Distribution and habitat use of sturgeon chubs (Macrhybopsis gelida) and sicklefin chubs (M. meeki) in the Missouri and Yellowstone Rivers, North Dakota

Scott R. Everett[1,2,*], Dennis L. Scarnecchia[1] & L. Fred Ryckman[3]
[1]Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83844-1136, USA
[2]Present Address: Department of Fisheries Resource Management, Nez Perce Tribe, P.O. Box 365, Lapwai, ID 83540, USA
[3]North Dakota Game and Fish Department, 13932 West Front Street, Williston, ND 58801, USA
(*Author for correspondence: E-mail: scotte@nezperce.org)

Received 3 September 2002; in revised form 12 January 2004; accepted 27 April 2004

Key words: Macrhybopsis, sturgeon chub, sicklefin chub, Missouri River, Yellowstone River, benthic trawl

Abstract

Sampling was conducted on the Missouri and Yellowstone rivers, North Dakota to obtain information on the distribution, abundance and habitat use of the sturgeon chub (

with a near natural hydrograph. Both segments are characterized by high main channel turbidity, no major shoreline development, and few revetment banks (rip-rap). The third segment (hereafter called the Bismarck segment; 53 km long) is in a portion of the Missouri River downstream of Lake Sakakawea (i.e., below Garrison Dam) and upstream of Lake Oahe. This segment extends into the northern Bismarck/Mandan urban area and is characterized by lower main channel turbidity, numerous revetments, and a much higher degree of shoreline development and bank stabilization (i.e., 25–40%) than the other two segments. In all, the three segments total approximately 139 river kilometers.

Distribution and abundance

The three river segments were stratified according to six macrohabitat types: main channel, border channel, side channel, sandbar, revetment and backwater. Starting from an initial random sampling unit, sampling sites were selected systematically along each macrohabitat type. Three samples were taken from within each site. This sampling design resulted in each macrohabitat type in each segment being sampled in proportion to its abundance in that segment (Table 1).

Sampling for chubs occurred from 10 July to 30 August, 1995 using two gear types, a benthic trawl and bag seines. The trawl has proven e ective in recent studies for capturing benthic minnows and chubs (Grisak, 1996; Herzog, 1997). It consisted of a 3 m cross bar and two triangular 0.5 m high steel sleds. These supported two nets, an inner sampling net (mesh size 0.6 cm) and an outer protective net (mesh size 3 cm). The trawl collected fish by scraping the substrate of main channel, border channel, deep (>4 m) side channel, and revetment habitats. Trawl tows occurred on pre-marked 100 m transects parallel to the channel and near the thalwag. The trawl was suspended from the bow of a boat, and trawling proceeded downstream. The trawl sampled an area approximately 300 m^2.

Historically, seines were more commonly used to sample benthic fishes in the Missouri River Basin, but more recently have been shown to be e ective at capturing both sturgeon chubs and sicklefin chubs (Werdon, 1993a, b; Hesse, 1994). The bag seines used for this study were 10 m long with a mesh size of 0.6 cm. Sandbars, backwaters, and shallow side channels were sampled using bag seines. Seine hauls were 30 m long (area 300 m^2) and proceeded downstream.

Catch per unit e ort (CPUE) of both chub species was calculated by segment. One trawl tow or one seine haul defined one unit of sampling e ort. All sturgeon chubs and sicklefin chubs were measured to the nearest mm for total length (TL), Water clarity was measured at each trawl and seine site using a 30 cm Secchi disk. The disk was lowered until it disappeared, and the length from the surface to the disk was measured. Then the disk was lowered well below this depth and slowly raised until it reappeared, and the length was measured again. The reported Secchi depth is the mean of these two measurements (Orth, 1989).

Substrate was sampled using an Ekman dredge at sites where trawling was conducted. At seining sites, the substrate was observed directly or a scoop was brought to the surface for identification. Samples were taken at the beginning and at the end of each sampling site. Sampling sites were classified based on the dominant substrate observed. Using the Wentworth Scale (Allen, 1995), inorganic substrate was categorized into three groups: mud/silt (particle size: ≤0.06 mm), sand (particle size: 0.06 mm ≤ 2 mm) and gravel (particle size: 2 mm ≤ 16 mm). Organic substrate (particle size: 1 mm ≤ 20 mm) was categorized as course organic matter (COM).

Because of the wide variation of discharge observed during the study, the e ect of discharge on CPUE for both the trawl and seines was examined. Daily discharge data from the U.S. Geological Survey's Sidney, Montana gauging station were used for the Yellowstone segment, and from the Bismarck, North Dakota gauging station for the Bismarck segment. Daily discharge for the Williston segment was calculated by adding the previous day's discharge at both the Sidney gauging station and the Culbertson, Montana gauging station (Bramblett, 1996). Spearman's rank correlation coe cient (r_s) was used to test the significance of the relationship between daily discharge and CPUE for each segment and gear type.

Multiple logistic regression models were developed for each species to test the null hypothesis that there was no di erence in habitat characteristics at sites where chubs were collected and not collected. Chub CPUE resulted in low numbers per sampling site and actual counts were converted to a simple measure of presence or absence. Logistic regression was selected because predictor variables need not be normally distributed and can be either continuous or categorical. The models had chub presence (1) or absence (0) as the dependent variable and depth, velocity, conductivity, temperature, water clarity, substrate and river macrohabitat as independent variables. First, a multiple logistic regression model was fitted with all variables. Categorical variables (substrate and macrohabitat) with α-values less than 0.05 were forced into the model (Johnson, 1998). Secondly, variable selection continued using a backward elimination procedure. The outcome was one best-fit model from available data for each species.

In order to estimate the relative contribution each macrohabitat variable made toward the presence of each chub species, the odds ratio between each macrohabitat variable was examined (Johnson, 1998). Each macrohabitat variable's estimated odds of being associated with the chubs' presence was calculated. The ratio of these probabilities is the odds ratio.

Model reliability was examined by calculating two indices. First, the χ^2 test for covariates was calculated to test whether the variables were statistically significant predictors of fish presence ($\alpha < 0.05$ for significance). Secondly, a summary classification matrix was created to identify the model's ability to accurately classify habitats as either containing or not containing chubs.

Species-specific habitat use

ANOVA procedures were used to test the null hypothesis that there was no di erence in habitat occupied by sturgeon chubs and sicklefin chubs during the summer. The chub catch variable was presence (1), or absence (0). If the F-test for treatments was significant, then pairwise comparisons were made using Tukey's pairwise test. Differences in substrate composition between successful and unsuccessful chub sampling sites were evaluated using a χ^2 test (Ott, 1993).

Age-specific habitat use

All fish scales were analyzed in the laboratory at the University of Idaho. Scales were cleaned, placed in a microscope slidewell filled with glycerin and aged with the aid of Biosonic's Optical Pattern Recognition System (OPRS). ANOVA procedures were used to test the null hypothesis that there was no di erence in habitat characteristics among areas occupied by di erent age-classes of sturgeon chubs and sicklefin chubs during the summer. If the F-test for treatments was significant, then

Table 2. Habitat characteristics of sites sampled for sturgeon chubs and sicklefin chubs

	Williston (n = 117)	Yellowstone (n = 63)	Bismarck (n = 66)
Mean depth (m)	4.8[a] (3.0 SD)	4.1[a] (2.5 SD)	8.7[b] (2.2 SD)
Range	0.3–13.7	0.3–12.4	3.9–15.2
Mean bottom velocity (m/s)	0.7[a] (0.3 SD)	0.5[a] (0.3 SD)	1.5[b] (0.3 SD)
Range	0.1–1.4	0.1–1.2	1.0–1.9
Mean Secchi depth (cm)	21.0[a] (3.2 SD)	20.0[a] (3.7 SD)	104.0[b] (9.8 SD)
Range	17.0–30.0	15.0–32.0	57.0–175.0
Mean conductivity (μmhos)	597[a] (45.2 SD)	594[a] (55.8 SD)	637[a] (51.2 SD)
Range	535–735	521–701	576–779
Mean temperature (°C)	22.7[a] (1.3 SD)	21.6[a] (1.4 SD)	19.4[a] (1.6 SD)
Range	16.7–24.4	18.0–23.5	15.4–22.6
Substrate composition (%)			
Sand	42.7	42.9	9.1
COM	23.9	25.4	48.5
Woody debris	14.5	12.7	30.3
Mud/silt	11.1	11.1	7.6
Gravel	7.7	7.9	4.5

channels (17.1%), and side channels (5.7%). No sicklefin chubs were found in backwater or revetment habitats. In the Yellowstone segment most of the 29 sicklefin chubs were collected from main channels (62.1%), followed by border channels (27.6%), sandbars (6.9%), and side channels (3.4%). No sicklefin chubs were found in backwater or revetment habitats.

One model for each species was developed to relate chub presence and habitat characteristics (Table 3). No model was developed for the Bismarck segment because of the lack of catch. Because there were few di erences in habitat characteristics at sampling sites between the Williston and Yellowstone segments, the models were developed by combining data from these two segments. Three variables, velocity, depth and turbidity were significantly ($p < 0.05$) related to sturgeon chub presence. For the sicklefin chub, four variables, velocity, depth, turbidity and substrate were significantly ($p < 0.05$) related to chub presence. Therefore, we rejected the null hypothesis that there was no di erence in habitat characteristics where sturgeon and sicklefin chubs were captured and not captured.

Variables that entered both models were good predictors of chub presence (χ^2 test of covariates; $p < 0.05$). The sturgeon chub model accurately predicted sturgeon chub presence at 72.2%. The model indicated that sturgeon chub presence increased significantly as depth decreased, velocity increased and water clarity decreased.

The sicklefin chub model accurately predicted presence at 85.5%. The model indicated that sicklefin chub presence increased as depth increased, velocity decreased, water clarity decreased and sand became the dominant substrate.

Species-specific habitat use

Significant di erences were found between the

Discussion

Significant di erences in habitat use between sturgeon chubs and sicklefin chubs are consistent with

Montana in the 1990s and found them to exhibit a more widespread distribution and higher catch rates than found elsewhere in its range. Similarly, Grisak (1996) reported high relative abundance of sicklefin chubs from trawl catches in Montana, as well as high catch rates of di erent aged fish, indicating a healthy population. These two species were captured in greater numbers in the two uppermost segments of our study area than any other cyprinids except the flathead chub (Platygobio gracilis) and common carp (Cyprinus carpio).

The sturgeon and sicklefin chubs' widespread distribution, high relative abundance, and diversity of ages in the Williston and Yellowstone segments indicate that their status in these segments is better than at most locations throughout their range. Therefore, maintaining a near natural hydrograph, a natural thermal regime, natural habitat diversity, and natural levels of turbidity should be considered vital to the survival of these two native Missouri River chubs.

Acknowe(3ndf1D2to)-7Wdankgme256gme256(r)-770us)d,gme23Rgme296arkey)-6gme256mo-252pplat21aWke27D(range)-94natu

Power, G. J., J. C. Henderickson, J. D. Lee & F. Ryckman, 1994. Missouri River system fishery reference and operational management document. North Dakota Game and Fish Department Division Report 10, Bismarck: 72 pp.

Reigh, R. C. & D. S. Elsen, 1979. Status of the sturgeon chub (Hybopsis gelida) and sicklefin chub (Hybopsis meeki) in North Dakota. Prairie Naturalist 11: 49–52.

Ricker, W. E., 1979. Growth rates and models. In Hoar, W. S., D. J. Randall & J. R. Brett (eds), Fish Physiology. Academic Press, New York: 677–743.

Stewart, D. D., 1981. The biology of the sturgeon chub (Hybopsis gelida Girard) in Wyoming. Master of Science Thesis, University of Wyoming, Laramie: 54 pp.

U.S.G.S. (United States Geological Survey), 1998. http://wargesua64i(Tg7(so-1uv-342.8(gelida)]TJ/F31T)-34/F3tm-539lG.S.)-3363.om4e345isystem