USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: DISTRIBUTION, HABITAT, AND LIFE HISTORY OF BRASSY MINNOW (*HYBOGNATHUS HANKINSONI*) IN EASTERN COLORADO STREAMS

Focus categories: COV, ECL, HYDROL

Keywords: Plains fish ecology, Ecohydrology, Conservation

Duration: 3/00 - 2/01

Funds Requested:

Federal Funds:	$17,852 Direct		
Nonfederal Funds:	$20,108 Direct	$15,596 Indirect	$35,704 TOTAL

Principal Investigator: Kurt D. Fausch, Dept. of Fishery and Wildlife Biology, Colorado State University

Congressional District: Fourth

Statement of critical regional or state water problems

Results of a recent survey of fishes of the South Platte River basin in Colorado, and comparison of with earlier surveys, showed that 10 native fish species were rare or imperiled (Nesler et al. 1997). In May 1998, the Colorado Wildlife Commission added six of them to the State of Colorado list of threatened and endangered species (brassy minnow and common shiner are threatened; northern redbelly dace, plains minnow, suckermouth minnow, and lake chub are endangered). Of these, the plains minnow, brassy minnow, and suckermouth minnow inhabit fluctuating streams of the Front Range and eastern plains, whereas the rest historically inhabited spring ponds along the Front Range, or cooler foothills streams with more stable flow.

A recent review reported that almost nothing is known about the habitat and life history of most eastern Colorado plains fishes (Fausch and Bestgen 1997). Water users and biologists alike are interested in understanding the ecology of these fishes to help direct their efforts in restoring fish to critical habitats, and restoring habitat and flow conditions that will allow these fish to thrive and prevent further endangerment and possible federal listing. Colorado Division of Wildlife Biologists responsible for managing South Platte basin fishes recently selected brassy minnow as the highest priority for study, and will provide $25,000 matching funding for the first year of this work. Similar matches are expected in subsequent years if the work is successful.

Expected Results and Benefits:

Field sampling will provide updated information on the current status of brassy minnow in Colorado, and some of the first data on their habitat and life history. Understanding their historical distribution will require analyzing museum collections to separate them from plains minnow with which they are often confused. A field study in reaches that contrast in hydrology (more vs. less flow fluctuation), location (foothills vs. plains), and channel morphology (natural stream channels vs. irrigation canals) will be used to relate habitat use of brassy minnow through time to flows, the dynamics of available habitat, and water quality.

Because reproduction is the key to population persistence for fishes living in fluctuating plains streams, the field research will also focus on reproductive ecology (timing and habitat for spawning and rearing) as well as the basic life history characteristics of age and growth. Combining data on habitat use and life history will allow us to define what habitats brassy minnow use at what life stage, when and where they spawn, how long they live and how fast they grow, and what features of habitats and flow regimes favor their reproduction, survival, and growth. This information is expected to lead to recommendations about habitats and flow regimes that should be protected or restored, to allow historic and transplanted populations of these species to thrive.

Scope and Objectives

Water has been diverted from the South Platte River and its tributaries for human uses since before 1850 (Eschner et al. 1983), changing flow regimes and affecting aquatic biota. Unfortunately, so few fish collections were made in the basin before about 1960, and almost none in the plains region, that little is known of the native distribution of most fishes (Fausch and Bestgen 1997). However, recent trends suggest some species are declining. Comparison of records from a comprehensive survey of fishes in the South Platte basin by Propst (1982) with those collected in 1992-94 by the Colorado Division of Wildlife (Nesler et al. 1997) indicated that 10 species were rare or imperiled. Of these, six were subsequently designated by the Colorado Wildlife Commission as threatened (brassy minnow, common shiner) or endangered (northern redbelly dace, plains minnow, suckermouth minnow, and lake chub) in the state of Colorado. Suckermouth minnow, brassy minnow, and plains minnow live primarily in the mainstem South Platte River and major tributary streams of the foothills and plains (e.g., Cache la Poudre River, St. Vrain Creek), and in plains tributaries (e.g., Pawnee Creek), whereas the other three fishes are restricted to cool streams or spring ponds in the foothills (e.g, West Plum Creek).

Colorado Division of Wildlife (CDOW) biologists responsible for managing South Platte River fishes recommended conducting in-depth studies of habitat and life history for all six threatened and endangered species (Nesler et al. 1997) to foster future efforts to restore habitat and start new populations via translocations. Of highest priority is research on the ecology of brassy minnow (*Hybognathus hankinsoni*) to understand reasons for its recent decline and develop strategies for its conservation. Toward that end, CDOW biologists have pledged $25,000 of matching funds for the first year of research proposed

here (Tom Nesler, Nongame and Endangered Wildlife Program Manager, personal communication). Linked to that is interest in plains minnow (*H. placitus*), a species in the same genus that overlaps brassy minnow distribution in downstream reaches of the mainstem South Platte River, and is so similar in appearance that the two are often misidentified in the field. Thus, an initial task of the research is to correctly identify the two in past collections housed in museums, to further clarify their historic distributions.

Objectives of this research are:

- Define the original distribution and current status of brassy minnow in the South Platte River basin in Colorado, based on historical data and specimens and resampling of all sites where previously collected
- Assess effects of flow fluctuations and habitat modifications on brassy minnow populations by measuring dynamics of stream habitat, and its use by brassy minnow, in study reaches that contrast in flow regime (strong vs. moderate flow fluctuations), longitudinal position (foothills vs. plains streams), and channel form (natural stream channels vs. irrigation canals).
- Relate basic life history characteristics of brassy minnow (reproduction, age, growth) to flow and habitat, to understand critical habitats needed for survival and reproduction, and to inform conservation management.

Background and Related Research

Almost nothing is known of the ecology of either brassy or plains minnow. Both are widespread species, the brassy minnow ranging across the northern Mississippi basin east to New York state and north to British Columbia, and the plains minnow ranging throughout the Missouri River basin and southwestern Great Plains (Lee et al. 1980). Despite this, there is only rudimentary information on their ecology. For example, a search of the Cambridge Scientific Abstracts computer database on Aquatic Sciences and Fisheries revealed only three refereed scientific papers on distribution or ecology of brassy minnow, six on plains minnow, and one on both species, none of which included data for the South Platte basin. Most information on their distribution in Colorado is from dissertations and theses (Li 1968; Propst 1982; Propst and Carlson 1986) and a recent survey (Nesler et al. 1997).

Basic information in books on fishes of various states (e.g., Fishes of Wisconsin; Becker 1983) reveals that both brassy and plains minnow eat primarily microscopic algae growing on the stream bed (often described as detritus and ooze), as indicated by their long coiled gut needed to digest this material. Plains minnow are most common in mainstem rivers over shifting sand substrates, but have no strong habitat associations with other species (Matthews and Hill 1980). Like many plains river fishes, and most other *Hybognathus*, they are known to spawn buoyant eggs on rising floods which drift downstream and develop and hatch within a few days (Taylor and Miller 1990, Platania and Altenbach 1998; see Fausch and Bestgen 1997 for review). The resulting juvenile fish apparently move back upstream throughout their life and colonize the original reaches. As a result, populations of plains minnow are reported to have been extirpated

from reaches fragmented by dams and diversions (Winston et al. 1991). Plains minnow were reported from one site in the lower South Platte River mainstem by Propst (1982) and were recently collected there by US Geological Survey personnel (K. Bestgen, CSU Larval Fish Laboratory, personal communication and specimen verification).

In contrast, brassy minnow occupy both smaller tributaries and mainstem river habitats (Baxter and Simon 1970; Becker 1983; Cross and Collins 1995), and in Colorado inhabit both foothills tributaries like St. Vrain Creek and lower mainstem South Platte River habitats (Propst 1982; Nesler et al. 1997; Fig. 1). In addition, a reproducing population was reported from the Larimer-Weld Canal east of Ft. Collins near Severence (Platania 1990). Brassy minnow tend to school in relatively slow flow over various substrates, but are apparently able to spawn and maintain a population in fluctuating flows or irrigation canals, or else recolonize from off-channel habitats. They likely tolerate a wide range of temperatures (to ca. 85 F; Becker 1983), but effects of degraded water quality are unknown.

Methods

Historical Distribution and Current Status

Distribution of brassy minnow has most recently been assessed by CDOW sampling throughout the South Platte basin during 1992-94 (Nesler et al. 1997). All sites where brassy minnow were reported by Nesler et al. (1997), Platania (1990), Propst (1982), Bestgen and Fausch (1993a, 1993b), and all earlier investigators (e.g., Cope and Yarrow 1875, Jordan 1981, Juday 1904, 1905, Ellis 1914, Hendricks 1950; Li 1968), will be resampled to determine current distribution. This will be needed because brassy minnow is similar in morphology and easily confused with other plains minnows (e.g., fathead minnow, sand shiner), especially the plains minnow. It also undergoes wide fluctuations in abundance (R. J. Behnke and S. A. Flickinger, personal communication) and so may be missed at some sites in any given survey. When found, additional sites will be sampled upstream and downstream and in adjacent habitats to measure their local distribution. In addition to natural stream channels, adjacent irrigation canals and ditches will be sampled, focusing on those fed from stream reaches where brassy minnows have been recorded.

Fish will be sampled by standard methods of seining for timed periods within defined habitat types (pool, riffle, run, backwater; see appendix in Lohr and Fausch 1997), and by using electrofishing in pools too deep to seine. Seining is highly efficient for brassy and plains minnows, which live in low velocity runs, backwaters, and at the margins of pools. All fishes captured will be identified, and all brassy minnows measured. All other species will be counted and weighed en masse by species, but will be subsampled when large numbers are captured to be efficient of time (>1000 individuals per site is not uncommon in plains streams). Most fishes will be returned to the water alive. A sample of fishes of each species from each site will be preserved to provide a permanent record of the collection, and after analysis (see below) will be curated in a regional museum. Habitat

information equivalent to the Colorado Division of Wildlife Level 2 Stream Habitat Survey will be recorded at each site.

Plains and brassy minnows may have been confused by previous investigators (cf. Fausch and Bestgen 1997; Nesler et al. 1997), so understanding the historical distribution will require examining collections in regional and national museums. Dr. Kevin Bestgen of the CSU Larval Fish Laboratory is an expert on taxonomy and ecology of *Hybognathus*, having worked with colleagues to sort out the taxonomy of the now endangered Rio Grande silvery minnow (*H. amarus*) in New Mexico (Cook et al. 1992; Bestgen and Propst 1996) and describe its ecology (Bestgen and Platania 1990, 1991). This work required Bestgen to compare this species with both brassy and plains minnow, as well as the other species in the genus, so he developed the special expertise needed to identify fishes of this problematic group. All extant specimens of brassy and plains minnow collected from Colorado (including the Arkansas and Republican basins) will be requested from museums and examined to verify their identification, including those curated in museums in New Mexico, Kansas, Nebraska, Oklahoma, and at the American Museum of Natural History in New York. Because museums are reluctant to mail valuable old specimens, travel may be required to examine or retrieve some of them. This work will establish the original range of the two *Hybognathus* species in Colorado.

Habitat Use in Reaches with Contrasting Flow Regimes

Sampling to define the current distribution will also provide data on potential study reaches for measuring brassy minnow habitat use in relation to flow, although the study design must remain flexible until more is known. Reaches will be selected that contrast in flow regime and habitat, to assess how brassy minnow populations persist in regulated reaches. A tentative plan is to select up to four study reaches; in the downstream portion of the mainstem South Platte River, a plains tributary like Pawnee or Lone Tree creeks, a foothills tributary like St. Vrain Creek, and an irrigation canal like the Larimer-Weld canal where brassy minnow has previously been collected (Platania 1990).

Past work on another plains fish in the Arkansas River basin, the Arkansas darter (Labbe 1997; Labbe and Fausch in review), showed the value of sampling habitat and fish through time simultaneously at both a fine spatial scale (individual pools) and larger scales (reaches or segments 1-10 km long) to understand their life history and ecology. Plains streams and regulated reaches are dynamic through time, drying and rewatering as natural flow regimes and diversions change. Fish may be concentrated in refuge pools or off-channel habitats at low water, recolonize and spawn in intervening reaches when they rewater, and the young migrate to other refuge areas before the next drought. Fish may be extirpated by summer drying, winter freezing of entire pools, or total loss of oxygen beneath ice cover during winter. In contrast, in regulated reaches newly hatched fry, often <10 mm long, may be flushed by strong flow fluctuations during the summer irrigation season (Strange et al. in press; Fig. 2). Thus, an accurate picture of brassy minnow ecology requires sampling habitat use, fish size and age distributions, and water chemistry at the pool scale, as well as recording the persistence of pools and connections among them at larger reach to segment scales. We have experience with these kinds of

sampling from our previous work with Arkansas darter (Labbe and Fausch in review) and will adapt those methods to this project.

An initial sampling plan is to select reaches with sufficient flow gauges on the stream channel and irrigation diversions to allow reconstructing flows throughout the reach. Thermographs will also be installed in each reach to measure water temperature. Gross habitat features of each pool in a segment (area, depth, substrate, vegetation, shade, basic water chemistry and temperature) will be measured, as well as recording presence of flow that connects them to adjacent pools, at approximately 2-month intervals throughout the study. Fish will be sampled by seining and dipnetting, or electrofishing, as described above. These data allow understanding, for example, when pools dry and extirpate fish, when they are again wet, and when fish recolonize and spawn in them. In turn, this allows understanding where the source areas for fish reproduction occur throughout the stream, and how refuges where fish survive during harsh periods interact with each other and with ephemeral habitats. For example, Labbe (1997; Labbe and Fausch in review) found that deep refuge pools sustained by groundwater in upper Big Sandy Creek were important for Arkansas darter survival through summer drought and winter freezing. However, adjacent pools that froze solid during winter nevertheless warmed earlier in the spring and were important nursery areas for juveniles, which hatched earlier and grew faster there than in refuge pools.

Life History to Understand Critical Habitat

Basic life history characteristics of brassy minnow -- age, growth, and reproduction -- will be measured and coupled with habitat use and dynamics to further understand critical habitat needs. All brassy minnows captured from the reaches above will be measured. During each season at each site, samples of fish of all lengths will be sacrificed and preserved to relate life history to flow and habitat. The ages of fish in these samples will be measured from otoliths (tiny bones in the inner ear) which record *daily* growth increments, as well as indicating how many years fish have lived. Thus, young-of-year fish captured can be aged to the day, allowing us to correlate their hatching date with previous flow and habitat events (Bestgen 1997).

Fish of older age classes (ages 1-3 are expected) will be sexed and their gonads weighed to measure reproductive condition, using the gonadosomatic index (GSI; Crim and Glebe 1990), which will allow defining the reproductive period. Like many plains fishes, brassy minnow are expected to have a prolonged spawning period from late spring to early fall, whenever water temperature conditions are suitable to develop gonads. Diet will not be studied, because all *Hybognathus* feed primarily on microscopic algae (Hlohowskyj et al. 1989). Combining information on habitat use and life history will allow us to define what habitats brassy minnow use at what life stage, when and where they spawn, how long they live and how fast they grow, and what features of habitats and flow regimes favor their reproduction, survival, and growth. In turn, this information is expected to lead to recommendations about habitats and flow regimes that should be protected or restored, to allow historic and transplanted populations of these species to thrive.

Training Potential

This project will train one Masters student in Fishery Biology, who will have primary responsibility for conducting all field sampling, with mentoring from the PI (Fausch) and other fish biologists and ichthyologists in our department (Dr. Kevin Bestgen, Mr. Darrel Snyder, Larval Fish Laboratory). In addition, the project will employ undergraduate students in Fishery and Wildlife Biology as summer technicians (1 person each summer) and as work study technicians (2 persons each year). We find this interaction invaluable for undergraduate students to gain work experience (a requirement for their Fishery Biology major) and develop career goals. In my laboratory, we have been successful at employing 3-4 women and men undergraduates each summer since 1984.

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