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Some problems with cage aquaculture in the Great Lakes

As proposed by the Quality of Life agencies

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There is a vast literature of scientific evidence that commercial cage (or net-pen) aquaculture is harmful to aquatic ecosystems and that its proliferation in the Great Lakes would be at odds with Michigan's obligation to manage and protect, as a public trust, the waters and resources of the Great Lakes for use by this and future generations of citizens.

While aquaculture takes various forms, some of which are not necessarily harmful to ecosystems, the focus here is on commercial cage aquaculture in the Great Lakes.

Concerns about commercial cage aquaculture in the Great Lakes can be placed into the following categories: 1) Public trust doctrine; 2) Water quality; 3) Fish health; and 4) Genetics.

Public Trust Doctrine

The following is summarized from the treatise by James Olson:
http://vjel.vermontlaw.edu/files/2014/01/Issue-2_Olson.pdf

Michigan's waters of the Great Lakes are subject to and protected by the public trust doctrine, which means State resource regulatory agencies have a duty to protect these waters and their public uses and limit private ventures that could prove deleterious to the resources and their public use. This principle has been tested and upheld by the US Supreme Court. The public trust doctrine defines a duty to protect public trust values and holds governments and individuals responsible when private gains are allowed to erode public trust values. Public trust resources cannot be sold or alienated by the State or owned or controlled by private interests. Public uses or interests protected by the public trust doctrine include navigation, boating, fishing, swimming, other forms of water based recreation, fish, habitat, and the integrity of the ecosystem. Thus, it can be argued that to the degree any of these attributes are endangered by a proposed private enterprise, public trust doctrine should be invoked to protect the public interests.

To be clear, the state may allow the use of public resources to enhance the public interest (for example, commercial fishing), as long as such use does not significantly impair the public trust resource or the public's use of the resource. Michigan's Natural Resources and Environmental Protection Act specifically references the public trust doctrine: "*The waters of the state are valuable public natural resources held in trust by the state, and the state has a duty as trustee to manage its waters effectively for the use and enjoyment of present and future residents and for the protection of the environment.*" Furthermore, the burden of proof (of no harm to the resource) is upon the private entity proposing to use public resources, and developers are generally required to demonstrate not only no harm from their actions but also lack of cumulative effects of theirs and similar proposed development.

Water quality degradation

Since the cages placed in the Great Lakes would be made of mesh and thus porous and open to the environment, nutrients and pathogens would be freely released to surrounding waters. The nutrients released by farmed fish through urine and feces and from uneaten feed would accumulate on the lake bottom and in the water near the cage sites. Effluent treatment is not possible with cages, as acknowledged by the summary of science report (Summery Report, found at the following address:
https://www.michigan.gov/documents/mdard/AquaRprt_504335_7.pdf.)

The Environmental Protection Agency describes phosphorus (P) removal from cages as "unpracticable" and solids removal as "not economically viable". The only effluent management option offered by the industry is assimilation, which is nothing different than dilution. Assimilation as a management practice for major nutrient and solids discharges was a disaster in the post-World War II era and there is no reason to believe it would work any better today. Consequently, cage aquaculture, as proposed by the QOL agencies and the industry, will significantly damage water quality, and by this measure alone is not consistent with public trust doctrine.

There has been only one published study of effects of cage aquaculture in the Great Lakes on water quality. That study demonstrated that a site in Lake Huron's North Channel became progressively more eutrophic, with anoxia (oxygen depletion) developing in the deeper waters of the cage site as fish culture increased. Recovery was slow after the operation was terminated. Trout-supporting water was lost and a fish kill was reported.
https://www.researchgate.net/publication/237175624_Cage_aquaculture_and_water-quality_changes_in_the_LaCloche_Channel_Lake_Huron_Canada_A_paleolimnological_assessment

The Summary Report is careful not to use the term "dilution"; instead the term used is "flushing". Flushing and variations on that term are used 30 times in the Summary Report. To deal with waste, the trend in Norway is to place the cages in deeper water up to about 1,000 feet deep http://icesjms.oxfordjournals.org/content/72/3/997.full.pdf+html. Water circulation near the cages is an important factor and the action of aggressive flushing with tides is important. The State of Maine cage farming permitting protocol outlined in the State Regulatory Analysis report stresses the importance of tides to facilitate removal of wastes. Of course, in the Great Lakes tides are minimal and flushing rates are much lower. Cage permits are only issued in Maine for sites that experience a significant tide. Even with heavy tidal flushing, disease and waste are major problems globally.

Using Great Lakes water to assimilate such a potentially large amount of nutrient-laden waste is an inappropriate allocation of public trust resources to one private enterprise sector and further limits others who might also wish to share the limited budget for P loading (see Interim Phosphorus Loading Targets, Annex 4 of the Great Lakes Water Quality Agreement, http://ijc.org/en_/GLWQA_2012_Annexes). One small operation raising 2 million pounds of rainbow trout per year would release as much P as if the City of Alpena were allowed to release

all its wastewater totally untreated. A 50-million-pound operation would release 1.5-2 times as much P as would the City of Grand Rapids if its wastewater were untreated.

Promotion of cage aquaculture in Michigan is tantamount to establishing two sets of water quality standards for Michigan: one for Great Lakes cage aquaculture, which would be exempted from effluent treatment requirements, and another for the rest of us, which requires diligent efforts at solids and nutrient removal.

Here is why Michigan cannot endorse or condone an exemption for aquaculture from wastewater treatment requirements that apply to other industries:

- Land-based hatcheries are required to treat their wastes; an exemption for cage aquaculture tilts the playing field to favor the more environmentally harmful cages and gives unfair economic advantage to cage operators over land-based hatcheries;
- Thanks to dreissenid mussels, the Great Lakes are now benthically driven systems, meaning nutrients are quickly locked into the bottom substrate by quagga mussels and filamentous algae (Cladophora for example). Before dreissenids, the impacts of nutrient enrichment were most evident in the water column, but they are now, in the dreissenid era, focused on the bottom and the beaches where they are more in proximity to users of the lakes. The result has been accumulation of unsightly piles of Cladophora and "muck" on the beaches and the lake bottom.
- Increases in nutrient loading near spawning reefs as a result of cage culture would increase plant growth and other organic debris resulting in reductions in oxygen levels in the reefs' substrates where incubating eggs could be suffocated. This would be a major setback to lake trout restoration, which has been making significant progress recently in Lake Huron. Whitefish and walleye also use nearshore reefs for spawning.
- Using two relatively small operations as a demonstration project will be far from adequate to document where the tipping point for substrates will be, considering the massive scale of aquaculture called for in the industry's plan.

Fish Health

When fish or other species are crowded into unnatural environments like cages, the chances increase for a relatively benign disease organism mutating into a virulent form that could spread to the wild fish populations
http://rspb.royalsocietypublishing.org/content/royprsb/277/1681/593.full.pdf

Viral hemorrhagic septicemia (VHS) is an example of a disease present in the Great Lakes that exists worldwide in several strains (https://www.aphis.usda.gov/animal_health/emergingissues/downloads/vhsgreatlakes.pdf). The most virulent strain originated in Europe and is prevalent in salt water. The strain present in the Great Lakes region has adapted to fresh water and it appears to have mutated from the European strain. The VHS virus is prone to mutating and it could change again. Another example is infectious salmon anemia (ISA) which devastated fish farms in Norway, Scotland, Chili, New Brunswick and Maine (http://www.cfsph.iastate.edu/Factsheets/pdfs/infectious_salmon_anemia.pdf). Currently, there

is an intense unsettled debate that fish from cage farms in British Columbia are releasing ISA disease organisms to rivers and infecting juvenile fish that are migrating to the ocean (http://www.salmonconfidential.ca/watch-salmon-confidential-documentary/ and https://www.watershed-watch.org/wordpress/wp-content/uploads/2012/07/Exh-1540-NonRT1.pdf). A global assessment of the impacts of cage aquaculture on wild salmonids showed that in numerous areas wild salmonid numbers decreased steadily as cage farming increased (http://www.plosbiology.org/article/fetchObject.action?uri=info:doi/10.1371/journal.pbio.0060033&representation=PDF).

Norway has an extremely large cage farming industry and, in spite of strict protocols, fish disease is a huge issue (http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0CCQQFjABahUKEwiCgbDL3pXJAhWBGR4KHZ4HCBY&url=http%3A%2F%2Fwww.vetinst.no%2Feng%2Fcontent%2Fdownload%2F10605%2F142950%2Ffile%2F2012_Fish_Health_Report.pdf&usg=AFQjCNEfBGxlIjkvPi2vOUPKYI0RUyJqQw&sig2=Z5loe5b0Pu_A9PwhD9JoZg). These diseases include: Infectious salmon anemia (ISA), pancreas disease (PD), infectious pancreatic necrosis (IPN), skeletal muscle inflammation (HSMI), cardiomyopathy syndrome (CMS), bacterial kidney disease (BKD), salmon lice, and other bacterial and viral diseases. It is apparent that if there is a major expansion of cage aquaculture in the Great Lakes, disease will become a serious concern, infecting wild fish populations and impairing public use and enjoyment of Great Lakes fisheries. Since the cages placed in the Great Lakes would be open to the environment the disease organisms released by farmed fish through urine, feces and other fluids would accumulate in waste and water near the cage sites allowing wild fish to be exposed. In addition, it has been shown that disease organisms can be moved long distances by currents (http://icesjms.oxfordjournals.org/content/72/3/997.full.pdf+html).

The Michigan Quality of Life agencies' Science Panel disease control protocol would only work for closed recirculating systems and would not prevent organisms from escaping into public trust waters from the open cages. The Science Panel report notes that the prevention and control of diseases in wild populations is typically extremely difficult or impractical so once a disease spreads to the wild population there are usually few or no options. Thus the damage to the public trust would be irreversible.

Fish raised in cages are often bred to be more resistant to certain diseases (http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0CCQQFjABahUKEwiCgbDL3pXJAhWBGR4KHZ4HCBY&url=http%3A%2F%2Fwww.vetinst.no%2Feng%2Fcontent%2Fdownload%2F10605%2F142950%2Ffile%2F2012_Fish_Health_Report.pdf&usg=AFQjCNEfBGxlIjkvPi2vOUPKYI0RUyJqQw&sig2=Z5loe5b0Pu_A9PwhD9JoZg and http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4245001/pdf/fgene-05-00415.pdf), thus caged fish could harbor pathogens that are more virulent to wild fish of the same species since the wild fish would have lower resistance than caged fish. With variation in the food web and the environment, wild fish stocks will be stressed from time to time and become more susceptible at times to diseases released from the cages.

Genetics

The Summary Report acknowledges that escapes will occur. Harsh weather, ice damage, defects in the cages, and vandalism are a few of the mechanisms causing escapes. Stocking cages with fish that are too small (a portion of fingerlings stocked will often be smaller than the mesh size can hold) is another cause of escapes. The escaped fish act as disease vectors and can cross with wild conspecifics and damage the genetic adaptability of wild fish to the environment. Over half of Great Lakes rainbow trout (steelhead) are wild; the other half stocked from eggs cultured from wild steelhead well adapted to the Great Lakes. Dilution of the genetic makeup of these wild stocks of steelhead from escaped domesticated rainbow trout could degrade the quality and quantity of the steelhead resource.

Perhaps the most serious source of escapement from cages is from storm and ice damage. There are few, if any, waters in the Great Lakes that are as well protected from wind, waves, and moving ice as the fiords and archipelagos of Scandinavia, the Pacific Northwest, and the coast of Chili, where most of the world's cage aquaculture is located. Unlike these oceanic coastal locations, the Great Lakes offer little protection from wave events. Where protection is offered, the lack of tides means there will be little flushing of nutrients; the nutrients will accumulate near the cages causing significant local water quality issues. The "Summery Report" suggests that cages be located where water currents are strong and flushing rates are high, but these locations are invariably exposed to the full wave energy of the lakes. Cages located where flushing rates are high are almost certain to experience episodes of severe cage damage and escapement, with economic consequences to the industry and potentially irreversible genetic consequences to Michigan's steelhead fishery.

Summary

Because commercially-scaled cage aquaculture would seriously harm water quality and the health and genetic integrity of wild populations of fish in the Great Lakes, public trust doctrine requires that the State of Michigan deny permits for such operations in the Great Lakes. Commercially-scaled cage aquaculture represents an unacceptable risk to Michigan's Great Lakes resources and to the enjoyment of the Great Lakes by this and future generations.