Aquatic Habitat and Fisheries Implications of the Removal of Big Rapids Dam
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Current Habitat

Presently, the Big Rapids Dam consists of a 4.4 foot sill located just upstream of the Pere Marquette Street. This sill impacts the upper part of the original rapids for which the City of Big Rapids was named. U.S. Geological Survey estimates that the sill directly impacts the stream gradient by 5 to 6 feet with a lost gradient being 9.8 feet/11,400 feet (USGS Personal Communication 1995). Additionally, USGS estimates that 6,900 feet of the river will be directly impacted by the removal of this sill.

The current habitat above the existing sill is entirely shallow run habitat with sand and gravel deposited by impoundment over cobble substrate. This type of habitat typically has a low diversity aquatic community because of the lack of habitat complexity stemming from relatively constant laminar flows over a smoothed sand substrate. Data collected by DNR personnel an August 1989 survey of 1000 feet of the river upstream of the impoundment near Paris Park, in a similar habitat type as that in the current impoundment, documented a fisheries community that consisted of 109 individuals from 14 species: white sucker, redhorse sucker, brook stickleback, green sunfish, blackside darter, rainbow darter, fathead minnows, burbot, common shiners, smallmouth bass, creek chub, johnny darter, logperch, central mudminnows and northern hogsuckers. Total biomass collected was under 20 kg and only 9 individuals were classified as gamefish. This was a single pass collection and assuming 50% catchability, the total number of fish in the reach was approximately 218 fish. The number of fish collected in this survey was low and these species are typically found in low gradient run habitat. It is expected that a similar fish community is currently found in the existing Big Rapids Impoundment.

Future Habitat

The removal of the Big Rapids Dam will re-establish the historic rapids which were the first large rapids on the Muskegon River as noted by early lumbermen. This will have a significant impact on the Muskegon River system both from physical and chemical habitat perspectives. First, it should be kept in mind that high gradient reaches are a very rare habitat type in large Michigan Rivers. The historic Big Rapids were 1.9 miles in length and had a gradient of 12.63 feet/mile according to the Fargo Engineering Survey conducting in August 1914 as reporting in Prein and Newhof (1996). Presently, the lower part of the rapids exists from the Big Rapids sill to the Maple Street Bridge, a total of 1.1 miles. The rest of the historic rapids are cut off from the river by the Big Rapids Dam. The removal of Big Rapids Dam will restore the upper end of the rapids with at minimum 0.4 miles of high gradient rapids (> 10 feet/mile) rehabilitated and an increase in gradient (rehabilitation of habitat > 3 feet/mile) over an additional 0.5 miles of the Muskegon River. This will provide rehabilitate this potentially important urban fishery in the City of Big Rapids.

The rehabilitation of this reach will restore a rare habitat type on the Muskegon River as there are no other reaches of the free-flowing Muskegon River with gradients over 10 feet per mile. The only other reaches with gradients in excess of 10 feet per mile are impounded under Croton and Rogers Dams. The next highest free flowing habitat is the reach at Pine Street below Croton Dam which has a gradient of 7.22 feet per mile. This reach is typified by a series of riffle and pool complexes and has a high species diversity and biomass in comparison to the lower gradient reaches of the river even when adfluvial fish are excluded. We expect the Muskegon river at Big Rapids will have a higher number of riffle and pool complexes than the Pine Street river reach and a standing crop of fish as high or higher than the Pine Street reach (documented in the Consumers Energy relicensing studies for the Croton Project). A total of 1481 individuals were collected in the Pine Street reach representing 26 species, excluding adfluvial species. The total fish population was estimated to be 1636 individuals in this 1000 foot segment and the biomass was estimated to be 213.3 kg/acre. Approximately 13% of the fish in this survey are classified as sportfish.

The increased habitat complexity will translate into increased aquatic community diversity as habitat will be available for obligate riffle, pool and run species. The additional habitat diversity will also translate into an increase in benthic invertebrate production. One component of the benthic invertebrate community, mussels, have very specific habitat needs and only can utilize a narrow range of physical habitat in rivers. The richest mussel assemblages occur in riffle or shoal areas, because of their filter feeding foraging method and their high dissolved oxygen requirements (Layzer et al. 1993). The rehabilitation of riffle habitat will increase mussel populations, which are nationally threatened as reported by Williams et al. (1993), by directly increasing available habitat and increasing fish community diversity which translates to additional reproductive hosts, a known limiting factor for mussel populations. In addition, the restoration of full fish passage will also provide the additional fish hosts for reproduction.

In addition to the increased habitat complexity, areas of the high gradient are also locations where groundwater is input into our river systems. Currently, there are a few trout that utilize the existing section of the rapids. The removal of Big Rapids Dam should enhance groundwater input into the Muskegon River and improve riverine trout habitat, increasing the species diversity of this system.

Fish Passage

The removal of the Big Rapids Dam will also restore full fish movement on the Muskegon River from Rogers Dam to Reedsburg Dam, a distance of 118.81 miles, which would become one of the longest free-flowing reaches of river in Michigan. The reestablishment of free fish passage is critical to the health of river systems as most fish in river systems move. Gowan et al. (1994) summarized recent field studies and showed that many riverine fishes move extensively. Fish make 4 types of movement: a) fairly long distance diel movements between feeding and resting habitats; b) episodic movements between feeding and refuge habitats; c) season movements to spawning and refuge habitats; and d) ontogenically movements as they grow from juvenile to adult fish. Many species in Michigan have been shown to make such movements. Of approximately 100 riverine species in Michigan, we have found evidence of substantial movement for about 70; the reminder are mostly small fish whose life history has not been closely examined.

Many of what are termed "resident" fish species utilize large amounts of riverine habitat and lake habitat when available. Johannes (1986) and Langhurst and Schoenike (1990) documented smallmouth bass movements of 60 miles or more. Studies by Wisconsin Department of Natural Resources (Jim Holzer, WDNR unpublished data; John Lyons, WDNR unpublished data; Al Hauber, WDNR unpublished data; and Tom Thuemler, WDNR unpublished data) and Department (Crowe 1954) on walleye show extensive riverine movements in excess of 40 miles. Channel catfish (Don Fago, WDNR unpublished data), yellow perch (Weber and I Les 1982), lake sturgeon (Thuemler 1988), brown trout (Clapp et al. 1990) and carp (Otis I and Weber 1982) all have been documented to undertake long distance migrations. Studies on walleye documented in WDNR files by Jim Holzer, Mississippi River, John Lyons, lower Wisconsin River; A1 Hauber, Wisconsin River; and Tom Thuemler, Menominee River; show extensive riverine movements in excess of 40 miles. The WDNR documented that a walleye tagged in the Mississippi River near Lynxville, Wisconsin traveled 174 miles upstream to near the mouth of the Kinnickinnic River (WDNR file report, Kurt Welke, Fish Manager, Prairie due Chien). Clearly, these frequent accounts of long distance travel indicate that many riverine fish species are not sedentary, "resident" inhabitants of a flowage or particular section of river.

In addition to the protection and rehabilitation of fish species, it has been noted on the lower Wisconsin River that freshwater mussel distribution may also be limited by the lack of fish passage at dams (Thomas Thuemler, Wisconsin Department of Natural Resources, Personnel Communication ,1995). Freshwater mussels require fish hosts for the dispersal of juvenile life stages and the lack of upstream fish passage has significantly reduced the diversity of mussel species above the lowest dam on the Wisconsin River when compared to mussel diversity below this dam. The habitat above and below this dam are similar so habitat differences do not explain the differences in the mussel community. The provision of free fish passage should increase mussel diversity in the Muskegon River.

The Big Rapids Dam has modified and fragmented this reach of river, this type of perturbation may not necessarily eliminate a population, but does create a bottleneck that limits its production which can be alleviated. Similarly, these habitat changes probably constraint the range of life history or migratory strategies that a population might employ to maximize its fitness and production, ultimately constraining genetic diversity. Peterson and Bayley (1993) documented complete recolonization of Illinois streams within 1 year after a severe drought completely dewatered the streams. This provides evidence for movement for even small minnows and darters. The equilibrium fish are intermediate sized, nestbuilders that include the trout and bass that recently have been found to exhibit extensive movements within rivers for diel foraging and seasonal migrations between habitats. Evidence is also mounting for the same species to have multiple life history strategies in the same river system. The effect of fragmentation is to eliminate most periodic and opportunistic species/populations and limit the productivity of many equilibrium species. Thus the riverine fish community we see today in the Muskegon River at Big Rapids may only represent a limited set of what once spanned a diverse plane of life history options.

The Big Rapids Dam is also prevents any upstream transfer or return of nutrients by fish. River systems collect nutrients from the landscape and deposit them in downstream segments, lakes and seas. Seasonal upstream migrations of fishes, especially concentrated spawning fishes, provide a direct mechanism for the transfer of nutrients/energy back upstream to headwaters in the form of carcasses, eggs, fry and juveniles. Fragmentation such as a dam barrier, directly impairs this upstream transport of nutrients. In addition, it is likely that there is a seasonal pulse(s) of energy from these spawning runs in the form of "hatches" (analogous to fly hatches) of the large number of eggs, fry and juvenile fish from these spawning efforts. Intensive feeding has documented on these energetic resources.

Thus in summary, we believe that without fish passage the Muskegon River system fish community is only a small remnant of it's former productive populations. The need to re-connect inland systems is real and is firmly grounded in accepted thought on fish ecology.

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