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FISH COMMUNITIES AND MACROHABITATS IN A NORTH AMERICAN PRAIRIE STREAM

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Abstract

To predict and mitigate the impacts of land uses on prairie stream fish communities in Montana it is necessary to learn more about the distribution and habitat requirements of stream fishes in the region. In order to identify and quantify the influences of macrohabitat factors on density and longitudinal distribution of prairie stream fish communities I determined fish population densities and quantified macrohabitat variables at 15 sites in Burns Creek, southeastern Montana, from 1997 to 2000. More instream cover, vegetative overhang, and lower channel width/depth ratio were associated with denser and more diverse fish communities in pool habitats, while larger streambed particle size (cobbles) was associated with denser fish communities in riffle/run habitats. In addition, contingent phenomena, including extreme storm flow events and distribution of beaver dams in time and space may often have greater influence on fish communities in Burns Creek than relatively fixed macrohabitat factors.

Introduction

Little research has inquired into distribution, habitat requirements, and ecological relationships of fishes in small prairie streams in eastern Montana. Clancey (1978) studied longitudinal distribution of fishes and aquatic habitats in Sarpy Creek, southeastern Montana, to provide baseline information for the assessment of potential impacts of coal mining in the watershed. Barfoot (1993, 1999) studied longitudinal distribution of fishes and aquatic habitats in Little Beaver Creek, southeastern Montana, to test the hypothesis that longitudinal zonation of fish communities in streams is related primarily to stream geomorphology variables. Several wider ranging surveys in eastern Montana sought to develop baseline data on prairie stream fish communities in order to assess potential impacts of energy development, particularly strip mining of coal and on-site power generation, on those communities (Elser et al. 1978, Elser et al. 1980, Morris et al. 1981).

In order to predict and mitigate the impacts of current and future land uses, including livestock grazing, irrigated agriculture, and energy development, on prairie stream fish communities in eastern Montana, it is necessary to learn more about the distribution and habitat requirements of stream fishes in the region. Moreover, from the perspective of basic ecological research, it would be interesting to further explore the ecological relationships among fishes and macrohabitat variables in small prairie streams.

In order to identify major macrohabitat factors that influence density and longitudinal distribution of prairie stream fish communities and to quantify those influences I conducted a study of fish communities and macrohabitat variables in Burns Creek, southeastern Montana, during the summers of 1997 to 2000 in cooperation with the Montana Department of Fish, Wildlife, and Parks (Barnes 1997, 1999, Barnes and Westlind 2000, Barnes and Silbernagel 2001).

Study Area

The Burns Creek watershed occupies the edge of the glaciated Missouri Plateau, Short Grass region, Great Plains Province and consists of rolling terrain that has been eroded into colorful badlands. The regional climate is semiarid continental, characterized by long, cold winters with intermittent snow and short, warm summers with isolated thunderstorms (WRCC 2002). Major land uses in the watershed include 41.3% crop and pasture, 32.7% mixed rangeland, 20.7% grass rangeland, 3.2% evergreen forest, and 2.1% other (NRIS 2002).

Burns Creek is a third-order tributary of the Yellowstone River, with a main stem length of 97.8 km and a drainage area of 600 km^2. Channel elevation ranges from 597.8 m to 883.9 m, with a mean channel gradient of 2.9 m/km (NRIS 2002). The lower 30-km section of Burns Creek exhibits perennial base flow that originates from a large groundwater seepage area. Mean monthly discharge ranges from 1.0 m^3/sec in early spring to 0.1 m^3/sec from late summer to late winter. However, annual, monthly, and daily discharges are highly variable in response to long-term variations in annual precipitation and to short-term local precipitation events. Daily flow ranges from 0.0 m^3/sec (drought) to 42.4 m^3/sec (flash floods from summer thunderstorms) (USGS 2002). However, isolated pools always persist during periods of zero flow, resulting in a relatively diverse fish community. All other lower-order tributaries are seasonal streams. About two kilometers upstream of the Yellowstone River, a regional main irrigation canal passes through a culvert under the Burns Creek channel, forming a 3.7-m barrier to upstream fish migration.

Methods

Fish population densities and macrohabitat variables were measured or estimated at 15 sites in the perennial section of Burns Creek. A site was defined as a unit of contiguous riffle, run, and pool habitats.

Fish population densities were determined at each site using seines and a DeLury (1947) type capture-removal approach as described by Ricker (1975). Sampling was further stratified by habitat type (riffle, run, and pool) within each site.

Macrohabitat variables were measured or visually estimated using a transect approach based on Simonson et al (1994) and McMahon et al. (1996) and described in detail by Barnes and Silbernagel (2001). Macrohabitat variables, defined according to Armantrout (1998), included water quality (temperature, dissolved oxygen, pH, conductivity, and total suspended solids), streamflow (velocity and discharge), channel morphology (lengths, widths, depths, and areas of riffles, runs, and pools), streambed composition (substrate material composition, sediment depth, and embeddedness), riparian conditions (adjacent land use, buffer width, bank erosion, bank height, bank angle, and canopy shading), and instream cover (vegetative overhang, bank undercut, woody and other debris, emergent vegetation, and submerged vegetation).

Results and Discussion

Burns Creek can be divided into four sections based on general habitat characteristics: (1) an intermittent upland section (upstream of the groundwater seepage area); (2) a perennial coldwater section (immediately downstream of the seepage area); (3) a perennial warmwater section upstream of the main irrigation canal; and (4) a perennial warmwater section downstream of the main irrigation canal. Fish communities varied significantly among these sections. We collected a total of 8,811 fish in 27 species from 1997 to 2000. Burns Creek supports one of the most diverse fish communities in eastern Montana.

Except for water temperature and instream cover, macrohabitat conditions were relatively uniform and stable in all sections of Burns Creek. Bank erosion and sedimentation were minimal and restricted to a few isolated locations where cattle had access to the channel. Due to natural erosion from the sparsely vegetated badlands in its watershed, Burns Creek carried a relatively high natural suspended sediment load. Instream cover, such as aquatic vegetation and woody debris, was extremely scarce in Burns Creek.

The intermittent upland section of the creek flowed only in direct response to precipitation or snowmelt. Fish species with high dispersal capabilities migrated upstream during high flow periods and occupied this section temporarily. These species included creek chub (*Semotilus atromaculatus*), longnose dace (*Rhinichthys cataractae*), and white sucker (*Catostomus commersoni*).

The perennial coldwater section exhibited relatively good cover in the form of submerged aquatic vegetation, woody debris, and low channel width/depth ratio, which should have attracted large and diverse fish communities. However, fish community diversity was generally low in this section. Summer water temperatures ranged from 10-19°C, which probably induced warmwater fish species to move downstream in the summer. This resulted in dense but low diversity communities of fathead minnow (*Pimephales promelas*) and brook stickleback (*Culaea inconstans*). Both species prefer vegetated coldwater habitats with few predators or competitors.

In the perennial warmwater section, pool habitats were dominated by western silvery minnow (*Hybognathus argyritis*), plains minnow (*Hybognathus placitus*), brassy minnow (*Hybognathus hankinsoni*), creek chub, and white sucker. The most important "fixed" macrohabitat factors affecting fish communities in these habitats were channel width/depth ratio, vegetative overhang, and instream cover. All other factors being equal, sites with lower width-depth ratios and greater vegetative overhang had lower view factors (providing more "virtual cover") and supported denser, more diverse fish communities. Although instream cover was scarce, when it was present it overrode all other factors in attracting dense fish populations. An old chassis in the channel at one site consistently attracted dense fish populations, although the site was used by cattle, had a high width/depth ratio, and lacked riparian vegetation.

Riffle and run habitats in the perennial warmwater section were dominated by longnose dace and stonecat (*Noturus flavus*). The most important factor affecting fish communities in riffles and runs was substrate composition. Cobbles (with greater interstitial hiding space) attracted more fish than gravel.

Riverine fish species from the Yellowstone River were unable to pass the barrier formed by the main irrigation canal. Downstream of the canal, goldeye (*Hiodon alosoides*), northern pike (*Esox lucius*), longnose sucker (*Catostomus catostomus*), and shorthead redhorse (*Moxostoma* *macrolepidotum*) may temporarily occupy Burns Creek, particularly during spawning and juvenile stages.

I believe that contingent events, such as major storm flows and the distribution of beaver (*Castor canadensis*) dams in time and space, may sometimes have a greater effect on prairie stream fish communities than relatively "fixed" macrohabitat factors. A major storm flow event occurred on Burns Creek in spring 1997 and destroyed most of the existing beaver dams. The number of beaver dams increased from 1997 to 2000 as beaver expanded usable habitat. In 1999 and 2000, beaver dams prevented fish from entering several sites with "high quality" habitat and trapped fish in several sites with "low quality" habitat. Extreme storm flows may flush fish downstream and temporarily reduce densities of many species.

Therefore, the use of indicator species and rapid habitat assessment techniques may be of limited value in evaluating prairie streams. The practice of removing beaver dams in order to improve fish habitat is also of doubtful utility. Beaver dams tend to conserve streamflow during periods of low precipitation, thereby preserving fish habitat and maintaining healthy riparian areas.

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