FISHERIES IMPACTS FROM DOUBLE-CRESTED CORMORANT POPULATIONS IN THE GREAT LAKES

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Honorable Rob Bishop, Chairman
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Managing Double-Crested Cormorants, Great Lakes Fish, and Sustainable Fisheries

To Chairman Bishop and Congressman Bergman, and on behalf of Keith Creagh, Director of the Michigan Department of Natural Resources (MDNR), I would like to thank you for the invitation to discuss fisheries impacts from cormorant populations in the Great Lakes. I am Randy Claramunt, the Lake Huron Basin Coordinator for the Fisheries Division of the MDNR.

Much of this testimony builds on the MDNR testimony provided during the U.S. House of Representatives, Subcommittee on Federal Lands hearing on February 15, 2018[1]. The testimony provided by MDNR was in support of House Bill 4429, the Cormorant Control Act, and in support of Congressman Bergman leadership in response to our stakeholder concerns regarding cormorant impacts on Great Lakes fisheries. Congressman Bergman's District has hundreds of miles of Great Lakes coastline and his district is built on communities that are tightly linked with the health of the water, the wildlife, and the fisheries. We share the concerns of his stakeholders, not only within Congressman Bergman's district, but across the Great Lakes, because cormorant numbers in northern nesting areas have risen well beyond historic levels and they are having direct impacts on valuable and sensitive fish populations. In combination with invasive species and habitat destruction, these threats not only disrupt the fragile balance of the Great Lakes ecosystem, but also the people, their livelihoods, and the communities upon which they support.

The Great Lakes supports several important fisheries including commercial, recreational, and tribal which are collectively valued at more than $7 billion annually[2] and support more than 75,000 jobs. These highly valued resources are jointly managed through comprehensive efforts by all levels of government. The State of Michigan is supportive of reinstating effective cormorant management, applied in the same collaboratively way that we use to protect our natural resources and people, to maintain a sustainable balance between fisheries and wildlife populations in the Great Lakes region and across the United States.

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[*] This testimony was written by Randall Claramunt and David Fielder with input from James Dexter, MDNR Fisheries Chief.

The History and Background on Cormorant Populations

Double-crested cormorants (hereafter referred to as 'cormorants') are a migratory, colonial nesting, water bird native to North America. There are five geographically distinct breeding populations within North America, stretching from coast to coast. The largest is that of the Mississippi flyway including the Great Lakes region. Cormorant numbers in the Great Lakes were documented beginning in the early 1900s and at their peak in the 1940s, cormorants appeared to have numbered around 6,000 birds. However, region-specific numbers were not documented until the early 1970s, which at that time it was estimated that about 2,000 cormorants inhabited the Great Lakes region. By the mid-1970s, there was concern over the declines of most migratory water birds due to the effects of contamination (i.e., DDT) in the environment. During that time, cormorant numbers were at their lowest and were estimated to be less than 100 birds[3].

Cormorants are migratory and they nest in northern latitudes, spending the spring, summer and fall on the breeding grounds and then they migrate south to the Gulf of Mexico to over winter. Cormorants nest on uninhabited islands, often along with other colonial water birds such as gulls, terns, and herons[1]. The diet of cormorants is almost exclusively fish and they depend on the surrounding waters to sustain both breeding adults and to feed their young once they hatch. Cormorants are not very selective in the fish they consume and adult birds have been documented to consume fish as long as 20 inches, albeit most cormorants tend to feed on smaller fishes[1].

In the Great Lakes, cormorant predation on fish will occur during the spring and fall migration, and most importantly, during the cormorant breeding season. Nesting colonies in the northern regions, especially for critical islands and coastal habitats in the Great Lakes, will tend to concentrate cormorants. But, adult birds are limited in their foraging excursions so as not to spend too much time away from the nest, whether incubating eggs or tending to newly hatched fledglings. Consequently, their feeding pressure will be most intense in island and coastal habitats, which are also critical fisheries habitats and important in sustaining fisheries populations.

An adult cormorant will consume about 1.3 pounds of fish each day[4]. Each adult is typically on the breeding grounds for about 150 days each year. In addition, a successful cormorant nest requires about 70 pounds of fish to sustain the nest over the breeding season[4]. As an example, a cormorant rookery of just 100 nests would result in the consumption of about 46,000 pounds of fish over the breeding season. The substantial expansion of nesting colonies in the Great Lakes has raised concerns over impacts from their predation on fish, especially in sensitive island and coastal habitats as these also tend to be the same areas that the support local communities and their fisheries. In the Great Lakes, cormorants increased steadily, peaking at about 115,000 breeding pairs around the year 2000. At these levels, fish consumption in the Great Lakes amounted to an estimated 77 million pounds each year[5].

There are additional concerns including competition with threatened and endangered co-nesting species, destruction of vegetation (including rare forms) on the islands, fouling of aids to navigation, and impacts on fish stocking in the Great Lakes that will not be covered in this testimony.

Why have cormorants in the Great Lakes region expanded beyond historic levels?

Once released from the limiting effects of DDT, which was banned in 1972, cormorants began to reproduce and grew in capacity to the available food resources and nesting habitat. During the latter half of the Twentieth Century in both the Great Lakes and Gulf States, food resources for cormorants increased substantially. In the southern U.S., fish from the easily accessible pond-reared aquaculture facilities increased the overwinter survival of the birds and in the northern region, there was a growing abundance of near-shore invasive prey fish in the Great Lakes, namely alewives and rainbow smelt. Alewives and smelt invaded the Great Lakes and reached extremely high levels in the 1970s and 1980s because predator fish populations had been decimated by the invasion of sea lamprey a decade earlier. The alewives and smelt provided a new high-energy, easily accessible food resource for cormorants that was not available historically. Under these conditions, cormorants expanded to numbers never before seen by fish and wildlife experts and to levels that were not sustainable for the Great Lakes.

During the same period of the rapid expansion of cormorants in the Great Lakes, state, federal, and tribal fisheries managers instituted extensive fish stocking programs to restore a better balance in the food web through restoration of native lake trout populations and stocking of Pacific salmonines[6]. The goals were to control alewife and smelt populations while restoring Great Lakes fisheries. During the late 1970s and through the 1980s, predator fish populations and cormorant populations expanded substantially and concurrently, but were headed for a collision course. In addition to record high salmon and trout levels, by the early 2000s every uninhabited island had some level of nesting cormorants and even many man-made structures, such as navigation buoys and break walls, also hosted nests. As cormorants reached all-time high levels in the Great Lakes, a new threat occurred through the invasion of zebra and quagga mussels thereby limiting the production of the Great Lakes food web through their high filtering rates. Fish stocking levels have been reduced to try to bring fish predation in balance with prey fish production[6]. In most of the Great Lakes, alewife and smelt populations are now at very low levels, salmon and trout fisheries are severely reduced, and cormorant predation on fish is an exacerbating stressor on Great Lakes fisheries.

The Impacts of Cormorants on Great Lakes Fisheries

Cormorants certainly have direct impacts on fisheries resources because they consume fish, but there has not been agreement on the relative impact of their predation or, most importantly, what level of fish consumption constitutes an acceptable level. One of the initial attempts to evaluate the level of cormorant predation on fish took place in the mid-1990s in a region of Lake Huron called Les Cheneaux Islands. It is a 36 island archipelago in the northern most portion of Lake Huron. The channels and embayments of this region form pristine aquatic habitat and is home to multiple small towns and communities that are dependent on important fisheries, of which yellow perch are the centerpiece. The study, led by researchers from the University of Michigan, estimated cormorant consumption of yellow perch and compared it to numbers that were being harvested by anglers[7]. Although they estimated as many as 470,000 Yellow Perch were consumed by cormorants in 1995, the researchers believed this to be a small fraction of the overall perch population and therefore likely inconsequential.

As referenced in the testimony to the Subcommittee on Federal Lands[1], the cormorant population in the Great Lakes could consume an estimated 77 million pounds of fish annually. Whether considering the overall consumption of fish in the Great Lakes or examples of local impacts of cormorant predation (e.g., 470,000 yellow perch consumed in the Les Cheneaux Islands), it is critical that the context of the Great Lakes food webs be considered. Over the past two decades and during the same era of the cormorant expansion, several of the Great Lakes have suffered dramatic declines in productivity from the invasion and proliferation of dreissenid mussels (commonly known as zebra and quagga mussels). In a recent report documenting the mussel impacts on the lower trophic levels in the food web, the authors state that mussels appear "to have disrupted the fabric of the entire pelagic food web so that this phenomenon may represent one of the single, largest perturbations ever observed" [8]. In lakes Huron (figure 1A) and Michigan (figure 1B), surveys of prey fish biomass during 2010 to 2017 declined by almost 90% of the average biomass in the 1990s[8]. Although the report was focused on Lake Michigan, many of the observations are similar or even more substantial for Lake Huron's food web.

In addition to the declines in nutrients and fish production, the mussels have had substantial impacts on water clarity. In lakes Huron and Michigan, water clarity has increased by over 60% since the mussel introduction and remain clear. It has been hypothesized and there is supporting information that predators of Great Lakes prey fish have had an increased search efficiency thereby adding stress to the already declining prey fish levels. The increased predation efficiency can rapidly deplete the prey fish populations, and in Lake Huron the alewives, once a dominate prey species, have declined by 99% and remain at record low levels since 2005. Fish predators that are reliant on alewives, such as salmon, declined soon after and have contributed to a loss of approximately 4 million angler hours on Lake Huron.

As documented in several of the cormorant diet studies, alewives made up a large proportion of their fish consumption in the Great Lakes. After alewives declined, cormorants were shown to be able to switch to other diet items and concentrate feeding nearshore versus offshore based on prey fish availability. In addition to switching prey species, cormorants have been observed to form large groups, near their nesting colonies, and hunt cooperatively on nearshore fish. The overall declines in the productivity of the Great Lakes[8], in combination with the focused feeding nearshore on limited fisheries resources, is causing substantial stress on Great Lakes fisheries. As referenced in the testimony to the Subcommittee on Federal Lands[1], the largest cormorant nesting colonies are in the Great Lakes, especially in lakes Huron and Michigan. Whether feeding on more traditional forage species like alewives, smelt, and gobies, or feeding on important game fish such as yellow perch, walleye, or bass, cormorants have become an important predator in the allocation of limited fisheries resources that compete with Great Lakes fisheries. The profound food web changes in Lake Michigan and Huron have left them prey limited and fishery managers are having to reduce game fish stocking to try and maintain balance[6,8]. While just one of many predators in the ecosystem, allowing cormorants to go unmanaged is essentially allocating limited fisheries resources to cormorants at the expense of the Great Lakes fisheries.

The perch population and fishery of the Les Cheneaux Islands collapsed within just five years after the University of Michigan concluded that the fish populations were sustainable and that cormorants wouldn't impact the fish populations. The local community felt a 40% drop in the local work force, especially including youth and families, because of the direct impacts from a loss of tourism and fishing. Community bait shops and resorts closed and

almost every service-based industry struggled financially. The Michigan Department of Natural Resources also documented that the harvest of yellow perch had declined from a high of 375,000 to just 695 fish by the year 2000.The perch collapse prompted further research by state and federal partners using an innovative approach of modeling metrics of perch population trends as explained by trends in cormorant abundance[9]. Those modeling metrics firmly established that cormorant predation was the major explanatory factor in the perch declines [10]. During the same period where cormorants were linked with perch declines in the Les Cheneaux Islands (figure 2), other studies emerged from around the Great Lakes establishing connections between cormorant abundance and declines of game fishes and fisheries[11,12].

Some of the studies looked at the feeding patterns of cormorant, and they proved insightful, but they are not very indicative of population level impacts and do not consider the overall declines of fish productivity in the Great Lakes following the mussel invasion. Often cormorant diets are dominated by small forage fishes, because of their abundance, and game fishes constitute only a minority of the consumption. Because cormorants tend to consume smaller, younger fish, their feeding will appear to mimic declines in fish reproduction. A number of research projects have documented this impact by cormorant predation on yellow perch, walleye and smallmouth bass. Even so, this impact is difficult to quantify on a larger scale because of the latent effect of Cormorant predation cannot be evaluated until years later in the fish populations.

The Management of Cormorants in the Great Lakes

The concept that predators like cormorants can be allowed to fluctuate naturally is based on the idea that they will not likely cause the collapse of a fish population. The basis for this understanding is the classic predator/prey dynamic which has often been interpreted as linking the abundance of a predator with the abundance of its prey; so the decline of the predator is expected with the depletion of its prey[13]. The Great Lakes, however, have very complex food webs, often undergoing severe disruptions, and have changed the way predators interact with prey. Cormorants have caused some prey fish to decline, especially ones favored by them or at a disadvantage because of the food web changes (e.g., mussel filtering the water thereby increase water clarity). When cormorant abundance increased because of a newly available and highly abundant prey fish such as alewives and smelt, then that caused a secondary impact on other prey and sport fish such as yellow perch, especially after alewives and smelt populations declined.

Based on the complexity of Great Lakes food webs, we recognize that assessing cormorant impacts is also complex and requires long term data, targeted surveys, and assessments. While this has been implemented in some locations across Michigan, Ontario, New York, and Minnesota, it is not conducted in all locations where cormorants occur in abundance. Consequently, policy makers have had to rely on the more detailed studies to reveal relationships and then apply those lessons to similar locations across the Great Lakes. But one fact is certain, we need to manage cormorant populations using the same multi-jurisdictional approach that agencies use on other critical issues such as invasive species. The sea lamprey program is a great example of a multi-jurisdictional and international effort to combat the impacts of this parasitic, non-native species.

In response to growing concern by anglers, the aquaculture industry, and natural resource

professionals, the U.S. Fish & Wildlife Service (USFWS) developed an Aquatic Depredation Order (AQDO) in 1998 to provide for state level management of cormorants to benefit the Aquaculture Industry (13 southern states[14]) and in 2003, a Public Resource Depredation Order (PRDO) to provide for state level management for the benefit of free-swimming fishes (in 24 northern states[15]). These authorities were necessary because cormorants are protected by the Migratory Bird Treaty Act, which held management authority at the federal level. The PRDO allowed for a maximum of 10% of the birds in a nesting colony to be culled each year unless special conditions were necessary and justified. The PRDO empowered the northern states, federally recognized Native American Tribes, and the U.S. Department of Agriculture's Wildlife Services Division to work with the USFWS on appropriate management of cormorants in the Great Lakes.

The Michigan DNR supported the collaborative management and worked with its partners and with the USDA's Wildlife Services to set cormorant population targets and exercise the PRDO. Under the authority of the PRDO, management agencies and stakeholders worked to reduce, not to eliminate, cormorants in key locations to better balance bird numbers with sensitive fish populations and rebuild important fisheries.

One of the first locations to implement cormorant management was the Les Cheneaux Islands because it was well-studied, cormorant numbers had swelled to over 11,000 birds, and fisheries impacts were clearly evident (figure 2). The effort was organized as an adaptive management experiment which intended to provide both benefits to the resource and to facilitate a further understanding of how to reach a better balance between birds, fish, and people. The PRDO provided for this opportunity via control methods to prevent reproduction in the islands by specific targets set annually. Within nine years, cormorant abundance was reduced and sustained at agreed upon target levels in balance with the ecosystem, and in support of management plans to restore the fisheries. All the yellow perch monitoring metrics had reversed direction after cormorant management under the PRDO was implemented and the fisheries reached recovery targets for the first time in decades[9,16].

Game fish populations began to rebound and the local economy began to recover less than 10 years after the PRDO. Many fishermen and tourists returned to the area and local anglers and business owners observed the first noticeable improvement in their business in years. In fact, the economic impact of the collapse of the yellow perch population and fishery was estimated to have cost the two local communities of Cedarville and Hessel, Michigan, approximately $5.3 million in yearly economic activity (expenditure in 2001 dollars) [17]. The restoration of the fishery is believed to have restored much of that loss. By contrast, the cost of annual cormorant management by the USDA Wildlife Services was approximately $2,400 for the Les Cheneaux site with agencies and volunteers contributing other indirect costs for cormorant management[18]. Most importantly, however, was the quality of life and local heritage that was restored, for both the residents and visitors, through cormorant management and restoring ecosystem balance between birds, fish, and people.

The State of Michigan, Native American tribal governments, the USFWS, and many stakeholder groups expanded the work with the USDA Wildlife Services for intensive cormorant management at four more key locations between Lakes Huron and Michigan to realize benefits for a variety of important fish species to our shared fisheries. At the request of the Michigan DNR, we also asked USDA Wildlife Services and our stakeholders to employ innovative measures to protect newly stocked hatchery fish because they are particularly vulnerable immediately after stocking and until they disperse. A complex volunteer network

was developed involving hundreds of volunteers and agency professionals to develop harassment methods reinforced by limited lethal take to disperse feeding cormorants from fish stocking sites.

Through all of these activities, the Les Cheneaux Islands emerged as one of the nation's most well documented areas showing the interactions between cormorants, important fisheries, and the communities impacted by an initial failure to manage, followed by a successful case where cormorants can be managed in balance with fisheries goals and local communities and businesses. This was followed by similar approaches to managing cormorants at other locations in the Great Lakes region to realize a better balance of cormorants and Great Lakes fish populations. We believe strongly that cormorant management for the benefit of all fish, including aquaculture, newly stocked fish, and free-swimming fishes, has been widely deemed a management success up to the point of the legal challenge of the federal depredation orders.

The Federal Court Case

Because cormorants are protected under the Migratory Bird Treaty Act, ultimate management authority rests with the U.S. Fish and Wildlife Service. The depredation orders allowed states and other management agencies to share in the management of cormorants to better protect fish, wildlife, and sensitive habitats across the country. However, in May of 2016, these depredation orders were rescinded by the U.S. District Court until the U.S. Fish and Wildlife Service can reissue an Environmental Assessment that more adequately takes in to account the effects of the depredation orders on the cormorant populations.

Despite oversight by the USFWS, cormorant management under the depredation orders utilized lethal control, along with other non-lethal measures, to manage cormorant numbers. The lethal control was controversial with some groups because they objected to the suppression of one species for the benefit of another. This is, however, a common practice in wildlife management and agra-science. For example, agricultural pests are controlled for the benefit of crops. In the Great Lakes, sea lamprey are controlled through several lethal control techniques including the primary approach where juveniles are annual poisoned in the wild with oversight by State, Tribal, and United States Federal and Canadian Federal governments under the structure of the Great Lakes Fisheries Commission. Lethal measures are necessary to suppress sea lamprey numbers and prevent excessive parasitic predation on important game species.

We understand that objections can become more visceral or emotional when control is elevated to a warm blooded animal that is a native species even if population numbers are excessive and out of balance. As stated by the USFWS in their original Environmental Assessment (EA) in support of the original depredation orders, the purpose was to "(1) reduce resource conflicts associated with DCCOs in the contiguous United States; (2) enhance the flexibility of natural resource agencies in dealing with DCCO-related resource conflicts; and (3) ensure the long-term conservation of DCCO populations." Some critics sought to address the policies at the state and federal levels while others sought to attack the science that served as the justification for cormorant control.

Controversy over the management of cormorants with lethal control appears to emanate more within the natural resource profession than with the general public. There are two schools of philosophy over the idea of population manipulation of one species for the benefit of another[19]. Proponents see the role of the Natural Resource profession and proper management as one of intervention, necessary to restore and maintain balance in a system that is no longer responding to historic conditions but instead an artifact of past and current man-made perturbations. Alternatively, where ecosystems are stable, the rationalist may view natural resource management mainly through the understanding of nature and taking a 'hands off' approach to management. Although this may be a preferred strategy, our environment and natural resources are becoming more disrupted with stressors requiring active and responsible management actions for fish, wildlife, and habitat to protect the resources and maintain a better ecosystem balance. We believe that the opportunity to leave nature to take its own course on the Great Lakes, in both fisheries and wildlife management, has long since passed and that management agencies need to take a shared responsibility in the management for sustainable fish and wildlife for generations to come.

That controversy took the form of the lawsuit Public Employees for Environmental Responsibility (PEER) vs. USFWS in U.S. District Court, District of Columbia in 2014 upon the renewal of the PRDO by the USFWS with plaintiffs asserting that the Service did not sufficiently consider full impacts of the PRDO as required by the National Environmental Policy Act (NEPA) in their EA. The honorable Judge John D. Bates ruled in favor of the plaintiffs and ordered the AQDO and PRDO vacated in May 2016 ending collaborative cormorant management. In testimony to the court during the proceedings, the USFWS indicated that the EA could be revised and brought into compliance within 8 months' time laying the foundation for the restoration of the PRDO. To date, only case by case permitting in support of aquaculture impacts have been restored (November 2017) and the USFWS has publicly stated that the restoration of the PRDO is not a priority of the U.S. Fish and Wildlife Service because they lack the necessary resources to undertake the revision of the EA[20].

More recently the Service has announced that they will engage states, tribes and stakeholders to take comment on concerns but will not commit to a renewed EA or a resultant PRDO. This proposed legislation (Cormorant Control Act H.R. 4429) would compel the U.S. Fish and Wildlife Service to allocate the necessary resources to pursue the PRDO and the EA necessary to fully restore the ability jointly manage cormorants. In addition to the fisheries impacts that will be seen on local fisheries and the communities that they support across the Great Lakes region, the State of Michigan and the Les Cheneaux Island case study was not included in the federal court case. It is unclear as to the intent to not include the vast amount of information from non-federal governments as to the impacts of uncontrolled cormorant populations on fish populations and the communities that they support.

What Happens Without Restored Management Authority?

Since the depredation orders were vacated in May of 2016, management agencies have used predictive models in an attempt to forecast what will happen with cormorant populations in the Great Lakes region[18]. Predictions were made for both trends in cormorant numbers as well as the responses of the fish populations for seven main management locations in the Great Lakes. The predictions indicated that in the absence of cormorant management nesting numbers will return to their former peak abundance within 14 years and have the

same impact on fish by causing declines or potentially collapse of the associated fish populations and fisheries. Unfortunately, the predictions may have substantially underestimated the response times as cormorant nest numbers in the Les Cheneaux Islands region, for example, have increased by 85% in just a couple years from the last controlled nesting level in 2015. It is highly likely that all of the progress made from collaboratively managing cormorants will be lost well before the 14 year prediction and will be realized within the next few years. For all of the Great Lakes fisheries communities, their way of life and heritage is at risk without federal agencies taking responsibility for cormorant management.

Conclusion

Fishery impacts from cormorant proliferation and predation occur at localized levels but collectively have broad implications across the states. The range of management ability is set by the Federal Government through the USFWS as a result of the Migratory Bird Treaty Act. States like Michigan seek the restoration of flexibility to manage hyperabundant cormorant populations to achieve our fishery management targets. The first PRDO proved successful in allowing for cormorants to be reduced in abundance in problem areas while the overall cormorant population statewide remained abundant and viable. We recognize that the redevelopment of the EA in support of the PRDO is not a small undertaking. The Michigan DNR and other Great Lakes management agencies stand ready to assist the USFWS in work on the EA. However, this is an urgent matter and more than two years have passed since the court order without progress. We greatly appreciate Congressman Bergman and the House Natural Resource Committee's leadership on this issue in providing the USFWS guidance and priority setting to provide the states the necessarily relief. The service has made overtures of intent to pursue this issue. If they are genuine in this intent, then they should welcome this legislation as Congressional support for their mutual goal.

Notes

[1] Claramunt, R.M., D.G. Fielder, and J. Dexter. 2018. Reinstating collaborative management for double-crested cormorant populations: a Great Lakes perspective. Testimony to the U.S. House of Representatives, Committee on Natural Resources, Subcommittee on Federal Lands, February 15, 2018.

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[13]Hilborn, R., and Walters, C. J. 1992. Quantitative Fisheries Stock Assessment. Springer US.

[14]AQDO States: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Minnesota, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, and Texas.

[15]PRDO States: Alabama, Arkansas, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, New York, North Carolina, Ohio, Oklahoma, South Carolina, Tennessee, Texas, Vermont, West Virginia, and Wisconsin.

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Figure 1A. Offshore demersal fish community biomass in the main basin of Lake Huron, 1976-2017. Valid data were not collected in 1992, 1993, 1998, 2000, and 2008; biomass estimates for those years represent interpolated values. Credit: USGS Great Lakes Science Center.

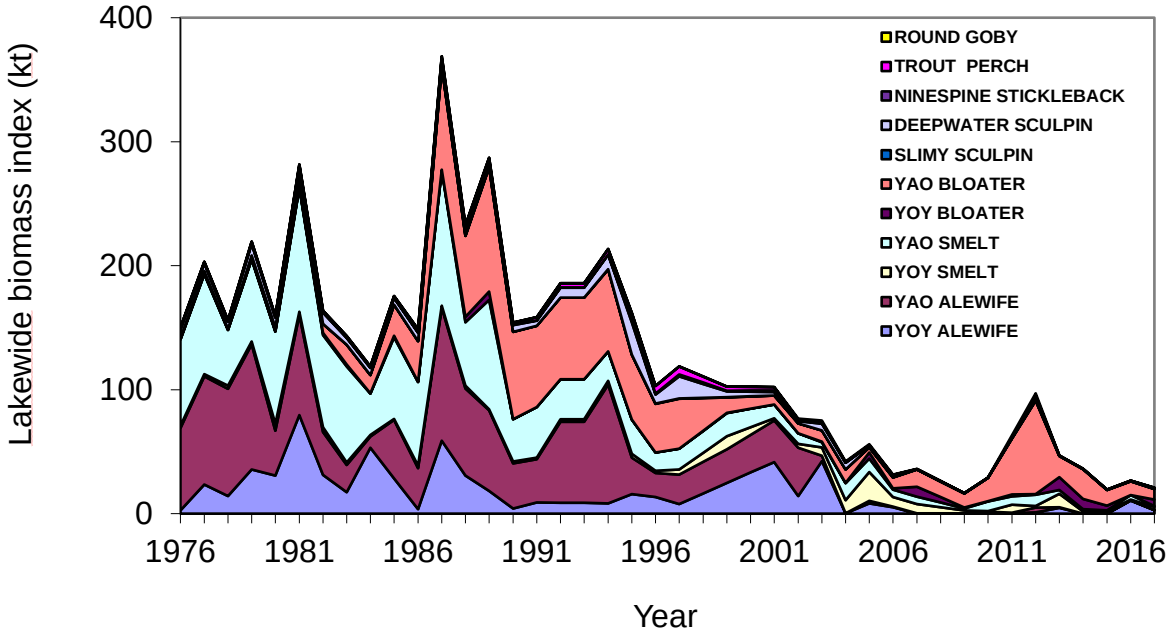

Figure 1B. Prey fish biomass as estimated by 70 daytime bottom trawls distributed across Lake Michigan during September-October, 1973-2016. Credit: USGS Great Lakes Science Center.

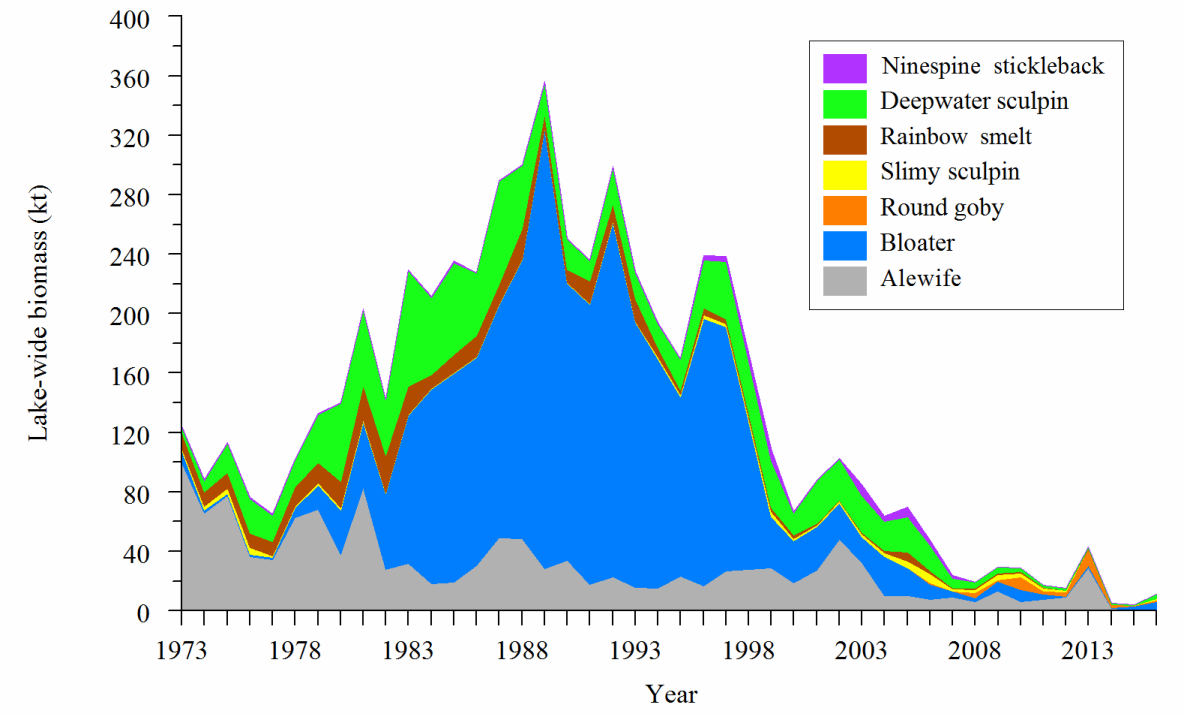

Figure 2. Yellow perch angler catch rate (number harvested per hour; dotted line) compared to cormorant nest counts (solid line) for the Les Cheneaux Islands, Lake Huron, during 1979 – 2016.