were further assessed for correlations among themselves (Hubert and Rahel 1989). For inter-correlated variables, we chose the variable most highly correlated with fish data. We examined remaining variables for normality and log-transformed them if the as-

sumption was not met. Relationships were further explored with regression models. All significant models ($P \leq 0.10$) were evaluated by examining raw data plots, plots of residuals, tolerance values, and studentized residual frequencies (Hatcher and Stepanski 1994).

RESULTS AND DISCUSSION

The general habitat data for these small (width = 3.7-9.9 m) streams reflected the unique ecosystem setting. Average midsummer temperature was 22 C, which is typical of streams classed as intermediate between cold and warm water streams (Moyle and Cech 1982:397). Temperatures were similar at the top (mean=21.5, SD=1.2), middle (mean=21.7, SD=1.9), and base (mean=21.6, SD=3.7) of the Coteau. Water temperature usually increases from upstream to downstream unless moderated by shading or groundwater inputs (Allan 1995), which probably influenced our study sites.

Water was clear, well oxygenated, and alkaline (Table 1). The steep gradient caused relatively swift velocity and the development of pools, riffles and runs (Allen 1995). Most upstream reaches were narrower and had higher percentages of gravel, rubble, and boulder substrates than did downstream reaches. In-stream habitat for fish consisted of a complex of boulders, undercut banks, submerged vegetation, and woody debris.

Most rare species were collected together, possibly indicating similar habitat requirements. For example, hornyhead chubs were present at all rosyface shiner sites and at > 50% of blackside darter sites. We collected two individuals of the Northern redbelly dace, so habitat associations could not be determined. Ernst (1972) did not find Northern redbelly dace in the adjacent Yellow Medicine River. However, the species was found at numerous sites in Minnesota in the 1990s (Kavanaugh 1993).

Catch rate for the hornyhead chub was 13.5 fish/hr, but catch rate for the others was <1 fish/hr (Table 2). We found hornyhead chub at 9 of 22 reaches (Table 2) in five streams; North Fork Yellowbank River, South Fork Yellowbank River, Monighan Creek, Cobb Creek, and North Fork Whetstone River. Relative abundance was negatively correlated with water temperature and positively correlated with mean stream width (Figure 1). However, these two variables were significantly correlated with each other ($P=0.032$, $r= -0.48$, $N=20$). We eliminated water temperature from further analysis because it had a lower correlation with hornyhead chub relative abundance than did mean stream width. There was a significant positive relationship between mean stream width and relative abundance of hornyhead chub (Table 3). Stream width averaged 7.3 m (± 1 SD = 1.2) in reaches where hornyhead chubs were collected, which is larger than the 6.0-m mean width for all reaches (Table 1). Hornyhead chubs were was most common in reaches at the base of the Coteau where stream widths tended to be widest. In Wisconsin streams (Becker 1983) the frequency of occurrence of hornyhead chubs in five stream-width categories was 1-3 m (17%), 3-6 m (24%), 6-12 m (18%), 12-24 m (26%), and >24.0 m (16%). In our study, hornyhead chubs were not present where widths were < 5.6 m. Hornyhead chubs and blackside darters used riffle habitat more than expected (Becker 1983, Cross and Collins 1995, Pflieger 1997).

Table 1. Physical habitat and water quality characteristics measured at stream reaches (N) in eight Minnesota River tributaries in northeast South Dakota, during the summer of 1993.

VARIABLE	N	REACH AVERAGE (±1 SD)	RANGE
Reach characteristics			
Mean width (m)	22	6.0 (1.6)	3.7-9.9
Mean depth (cm)	22	42.7 (12.0)	19-63
Maximum depth (cm)	20	100.7 (20.6)	60-150
Riffle velocit y(m/s)	20	0.62 (0.22)	0.23-1.13
Pool velocity (m/s)	20	0.26 (0.17)	0.03-0.55
Run velocity (m/s)	20	0.37 (0.22)	0.04-0.76
Water quality			
Dissolved oxygen (mg/L)	22	8.8 (1.0)	7.2-12.2
Turbidity (JTU's)	20	57.2 (58.1)	7.0-245.0
Water temperature (ºC)	20	22.1 (2.3)	16.0-26.0
pH	21	9.6 (0.3)	9.0-10.2
Conductivity (uS/cm)	21	891.2 (264.3)	495.0-1461.0
Habitat type (%)			
Pools	22	42.4 (21.0)	0-87
Riffles	22	25.7 (14.7)	0-49
Runs	22	32.0 (22.8)	0-84
Substrate (%)			
Boulder	22	7.1 (9.8)	0-31
Rubble	22	12.7 (13.3)	0-52
Gravel	22	34.2 (19.5)	0-79
Sand	22	28.5 (14.4)	0-59
Silt	22	14.6 (13.7)	0-58
Clay	22	2.6 (4.5)	0-18
Detritus	22	0.1 (0.4)	0-2
Muck	22	0.2 (0.9)	0-4
Cover type (%)[1]			
No cover	13	45.5 (21.2)	10-83
Woody debris (< 7.5 cm diameter)	13	9.2 (5.6)	2-25
Log (> 7.5 cm diameter)	13	1.2 (2.4)	0-7
Undercut bank	13	6.5 (7.3)	0-21
Rubble/Boulder	13	28.7 (19.7)	4-56
Instream vegetation	13	4.2 (4.1)	0-15
Overhanging vegetation	13	4.8 (6.2)	0-22

[1]Cover type measurements added after study was underway.

Table 2. South Dakota Natural Heritage Program designation, percent of reaches where found, and mean(± 1 SD) electrofishing catch-per-effort (#/hr) of four rare fishes collected in Minnesota River tributaries in South Dakota, during 1993.

Species	Designation	Reach %	Catch rate
Hornyhead chub	rare	41	13.45 (28.09)
Blackside darter	rare	32	0.86 (1.55)
Rosyface shiner	rare	14	0.70 (2.15)
Northern redbelly dace	state threatened	9	0.19 (0.67)

Table 3. Linear regression models for the relation between relative abundance of three rare fish species and habitat in tributary streams of the Minnesota River in South Dakota.

REGRESSION EQUATION	N	R^2	P
Hornyhead chub			
-56.0 + 11.5 (mean stream width)	22	0.45	0.0006
Blackside darter			
9.8 - 0.41 (water temperature)	20	0.43	0.0016
Rosyface shiner			
2.14 - 0.05 (percent riffle)	21	0.15	0.0790

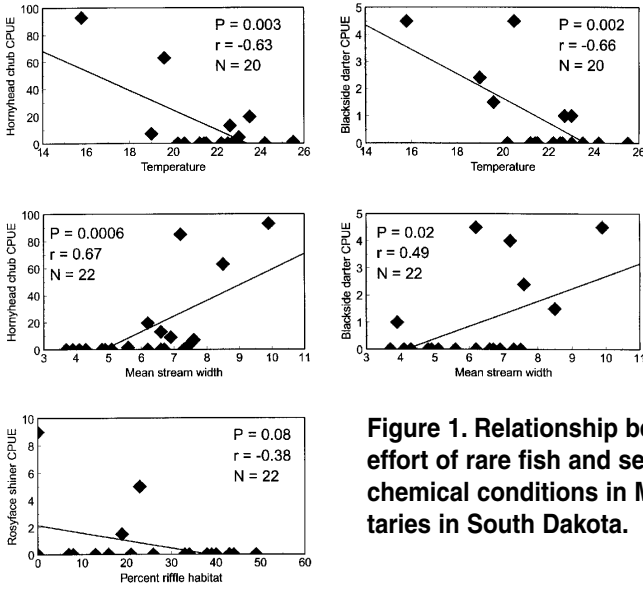

Figure 1. Relationship between catch per unit effort of rare fish and selected physical and chemical conditions in Minnesota River tributaries in South Dakota.

Blackside darters were collected at 7 of 22 reaches (Table 2) in five streams; North Fork Whetstone River, North and South Forks Yellowbank River, Lost Creek, and Cobb Creek. Relative abundance of blackside darter was negatively correlated with water temperature and positively correlated with mean stream width (Figure 1). Water temperature was retained in lieu of mean stream width because it was more highly correlated with relative abundance. The result was a significant negative relationship between water temperature and blackside darter relative abundance (Table 3). Mean water temperature was 20.3ºC (SD=2.6) at sites with blackside darters and 22.9ºC (SD=1.7) at sites without them. Reaches at the top and middle of the Coteau had ground water inputs and blackside darters.

Rosyface shiners were collected in three streams; North Fork Whetstone River, North and South Fork Yellowbank River (Table 2). Both correlation and regression analyses indicated a negative relationship between rosyface shiner relative abundance and percent riffle habitat (Figure 1; Table 3). A negative relationship with percent riffle habitat may indicate an association with pools and runs, which are habitat types important for this species elsewhere (Becker 1983, Etnier and Starnes 1993, Cross and Collins 1995). Our average percent riffle habitat was 26% in a 100-m stream reach (Table 1), and all reaches where this species was collected had less than 25% riffle habitat. Long stretches of pools and runs appear important to this species in South Dakota also.

Most reaches with rare species were located at the base of the Coteau, which agrees with our finding of a relationship between hornyhead chub relative abundance and mean stream width, and the negative relationship between rosyface shiner abundance and length of riffles. Stream reaches at the base of the Coteau have more water permanency than those on top (e.g. Lost, Crow, and Crow-Timber creeks) that are sometimes intermittent (McCoy and Hales 1974). Hornyhead chubs and rosyface shiners are associated with permanent flows (Cross and Collins 1995, Pflieger 1997), which might explain their absence from these creeks. Intermittency in the summer can stress aquatic biota through increased water temperatures and reduced dissolved oxygen levels (Matthews 1998). Hornyhead chubs and rosyface shiners are intolerant of hypoxia and hyperthermia (Smale and Rabeni 1995).

The habitat of the Prairie Coteau escarpment is unique (Milewski and Willis 1989, Dieterman and Berry 1994, Higgins et al. 1997). The permanent, cool-water flows in medium-sized streams are not usually found in other prairie streams today, but may have been more common in the past (Rabeni 1996). Focusing management (e.g., Isenhart et al. 1995) on these factors may help conserve fish communities of streams flowing off the Coteau.

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