Muskegon Futures:

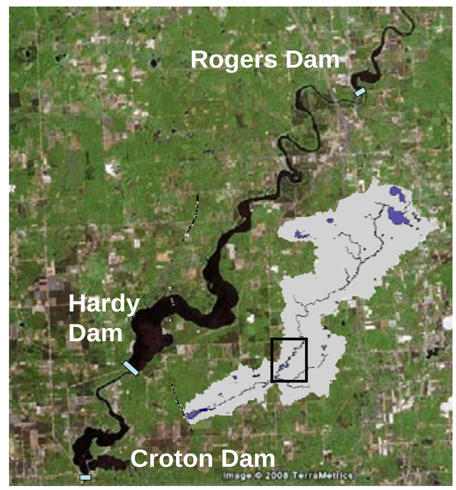
Dams & Fishes

Muskegon Watershed Research Partnership **Volume 4**

A Long Standing Controversy

Ecological boon? Or ecological disaster? Put ten Muskegon River lovers in a room and you will undoubtedly find many takers for both points of view! One thing is for sure, for over a hundred and fifty years dams have been an integral part of the Muskegon River ecosystem. That much is clear. The first major dam was built on the Muskegon main stem at Newaygo in 1854 to power a sawmill. Then came a dam at Big Rapids in 1866. The Big Rapids dam became the river's first hydroelectric station in 1889. Then came Rogers in 1906, Croton in 1907, and last of all Hardy Dam built in 1931. Today Rogers, Hardy, and Croton dams lie at the heart of a major hydroelectric generating operation. Together they provide the regional grid with about 46,000 kilowatts of power, with Hardy doing the majority of the generation.

Everyone has their preferences. But what can we really say about the ecological facts surrounding this controversy? MRWP studies provide some important insights on both sides of the argument.



The Croton Dam in Newaygo County

"The facilities are licensed to operate through 2034, at which time the structures could be re-licensed, decommissioned and left in place, or removed from the river."
-Jeff Alexander 2005

"To those who live here, it's alive, a part of us. The old dam... is loved by all."
- Fred Mare 1982

"What people cannot see, because it is buried beneath the dams, is the potential of the river."
-Paul Seelbach 2003

Quoted from: The Muskegon: The majesty and tragedy of Michigan's Rarest River , by J. Alexander

Great Lakes Protection Fund

Fremont Area community foundation Serving Newaygo County

Inside this issue:

Pros & Cons: On the Positive Side

In an age of rising atmospheric Carbon Dioxide (CO_2) levels and rising energy costs, clean, safe, emission free electrical generation is a valuable asset. While hydroelectric supplies only a minor amount of our States' need, the scenic dams of the Muskegon provide an iconic contrast to coal and gas fired plants that somehow seem part of a passing age. The backwaters of the impoundments too have their advantages. Beautiful lake-like frontage on all three impoundments provide a recreational Mecca for many. Fishing, skiing, swimming, boating. The impoundments themselves figure large in the economy and hearts of many local residents.

But are there ecological benefits to the river, and not just to people? Yes there are. Many rivers have in-line lakes and natural impoundments. In all these cases lakes and reservoirs function as a kind of inline trap for sediments and especially for dissolved nutrients that are routinely transported downstream by rivers. Reservoirs enhance the "self cleansing" aspect of river function in the sense that they remove and store material loads in transport. Water enters a reservoir carrying sediment and nutrients. When that water falls over the spillway it has left much of its "load" behind. As a result the river reach downstream sees "cleaner" water; the nutrients and sediment left behind having become trapped in the local reservoir ecosystem. The amount of sediment being carried by a river as it exits an impoundment is very small indeed. That water is said to be "hungry" and it quickly picks up smaller bed material like sand from the riverbed below a dam.

MRWP modeling and measurements make it clear that Rogers, Hardy and Croton do indeed function like large load traps on the Muskegon. Nitrogen, Phosphorus (a key plant nutrient), and sediment load are all significantly reduced as the river passes through them. Our models suggest for example that Croton Pond removes more than 8 tons of Phosphorous (as TP– Total Phosphorous) from the Muskegon each year and stores it in reservoir bottom sediments. The capture of nutrients and sediment in the reservoir helps keep the rivers' most productive spawning grounds (from Newaygo to Croton) relatively free of fine sediments and algal accumulations to a minimum . This filtering of the Muskegon would obviously be lost if the large dams were removed (see FIG. 1).

Finally, as is often correctly pointed out by dam advocates, the system of reservoirs helps keep most of the upper river system free from sea lamprey. Likewise it restricts the upstream movement of other invasive species like the round goby which is currently spreading up the river from Lake Michigan.

FIGURE 1

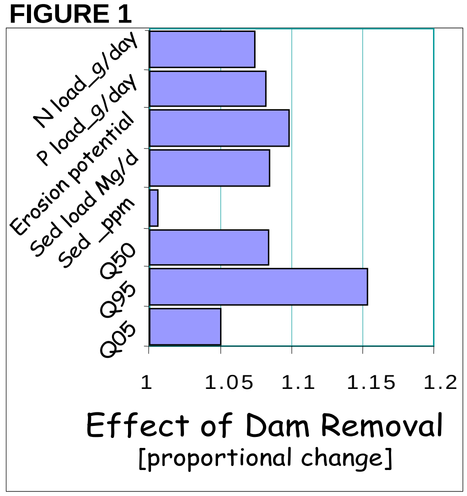


TABLE 1. Physical characteristics of the Rogers, Hardy, and Croton impoundments.

Impoundment Characteristics	Rogers	Hardy	Croton
Location (RM)	83.7	58.7	52.8
Drainage Area (mi2)	~1,746	~1,851	~2,224
Max. Surface Area (acres)	449	3,902	1,209
Max. Surface Level (ft)	861.6	822.5	722.0
Gross Storage Capacity (acre-ft)	4,678	134,973	21,932
Target Surface Level (ft)	861.3	822.0	722.0
Mean Depth (ft)	10.4	34.5	18.1
Normal Usable Storage Capacity (acre-ft) / Impoundment Fluctuation (ft)	300/0.7	5,007/1.3	1,181/1.0
Normal Impoundment Fluctuation (ft)	0.7	1.0	1.0
Drawdown (ft.) : dewatered acres (% surface area)	N/A	0.5 : 51 (1.3%)	1.0 : 57 (4.7%)
Average Annual Flow (cfs)	1,344	1,460	1,871
Impoundment Retention Time (days) @ Avg. Annual Flow[1]	1.8	46.6	5.9

Pros & Cons: On the Negative Side

The primary argument against the main stem dams is that they ecologically fragment the river system. Practically this means that fish movement is severely restricted and that recruitment by river spawning species that return to Lake Michigan is much reduced from what it could be. This includes Lake Michigan river-spawning salmonids like steelhead, coho and chinook salmon, as well as Lake Michigan (and Muskegon Lake) populations of Walleye. The same applies for other river run species like the endangered sturgeon, as well as several species of suckers (white suckers, and the river redhorses).

The MREMS "dams removed" scenario simulations support the contention that large areas of useful habitat would become available (FIGS. 2 and 3) if the three hydropower dams were removed. Steelhead and walleye in particular would have more than triple the current levels of useable habitat (greater than 200% increase). Interestingly, the modeling predicts small increases in small mouth bass habitat as well (up 6%), as some downstream areas become cooler. On the other hand northern pike, and the inland trout all lose small amounts of habitat below Croton. For the pike it is because some main stem areas become cooler; for the trout because higher main stem flows dilute colder tributary flows in the Muskegon Valley and those reaches warm a little.

The complexity of the response to a dam removal scenario is a good illustration of the many important indirect (and often unexpected) linkages that occur in riverine ecosystems. The MREMS modeling highlighted and/or confirmed several other important impacts of the existing system of dams: (1) water temperatures below Croton is warmer in the Summer and Fall, and colder in the late Winter and Spring than they would other wise be. And, (2) the hydrologic models suggest, (and empirical flow studies confirm) that flows below Croton are reduced somewhat by the impoundments both because of increased evaporation in the reservoirs, and because higher depths in those flooded areas reduce the hydraulic gradients that promote groundwater upwelling . The overall impacts of these changes on the total ecosystem is difficult to assess but certainly include the costs in fish habitat described above. Furthermore, warmer summer temperatures and decreased river flow

FIGURE 3. MREMS estimates proportional increase in habitat for key river sport fish habitats with dams removed.

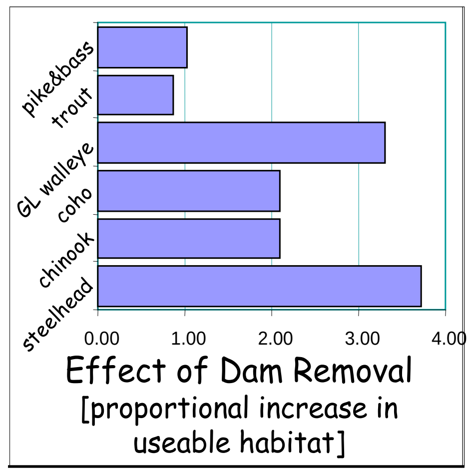
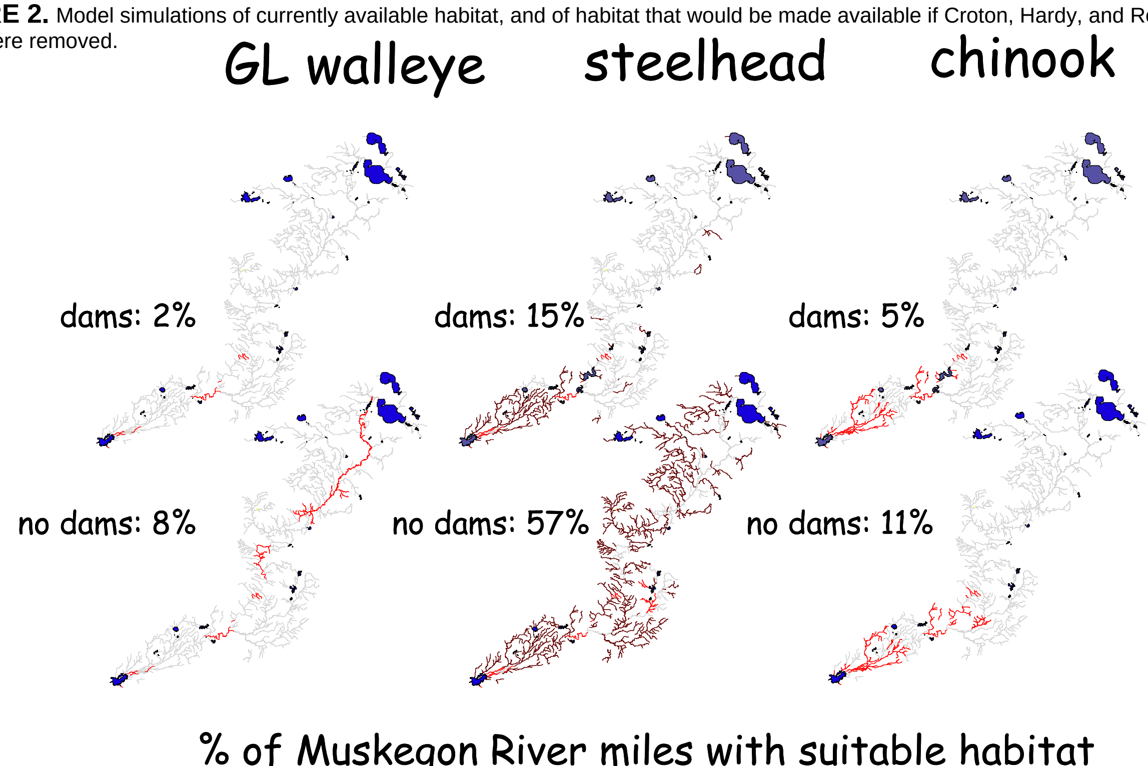


FIGURE 2. Model simulations of currently available habitat, and of habitat that would be made available if Croton, Hardy, and Rogers dams were removed.



Pros & Cons: On the Negative Side (continued)

exacerbate oxygen problems in both dam tail and head waters. Removal obviously would reduce these negative effects. Problems below Croton dam are particularly troublesome given that this stretch of the river holds one of the most sensitive fisheries and critical spawning areas. High temperature, low oxygen episodes result from the accumulating nutrient loads in the reservoirs above. Nutrients drive the production of plants, and that biomass is ultimately broken down using oxygen from the water. The organic matter combined with incoming river sediment slowly fills the reservoir making it shallower and progressively easier for the sun to heat.

This leads to a particularly difficult situation in the headwaters where both river fish and invertebrate communities are impacted. MWRP biological assessments found degraded diversity and biological integrity in the headwaters of all three dam ponds . The same processes affect river communities below the dams, (although to a lesser degree), contributing to the periodic failure of the Croton release to meet it's licensing targets for oxygen and temperature.

What does the future have in store? MREMS scenario simulations suggest that given a constant climate, land use changes will drive a slow but steady acceleration in the rate of nutrient and sediment supply to these three reservoirs until late in this century. At present Rogers, Hardy, and Croton together receive over 100 metric tons of phosphorus and about 6000 metric tons of sediment each year from their main tributaries. By 2070, under the Business As Usual (BAU) scenario these rates will have increased by 10-20%. The reservoirs are large enough that they are in no danger of filling up any time soon! But, more sand and silt, more nutrients and plant growth, will impact oxygen sensitive fish like trout and walleye. Below the dams the river will also experience more frequent traverses into suboptimal temperature and oxygen conditions.

It is important to remember that annual precipitation totals and annual discharge in the Muskegon watershed are in fact already rising (presumably related to increased evaporation from a warming Lake Michigan). The MREMS scenario forecasts therefore actually underestimate the rate at which these impoundments will face additional nutrient loading since we hold climate constant in the simulations. What would help? The Reduced Urban Sprawl (RUS) rate scenario, with a substantially smaller urban footprint and a maximum forest coverage, cuts river loading to the dam ponds more than in half.

Photo Courtesy of Gale Nobes

Think Ecologically

Muskegon's main stem dams provide important services to our greater watershed ecosystem (people included!). They also exact a steep price in terms of ecological function and fisheries. All river impoundments function as load traps, which means that eventually that trapping function will lead to a future of eutrophication and filling (see FIG. 4). In a natural river system, filling lakes are ultimately abandoned by the river channel itself and left as an oxbow lake or valley wetland. For a human built reservoir, things aren't that easy!

Global climate warming is also a wildcard. If temperatures rise substantially, as predicted, much of the Muskegon's extensive coldwater habitat could be at risk. The deep cold water storage capacity of Hardy dam could someday play a role in protecting the salmonine fishery it now obstructs.

Current operations at Croton, Hardy, and Rogers are licensed by FERC through 2033. That gives us about 25 years to plan a "next move" that makes sense for both the river and the people around the river!

What is required is a commitment to holistic (i.e. ecological) thinking. The MRWP computer simulations suggest a first basis for discussion might be to give a little in both directions: a partial drawdown of Croton to ensure passage to the Little Muskegon, and a new Sate-of-the-Art restoration of Hardy to better meet both the challenges of hydropower generation and the need for cold water sources in the future.

FIGURE 4