Alberta Conservation Association
2010/11 Project Summary Report

Project Name: *A Fish-based Index of Biological Integrity for Assessing Ecological Condition of the Beaver River*

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Partnerships

Alberta Environment
Alberta Sustainable Resource Development
Alberta Tourism, Parks and Recreation
Beaver River Watershed Alliance
Municipal District of Bonnyville

Key Findings

- Surveyed 19 sites in the Beaver River watershed (in addition to 28 sampled in 2009).
- In total (2009 – 2010), caught 5,601 fish of which 52% were white suckers.
- Used four fish metrics to construct the IBI: percentage of invertivorous cyprinids, number of benthic invertivores, percentage of lithophils and percentage of omnivores.
- IBI results showed that the Beaver River watershed is highly affected by land-use changes linked to agricultural and industrial development.

Introduction

The Beaver River Watershed Alliance is currently developing an Aquatic Health Ecosystem Monitoring Program (AHEM) for the Beaver River watershed which is an assessment of the health of the aquatic environment, including the fisheries resources. While the health of the full scope of the ecosystem is being considered in the AHEM program, fish health is the focus of our study as fish are considered good indicators of how well the aquatic ecosystem is functioning (Karr 1981). Most of the Beaver River watershed is within the boreal central and dry mixedwood subregions in the northeast region of the province, a region that is experiencing rapid industrial growth. Cumulative effects of human activities on aquatic health, including fisheries resources, is largely unknown. The purpose of this study is to develop an index of biological integrity (IBI) for assessing the health of the Beaver River using data collected on fish assemblages and a suite of physicochemical variables.

Methods

We collected data on fish community composition using boat electrofishing. Sampling occurred in the summers of 2009 and 2010. Length of study sites was based primarily on the 85 times the mean wetted-channel width procedure as per Hughes et al. (2002). For all fish species, we recorded number captured, measured lengths and examined fish for disease, deformities, eroded fins, lesions and tumors (DELTS). We recorded catch-per-unit-effort (CPUE) as the number of fish/100s of electrofishing. At each site, we measured dissolved oxygen, pH, temperature and conductivity with a multi-parameter instrument (YSI Professional Plus) and analysed grab water samples for nutrients, physical variables and algal biomass. As well, we collected standard habitat data (e.g., stream wetted-width, stream depth and riparian width) from all sites. Land use and other physical variables were derived using a geographic information system (GIS) (Table 1). Using these data and following methods used in other IBI (Bramblett et al. 2005; Stevens et al. 2010), we calculated fish metrics (Table 2) and chose those that were not redundant and related to human disturbance to construct an IBI.

Table 1. Land use and physical variables used in developing the Beaver River Index of Biological Integrity (IBI).

Variables
Percentage Cropland in Basin
Road Density in Basin (m/ha)
Percentage Urban in Basin
Human Density in Basin (pop/ha)
Cattle Density in Basin (cattle/ha)
Basin Size (ha)

Table 2. Candidate fish metrics used in the construction of the Beaver River Index of Biological Integrity (IBI), positive metrics are expected to decrease with disturbance, whereas negative metrics are expected to increase. Species codes: NRPK = northern pike, WALL = walleye, WHSC = white sucker, LKCH = lake chub, LNDC = longnose dace, SPSH = spottail shiner, LNSC = longnose sucker, LGPR = logperch, LKCH = lake chub, FTMN = fathead minnow, BRST = brook stickleback, NRDC = northern redbelly dace.

Candidate Metrics
Positive Scoring
Percentage of long-lived fish species (NRPK >600 mm, WALL >450 mm, WHSC >400 mm)
Percentage of invertivorous cyprinids (LKCH, LNDC, SPSH)
Percentage of individuals as top carnivores (WALL >450 mm, NRPK >600 mm)
Percentage of intolerant individuals (LNDC)
Number of benthic invertivores individuals (LNSC, LNDC, LGPR)
Number of native fish individuals
Percentage of litho-obligate reproductive guild (LNSC, WHSC, LKCH, LNDC, SPSH)

Total individuals in sample (Catch/100s)

Negative Scoring

Percentage of tolerant individuals (WHSC, FTMN)
Percentage of tolerant reproductive guild individuals (BRST, FTMN)
Percentage omnivores (WHSC, FTMN, NRDC)
Percentage of FTMN
Percentage of individuals with DELTs (deformities, disease, fin erosion, lesions or tumors)

Results

Of the 47 sites we surveyed, 33 sites were on the Beaver River, 12 on the Sand River and two on the Amisk River (Figure 1). We caught 5,610 fish representing 17 different species and 6 families. Of this total, 52% were white sucker (*Castostomus commersonii*), 31% lake chub (*Couesius auratus*), 9% longnose sucker (*Catostomus catostomus*), 3% fathead minnow (*Pimephales promelas*) and 1% walleye (*Sander vitreus*). Other species caught represented less than 1% of the total.

Of the 13 candidate metrics calculated, we used four to construct the IBI: percentage of invertivorous cyprinids, number of benthic invertivores, percentage of lithophils and percentage of omnivores. Resulting IBI values ranged from 0 (poor) to 40 (excellent) and presented on a colourometric scale. The Beaver River IBI is sensitive to the following variables: human disturbance on the river bank and road density. Disturbance of the river bank is mainly linked to cattle grazing which intensifies nutrient run-off, degrades riparian areas and disturbs river substrates resulting in a decrease in sensitive invertivorous cyprinid fish species. In the Beaver River watershed, road density is a surrogate of both agricultural and petroleum extraction activity and was linked to a decrease in sensitive benthic invertivores and an increase in more tolerant omnivore fish species. This result means that watershed health decreases as a result of development and land use change.

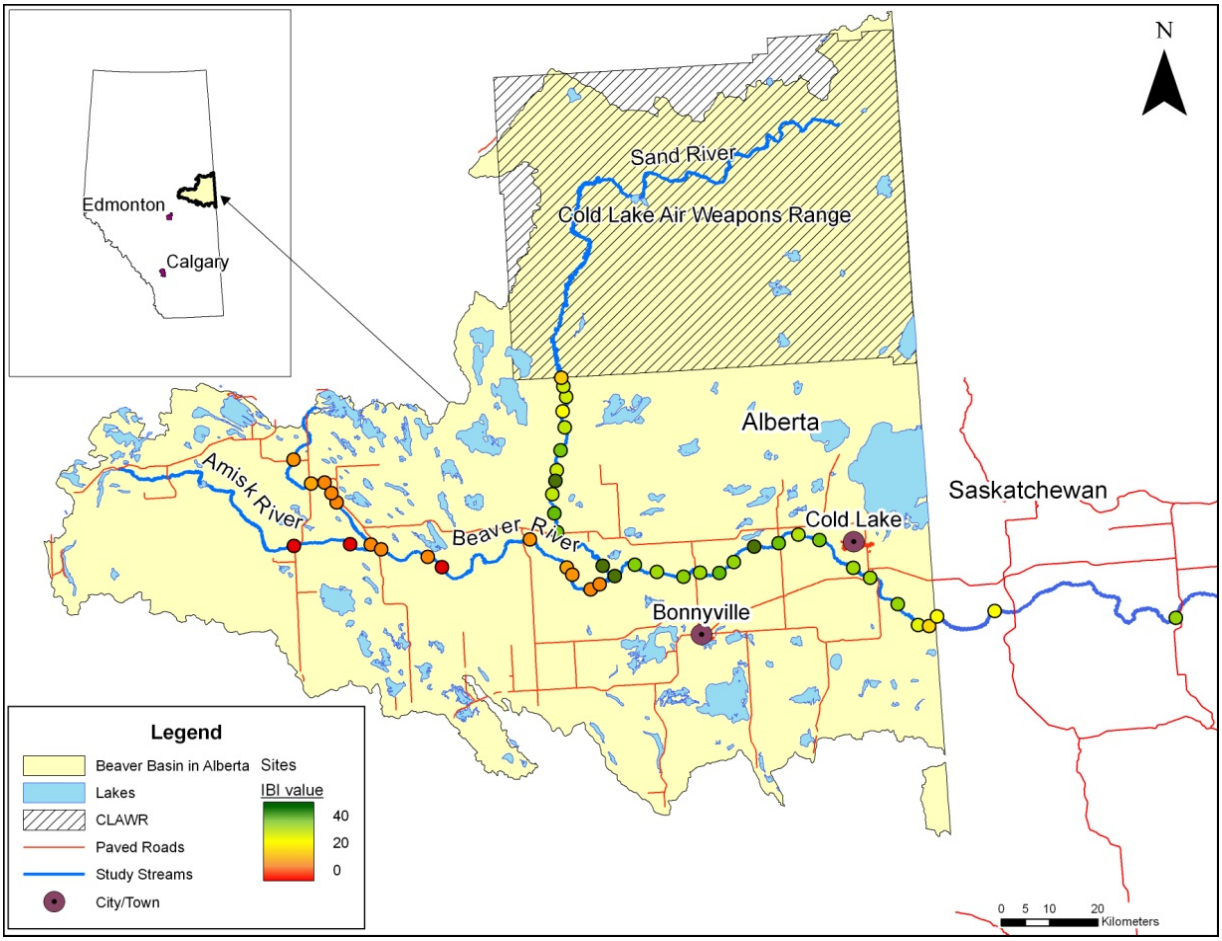

Figure 1. Location of fish sampling sites and Index of Biological Integrity (IBI) values (red = poor, yellow = intermediate, green = good) along the Beaver, Sand and Amisk rivers, 2009/10.

Conclusions

We used data collected at 47 sites in the Beaver River watershed to construct an IBI based on the fish community. The resulting IBI has been linked to agricultural and industrial disturbance. This study provides a better understanding of the influences of human disturbances on the health of the aquatic ecosystem and provides resource managers with a rapid assessment tool for characterizing aquatic ecosystem health.

Communications

- Presented project findings to the Beaver River Watershed Alliance.
- Distributed project report to partners.

Literature Cited

Bramblett, R.G., T.R. Johnson, A.V. Zale, and D.G. Heggem. 2005. Development and evaluation of a fish assemblage index of biotic integrity for northwestern Great Plains streams. Transactions of the American Fisheries Society 134: 624-640.

Hughes, R.M., P.R. Kaufmann, A.T. Herlihy, S.S. Intelmann, S.C. Corbett, M.C. Arbogast and R.C. Hijort. 2002. Electrofishing distance needed to estimate fish species richness in raftable Oregon rivers. North American Journal of Fisheries Management 22: 1229-1240.

Karr, J.R. 1981. Assessment of biotic integrity using fish communities. Fisheries 6: 21-27.

Stevens, C.E., T. Council, and M.G. Sullivan. 2010. Influences of human stressors on fish-based metrics for assessing river condition in central Alberta. Water Quality and Research Journal of Canada 45: 35-46.

Picture captions

Photo 1.
Aerial view of the Beaver River downstream of Highway 28. (Photo: Ariane Cantin)

Photo 2.
Alberta Conservation Association staff members boat electrofishing on the Beaver River. Left to right: Jason Leathem, Matthew Szumilak and Ariane Cantin. (Photo: Tyler Johns)

Photo 3.
Alberta Conservation Association staff member, Kevin Fitzsimmons, with a walleye caught by electrofishing along the Sand River. (Photo: Tyler Johns)