Integrated Assessment of Cisco (Coregonus artedi) Restoration in Lake Michigan. Project Summary

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Abstract

When the Integrated Assessment (IA) of Cisco Restoration was initiated, there was support for restoration efforts in Lake Michigan but managers were undecided on their approach. Most divergent views were to allow recovery of a Grand Traverse Bay population without intervention and to stock fingerlings from Lake Superior origin. The Native Planktivore Task Group, formed by the Lake Michigan Committee, was charged with scoping issues related to restoration of native planktivores including Cisco. The IA was intended to help move forward the decision-making process. We conducted interviews and surveys, participated in meetings, organized a workshop, created factsheets and provided other relevant information to stakeholders through oral presentations and websites. We engaged managers from local, state, federal, and non-government organizations involved in decision-making as well as fishers affected by cisco restoration. The IA increased the level of awareness about the restoration process. Interviews, surveys and the workshop provided information on perceptions about the status of Cisco remnant population(s) and restoration impediments, restoration options and preferences. A desirable level of consensus on how to proceed with restoration was not reached. Divergent stakeholder views became contentious and fisher's support for restoration declined. These impediments were partly due to lower lake productivity affecting Chinook salmon population status. This trend triggered stocking reduction and Salmon fishers did not want resources diverted towards Cisco. In addition, tribal fishing organizations shifted research focus on Cisco to Lake Whitefish, their primary commercial fishery, as recruitment declined. The situation by the end of the IA was that approval of the White Paper by the Lake Michigan Committee's Native Planktivore Task Group was tabled. This resulted in allowing time for the Grand Traverse Bay population to recover without additional interventions.

Keywords *Lake Herring, Cisco, Lake Michigan, Restoration, Stakeholder Process.*

Executive Summary

When the Integrated Assessment (IA) started in 2017, there was support to restore Cisco (*Coregonus artedi*) in Lake Michigan but managers were undecided on their approach. Cisco, historically the dominant prey that also supported large fisheries, was decimated by overfishing, habitat deterioration, and invasive species interactions. While the main population(s) in Green Bay was eradicated, a remnant population(s) in Grand Traverse Bay (GTB) was showing positive signs. Further, there was potential for restoration given habitat improvements that advanced natural conditions, declines in key invasive species, and a less productive lake for which Cisco is well suited. In addition, restoration was considered critical to support fish communities as the prey base, invasive alewife and smelt, was at an all-time low. Thus, restored Cisco was thought to provide for more sustainable fish community and fisheries. Views for restoration included allowing the GTB population to recover without stocking while improving habitat and controlling harvest, and stocking with fingerlings from GTB and other lakes origin. Therefore, the Lake Michigan Committee (LMC) charged the Native Planktivore Task Group (NPTG) with a White Paper to articulate restoration impediments for candidate species of coregonids including Cisco, potential management actions and likelihood of success, and summary of research needs. Our IA was to advance the decision making process by helping those involved in management and affected by fisheries to evaluate options.

Our IA accomplished its goals by providing relevant information and facilitating discussion. We summarized available information into four factsheets made available at meetings and the Michigan Sea Grant (MISG) website. We engaged managers from local, state, and federal agencies and non-government organizations involved in decision-making and fishers affected by cisco restoration by giving presentations at 12 regional meetings, conducting multiple interviews, implementing five surveys, and organizing IA meetings and a workshop. The interviews, surveys and discussions and the workshop provided valuable information on the perception about status of Cisco remnant population(s), restoration impediments, and restoration options and preferences. Survey respondents indicated that IA presentations informed their opinion regarding options for cisco management in Lake Michigan. Most respondents perceived GTB population(s) as small or medium size and undergoing an increasing trend; and were supportive of restoration through management actions. Among impediments to restoration, uncertainties about population status and population genetics rated the highest, followed by conflicting agency goals. The majority of respondents rated as important challenges for restoration the low size of the remnant population, budget limitations and lack of stakeholder engagement in the decision-making, while reduced spawning habitat and food availability, high predation, fishing mortality and Cisco restoration proposals for other lakes ranked low. Main reasons for supporting restoration were that Cisco would provide forage for top predators salmon and trout, and value to the sport fishery. Interviews indicated that the position held by stakeholders and managers at the Michigan Department of Natural Resources (MDNR), The Nature Conservancy (TNC), and The Little Traverse Bay Bands of Odawa Indians (LTBB) were in favor of allowing the GTB population to recover without stocking. Stakeholders and managers at US Fish and Wildlife Service (USWFS) and the Great Lakes Fishery Commission (GLFC) were in support of stocking Cisco from Lake Superior origin. This was confirmed by position statements presented by these organizations later in the process.

Despite the IA accomplishments, the Cisco restoration decision-making process stalled. During the IA period it became evident that available data were insufficient to support a desirable level of consensus. The process lacked clear restoration objectives and managers involved in the restoration process struggled to find much common ground on interpreting aspects of Cisco biology relative to restoration strategies. These issues guided divergent perceptions on restoration options. In fact, differences among manager and researcher positions about restoration at the beginning of the process remained unchanged, if not more entrenched. It became evident that among main impediments for a productive process were the high level of distrust among managers and researchers and deficiency in data to support decision-making. Further, sport and tribal fishers changed perception about restoration benefits as they became affected by declines in Chinook salmon and Lake Whitefish fish stocks. Fisher positions with respect to restoration were contingent on the species they targeted: while fishers benefiting from increasing Cisco catch supported restoration, those targeting Chinook salmon strongly opposed restoration efforts. Because the salmon fishery saw stocking reductions in Michigan waters as forage fish declined, fishers did not want to divert support from salmon. Cisco restoration was perceived as impacting the salmon fishery, even as a "conspiracy by the Feds in an all native agenda." Tribal fishers experienced a shift in their interest in restoration with the decline in population abundance of Lake Whitefish, species that supports their most important fishery. The tensions and difficulties encountered to find a level of consensus were not unique to the IA process. After reception of the NPTG White Paper, these issues caused the LMC to table the approval of the report indefinitely in hopes that, in time, camps would be able to come together and finalize the document. The situation by the end of the IA was that the status quo remained. Thus, there was the implicit decision made that there would be no Cisco stocking, which was one of the identified restoration options.

Introduction

The "wicked problem" addressed in this IA is that restoration was envisioned for collapsed Cisco (*Coregonus artedi*) populations in Lake Michigan but managers differed in their views on how to accomplish this goal. The issue was complicated because there was not yet agreement among managers on whether restoration of Cisco populations was possible by control of their mortality sources and habitat enhancement, or if efforts required stocking (Claramunt, MDNR, IA Initial Policy Contact). There were also different opinions among managers on what Cisco populations to use as brood stock if stocking were conducted. For example, one option was introducing fingerlings from populations from Lake Superior (LS); another was to rely on the remnant Cisco population in Grand Traverse Bay (GTB). There were arguments that the GTB population was too small to support egg take operations and that it is genetically bottlenecked, thus introducing stocks from other lakes would enhance genetic diversity. However, there were also concerns regarding effects of stocking on genetic population diversity and introducing pathogens (Jones and Dettmers 2007). The five tribes fishing in Lake Michigan were also undecided as to the concept of introducing Cisco from other lakes (Donner, LTBB personal communication). While there had been discussions about stocking fish only into Lake Michigan areas where Cisco currently do not occur, namely in Green Bay, there were concerns that a successful restoration would result in population expansion affecting the GTB population. Another argument to stock with GTB fingerlings was that Cisco life history strategies differ between populations, and that introducing LS fingerlings was less likely to succeed. According to MDNR unpublished sources, the GTB population is more piscivorous than the LS population, grows faster, matures earlier, reaches larger size, spawns on rocky reefs rather than on sandy substrate, and has little to no larval pelagic phase. Another consideration was that restoring cisco needs an ecosystem perspective (Zimmerman and Krueger 2009), thus understanding the cisco role in food webs, which entails having comprehensive data and tools that were not available. Further, of great importance is that restoration requires limiting harvest to allow building critical population abundance. This limitation affects the fishing community perception of the value of restoring the fishery, as Cisco is targeted by recreational fishers and is bycatch in the Lake Whitefish fishery. Harvest restrictions were thought to turn off fishers' support if they did not foresee benefits; or worse if they perceived Cisco restoration as having negative effects on the more profitable Lake Whitefish fishery. Thus, the objectives of the IA were to provide a framework for managers and the fishing community for building consensus on feasibility and preferable options to restore cisco populations in Lake Michigan.

Background

Cisco populations collapsed in all five Great Lakes between 1920 and 1970. The species was historically the dominant pelagic planktivore in the prey fish communities and supported large fisheries (Brown et al. 1999). An average of 4.85 million pounds was annually landed in commercial fisheries in Lake Michigan before its major decline starting in the late 1950s and currently it is landed as bycatch (Baldwin et al. 2009). Cited reasons of the declines are overfishing, predation by and competition with exotic alewife and smelt, sea lamprey impacts, and habitat deterioration (Smith 1972, Wells and McLain 1973, Selgeby 1982, Madenjian et al. 2008 and 2011). The relative contribution of these effects is still debated. While restoration was envisioned for all lakes, populations seem only recovered in Lake Superior (Gorman 2008, Kitchell et al. 2000). The Great Lakes Regional Collaboration Strategy states that having self-sustaining Cisco in open and nearshore waters is a desirable state for the Great Lakes and identifying donor stocks

for restoration is listed as an information need.

In Lake Michigan, there are remnant Cisco populations, and restoring sustainable populations and fisheries may be feasible, but physical and ecological conditions of the lake are dramatically altered, raising concerns over restoration viability. This fact is particularly concerning since historic production of Cisco was based in Green Bay (Smith 1956), where Cisco were extirpated and is now an Area of Concern. On the other hand, opportunities for restoration are declines of exotic competitors alewife and smelt (Bunnell et al. 2012), fisheries are small, source populations exist, and (although primary and secondary production is now lower) zooplankton communities and Mysis may be adequate to support restoration (Vanderploeg et al. 2012). Further, nutrient flow through the lake has changed and may be well suited for Cisco stocks and provide a link between near and offshore production, whereas non-native prey are primarily dependent on offshore production. Trophic conditions now resemble those of Lake Superior (Barbiero et al. 2012). Lastly, there is need for alternative forage given declines of alewife and smelt.

There have been ongoing attempts to restore Cisco in Lake Michigan. Some restoration objectives are articulated in the Fish Community Objectives (Eshenroder et al. 1995) and documents authored by tribal, federal, and state agencies, and non-governmental organizations. Experimental stocking has been carried out. LTBB completed construction of a hatchery capable of annually producing up to 105,000 fingerlings. Stocking (and tagging) is conducted in Little Traverse Bay from GTB population origin. It is too early to determine survival of stocked fish. Habitat (reef) enhancement is taking place with involvement of TNC. The LTBB conducts surveys in northeastern Lake Michigan but there are no reports on population trends. Through MDNR-Charlevoix efforts and research, it is known that a Cisco population spawns near the Grand Traverse Bay northeastern shore and juveniles utilize nearby areas in spring.

The Lake Michigan Committee (LMC) of the Great Lakes Fishery Commission (GLFC), responsible for developing and coordinating joint state/provincial/federal/tribal management programs, approved the formation of a specialized Task group (NPTG) to scope issues related to restoration of native planktivores including Cisco. NPTG was by design a small group made up by biologists from the US Fish & Wildlife Service (USFWS), US Geological Survey (USGS), Michigan Department of Natural Resources (MDNR), Wisconsin DNR, Chippewa/Ottawa Resource Authority (CORA), The Nature Conservancy (TNC), GLFC, and MISG. The charge to the Group was to produce a “White Paper” to articulate restoration impediments for candidate species, potential management actions and likelihood of success, and research needs. A draft White Paper existed when the IA started (NPTG 2015) but the document was only recently completed (NPTG 2018). Claramunt (MDNR) identified the need to expand the NPTG membership to discuss the restoration decision making-process with a wider audience, which was what prompted the IA on the Cisco restoration.

Methods

To facilitate the Cisco restoration decision-making process we conducted unstructured interviews, participated in meetings and provided information relevant to the restoration through oral presentations, conducted surveys, created factsheets that were distributed at meetings and through the MISG website, and organized meetings and a workshop. Through these tools and actions, we engaged managers and researchers from local, state and federal agencies, and non-government organizations involved in decision-making as well as fishers affected by cisco restoration.

Interviews

We conducted frequent and periodic informal interviews throughout the IA period by phone, electronic mail and in person. Interviews engaged over hundred fishers, team members, collaborators, managers, and researchers from multiple agencies who were stakeholders of the Cisco fishery. These included members from the NPTG. Interviews were structured to obtain information about perception on impediments to move the restoration decision-making process forward, preferred options for cisco restoration and reasons why particular options were favored. As several organizations focused on Cisco restoration efforts, interviews were also to follow up on ongoing developments related to the restoration process and reaction to their outcomes. For example, the Department of the Interior organized an exclusive Coregonine Restoration Science Workshop to which several collaborators were invited. Information on the level of entrenched perspectives expressed at these meetings was used to determine what topics were better addressed through interviews.

To inform interview questions we implemented an organization situational assessment and reviewed case studies. A situational assessment is a systematic process to gather, analyze, and synthesize data to inform planning decisions; it helps develop a basis of understanding of the environment in which a plan is delivered. Our assessment identified the stakeholders of the cisco restoration and their organizations, their roles in resource management to help advance understanding of stakeholder perceptions generated by their affiliation. Each interview was unique and did not follow a particular outline, but rather addressed questions that arose as issues related to cisco restoration developed. Additionally, to become aware of previous restoration processes for fish populations in the Great Lakes and inform the interview questions, we reviewed relevant case studies such as rehabilitation of lake trout populations in Lake Huron and Michigan (Bronte et al. 2008), chub restoration in Lake Ontario (Connerton 2014) and Cisco restoration in Lake Superior (Stockwell et al 2009). These case studies provided a reference for discussing the approaches taken, information used, and outcomes of restoration efforts.

Public presentations

To create presentations we gathered, reviewed, and summarized information relevant to Cisco and the restoration decision-making process. We delivered presentations adapted for different audiences at meetings attended by stakeholders of the Cisco fishery. Presentations provided stakeholders with information about the IA process, Cisco population(s) and fishery assessments, restoration efforts, and biological and ecological aspects relevant to restoration. Information was to guide the participatory process. To deliver presentations we targeted regularly scheduled meetings (Table 1). We used these opportunities to reach an inclusive group membership and to attract stakeholders to later attend the IA workshop. In addition, a set of presentations by IA team members and guest speakers were delivered at the IA Workshop and the content constituted the basis for the moderated session on restoration options.

Table 1. Public presentations conducted during the Cisco Restoration IA.

- Lake Michigan Technical Committee Meeting Winter 2016
- Michigan Charter Boat Association Annual Meeting 2016
- Ludington Regional Fishery Workshop 2017*
- Fish Producer Meeting 2017
- Lake Michigan Technical Committee Meeting Winter 2017*
- Lake Michigan Technical Committee Meeting Summer 2017
- Michigan Charterboat Association Annual Meeting 2017
- Wisconsin Federation of Great Lakes Sport Fishing Clubs Meeting 2017
- Lake Michigan Fisheries Forum 2017
- Michigan Fish Producers Association Meeting 2017
- Ludington Regional Fishery Workshop 2018 *
- Michigan Fish Producers Association Annual Conference 2019

* surveys were conducted

Surveys

We developed and implemented surveys to understand stakeholder level of awareness and perspectives about Cisco restoration, to help identify issues in the process and to refine information tools. Responses from surveys and interviews were used to plan and facilitate stakeholder interactions. Gathering this type of information is standard practice for facilitating stakeholder participation for environmental management (Reed 2008). Surveys were distributed at four public meetings attended by the wide range of stakeholders of the Cisco fisheries (Table 1). Before each survey, there was a presentation as described in the previous section. Survey 1 was distributed at the 2017 Ludington Regional Fishery Workshop as part of the meeting exit survey. The event was selected to reach a large number of fishers who attend these meetings. It contained only one question in a 5-point Likert scale (Likert 1932) asking if participants had a more informed opinion regarding options for cisco management in Lake Michigan from participating in the workshop. Survey 2 took place at the 2017 Winter Lake Michigan Technical Committee meeting. It consisted of a clicker polling survey using TurningPoint technologies (https://www.turningtechnologies.com). The event was selected to reach researchers, managers and fishers who attend these meetings. Participants had to indicate if they were members of the Lake Michigan Technical Committee, and other survey questions were about perception of the size and trends of the Cisco population(s) found in GTB, impediments to the restoration decision-making process, awareness of restoration efforts, level of support for restoration, and preferred strategy for restoration (Table 2). The survey included 5-point Likert scale and multiple-choice questions. Survey 3 was distributed at the 2017 Ludington Regional Fishery Workshop, Lake Michigan Fisheries Forum and Wisconsin Great Lakes Federation Sport Fishing Clubs meeting. These events were selected to reach mostly fishers who attend these meetings. The first three questions on a 5-point Likert scale were about prior knowledge related to Cisco restoration in Lake Michigan and other multiple-choice questions were on the level of support for restoration, and rationale (Table 3).

Factsheets

To distribute information relevant to Cisco restoration we developed factsheets summarizing the IA, on Cisco status and trends in Lake Michigan, and about Cisco management (stocking, habitat restoration, and fishery regulations). To create the factsheets we gathered, reviewed, and summarized relevant information across the Great Lakes. Information was from publications, reports, and available databases and

unpublished sources provided by collaborators. The factsheets were to expand the information in the NPTG White Paper, to be distributed at meetings including the IA Workshop, and to be made available to the public through the MISG website.

Workshops

We conducted a Workshop to identify a series of potential restoration options with participation of stakeholders and facilitate the decision-making process. The workshop took place in coordination with the 2017 Summer Lake Michigan Technical Committee meeting in Kenosha, Wisconsin. Participants were invited among fishers, researchers and managers from organizations involved in different aspects relevant to Cisco restoration. The morning session with a formal agenda was designed to generate participatory interactions. The afternoon session was dedicated to an informal conversation on how to move the process forward.

Results

Results of the IA consist of factsheets, outcomes from stakeholder interviews, meetings, surveys, and the workshop.

Interviews

Interviews helped to understand perceptions relative to cisco restoration over the IA period. We used responses to design surveys, guide participation in meetings, and to organize the workshop. They also allowed assessing the evolving fishery situation in Lake Michigan fisheries and its effects on stakeholder perspectives on cisco restoration. Ongoing communication was instrumental to understand levels of disagreement and dissent among stakeholders including managers, researchers and fishers, and identify the origin of these differences. The situation clearly diverged between two groups, with USFWS and GLFC managers advocating for stocking Cisco from Lake Superior origin and State and tribal agency members advocating against intervention. Through interviews, we learned that by extension, our Cisco IA assessment funded by MISG was seen as aligned with the federal agency position rather than as independent facilitator of the decision-making process. Understanding of this contentious climate determined that a planned second IA workshop be replaced by smaller meetings among members and collaborators.

Interviews revealed that there were many points of disagreement based on perceptions affecting the restoration efforts that could not be resolved due to lack of data. Some of those points gave origin to our survey questions. One main issue was about the size of the GTB Cisco population(s). In absence of population assessments, some researchers perceived size as small and stagnated, while others perceived it as large and making a recovery. There were arguments on what constituted a significant population size so that restoration efforts through stocking and introducing Cisco from other lakes would not be necessary. Researchers who perceived the population to be small supported restoring Cisco by stocking from sources other than Lake Michigan. On the other hand, researchers who perceived the population making a recovery supported restoring Cisco through non-stocking options. Another issue was about perception of the Cisco distribution. Some researchers proposed that before populations collapsed, Cisco were found in coastal areas, similar to the current distribution, while others maintained that Cisco occupied offshore areas and that the current distribution was restricted. These arguments relate to notions of Cisco morphotypes, genetics and ecology with restoration implications. Researchers who thought that Cisco were distributed lake-wide supported stocking Cisco from Lake Superior origin, while those proposing that Lake Michigan

Cisco were always coastal opposed the stocking of Cisco from other sources. As we continued the interviews, we gradually realized that the IA efforts could be no match to existing uncertainties to guide Cisco restoration and to the personal dynamics around the decision-making process. Given the history of interagency and interpersonal mistrust about these issues, it became clear that it would be unlikely to have constructive discussions without additional data to provide some clarity.

Public Presentations

We reached hundreds of community partners representing the range of stakeholders of the Cisco fisheries attending the 12 public presentations about the Cisco Restoration IA between 2016 and 2018 (Table 1). Together with presentations, participants received IA factsheets as they became available, and responded to surveys in five of them (Tables 2 and 3). These presentations were effective based on survey (see survey results).

Surveys

Survey 1. Results of the survey conducted at the 2017 Ludington Regional Fishery Workshop indicated that the IA presentation increased participants' knowledge about Cisco restoration. There were 42 respondents and 38 agreed or strongly agreed that participating in the workshop informed their opinion regarding options for Cisco management in Lake Michigan. Only three responses were neutral and nobody disagreed. Discussions with captains and sport fishing organization representatives were productive and civil, and it was possible to adequately frame the role of MISG and the IA process in restoration so that it would not further polarize the audience. The focus was kept on educating anglers, and we explicitly stated the goal of informing (rather than soliciting) their opinions.

Survey 2. The clicker survey conducted as a TurningPoint polling session at the 2017 LMTC meeting provided valuable insights about stakeholder perspectives on several aspects of the Cisco restoration process in Lake Michigan. There were 49 respondents, of which 15 were members of the LMTC, therefore familiar, if not engaged, with Cisco restoration. Thus, responses on awareness of restoration activities before the IA presentation were mixed, indicating that about half of the respondents were highly or very highly aware. Most respondents able to characterize the size of the Cisco population(s) in GTB (31), perceived it as small or medium size (Table 2). There were 28 respondents able to identify the trend of the GTB population(s) and most perceived it as increasing. Most respondents, over 80%, were highly supportive of restoration through management actions. Among questions about biological aspects perceived as impediments to restoration, over 60% of the respondents rated the low remnant population size as significant. Uncertainties about population status and population genetics rated the highest (~ 90%) among all restoration impediments by most respondents. On the other hand, about half of the respondents rated budget and lack of stakeholder engagement in decision-making as important challenges for restoration, thus lower than the importance about uncertainties related to population status or genetics. Reduced spawning habitat was considered less of an impediment than low remnant population size, with about only one fourth of the respondents rating it high. Food availability and high predation ranked low as impediments but uncertainty among respondents was also higher. Fishing mortality ranked even lower than food availability, with about half of the respondents rating the importance of this aspect as very low or low. The questions related to policies and restoration indicated that a large respondent majority (over 70%) perceived that conflicting agency goals was an important impediment. Cisco restoration proposals for other lakes was not considered an impediment although about a third of the respondents were unsure about its importance.

Table 2. Responses from the clicker survey on stakeholder perception of Cisco restoration efforts in Lake Michigan conducted at the 2017 Winter Lake Michigan Technical Committee meeting. Respondents = 49.

Prior awareness of Cisco restoration	Very low	Low	Neutral	High	Very high	Unsure
	8%	19%	27%	29%	17%	0%
Characterize population size in Grand Traverse Bay	Extremely small	Small	Medium	Large	Very large	Don't know
	7%	27%	26%	6%	0%	34%
Characterize population trend in Grand Traverse Bay	Increasing slowly	Increasing rapidly	Stable	Decreasing slowly	Decreasing rapidly	Don't know
	30%	23%	4%	0%	0%	43%
Support for restoration through management	Very low	Low	Neutral	High	Very high	Unsure
	2%	6%	9%	32%	51%	0%

Rating of factor severity for Cisco restoration

	Very low	Low	Neutral	High	Very high	Unsure
Low population size	2%	11%	11%	33%	29%	14%
Uncertainty on population status	0%	0%	0%	40%	50%	10%
Budget limitations	4%	17%	11%	39%	13%	16%
Uncertainty on genetics	2%	2%	9%	25%	52%	10%
Lack of stakeholder engagement	4%	13%	20%	30%	7%	26%
Reduced spawning habitat	5%	20%	30%	15%	2%	28%
Low food availability	5%	12%	22%	22%	2%	34%
High predation	0%	21%	21%	21%	4%	33%
Fishing mortality	18%	39%	8%	8%	2%	25%
Conflicting agency goals	0%	2%	11%	36%	36%	15%
Restoration proposals in other lakes	0%	24%	18%	27%	4%	27%

Survey 3 distributed at the 2018 Ludington Regional Fishery Workshop (LRFW), the Lake Michigan Fisheries Forum (LMFF) and Wisconsin Great Lakes Federation Sport Fishing Club (WGLSFC) meetings, provided useful information on reasons why stakeholders supported restoration and about their preferred strategy for restoration. Among the 63 survey respondents (mostly charter captains and salmon/trout anglers) at the LRFW, over 60% were knowledgeable about Cisco restoration efforts in Lake Michigan and indicated support for Cisco restoration (Table 3). Many skipped the question on reasons for restoration support with top reasons being to provide forage fish for salmon and trout (22) and the value of Cisco to the sport fishery (18). There were no answers on preferred restoration methods. Among the 18 participants who responded to the survey distributed at the LMFF, over 70% indicated they were well informed about Cisco restoration efforts in Lake Michigan and were supportive (Table 3). The one respondent who strongly disagreed in the support of Cisco restoration indicated that the restoration should

focus on other species such as Lake Whitefish. With respect to reasons for supporting restoration, the top ratings were for Cisco providing forage fish for salmon and trout, and decreasing importance because of the value of Cisco to the sport fishery, the commercial fishery, and for its cultural significance. Responses on preferred restoration strategy were most in support to stocking cisco from Lake Michigan and Superior strains, followed by support for allowing time for natural recovery of the remnant population, and restoring habitat. Among the 15 participants who responded to the survey distributed at the WGLSFC, over 70% were informed about cisco restoration efforts and over 90% supportive of restoration (Table 3). With respect to reasons for their support, the top ratings were for Cisco value for the sport fishery and for providing forage fish for top predators, followed by value in the commercial fishery and cultural significance. On preferred restoration strategy, most respondents favored stocking with Lake Superior origin, followed by stocking with Lake Michigan origin and restoring habitat. There were no responses supporting time for natural recovery. Other strategies proposed were following the Lake Huron lead and imposing restrictions on commercial fishing.

Table 3. Survey 3 results on stakeholder restoration awareness and support, distributed at Ludington Regional Fishery Workshop (LRFW) in Michigan (n= 63), Lake Michigan Fisheries Forum (LMFF) (n=18), and Wisconsin Great Lakes Federation Sport Fishing Clubs (WGLSFC) (n=15) meetings.

I know about efforts to restore Cisco in Lake Michigan	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Unsure
LRFW	5%	9%	21%	42%	21%	2%
LMFF	0%	18%	6%	18%	53%	6%
WGLSFC	0%	17%	8%	17%	58%	0%
I support restoring Cisco in Lake Michigan	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Unsure**
LRFW	2%	0%	24%	31%	31%	12%
LMFF	*6%	0%	18%	18%	59%	0%
WGLSFC	0%	0%	8%	42%	50%	0%

*Current focus should be on Lake Whitefish, perch, and other native and non-native stocked (restore sustainable balance).

If you are in support of restoring Cisco, please indicate why (check all that apply):			
	LRFW	**LMFF**	**WGLSFC**
It would provide forage fish for top predators	22	10	9
It has value for the commercial fishery	10	6	3
It has value for the sport fishery	18	8	11
It is a species of cultural significance in the region	10	5	5
Other_____	3	-	-

Please check your preferred restoration strategy:		
	LMFF	**WGLFSC**
Allow time for natural recovery	3	0
Restore spawning habitat	3	2
Stocking from Lake Michigan spawners	6	5
Stocking from Lake Superior spawners	5	10
Other_____		Follow Lake Huron lead Restrictions on commercial fishing

No answers from LRFW on preferred restoration strategy

Factsheets

There were four factsheets produced for the Cisco Restoration IA. The first factsheet describes the project, the second is an account of Cisco population(s) status and description of population trends in Lake Michigan based on up-to-date estimates from survey and fishery data. The third is a comprehensive review of Cisco management measures, including restoration efforts, in Lakes Michigan, Superior, Erie, Huron and Ontario. Management measures consisted of stocking, habitat restoration, and harvest controls. This Project Summary is the fourth factsheet. Factsheets were distributed as they became available and are posted in the project URL in the MISG website.

https://www.michiganseagrant.org/wp-content/uploads/2018/08/Cisco-Restoration-in-Lake-Michigan-project-summary4.pdf
https://www.michiganseagrant.org/wp-content/uploads/2018/08/Trends-and-Statusdistributed-04162018-MISG.pdf
https://www.michiganseagrant.org/wp-content/uploads/2019/04/Cisco-Management-Restoration-Efforts.pdf

Workshops

The IA workshop, carried out in conjunction with the 2017 Summer LMTC meeting, accomplished our main objective of identifying all possible options for rehabilitating Cisco with participation of stakeholders. We provided participants with a general overview of the IA project, process, and goals, and delivered information on a range of relevant topics. To that end, we delivered compiled information on background knowledge, identified information gaps, and reviewed cisco restoration strategies in other Great Lakes including a discussion on lessons learned. There were 40 community partners in attendance. Restoration options articulated by participants included Cisco non-stocking and stocking alternatives (Table 4). Non-stocking options ranged from maintaining status quo to actions to improve reproduction and survival, while stocking options included using brood stock from Lake Michigan or other lakes and using different life stages.

Table 4. Cisco restoration activities identified by IA Workshop participants.

Non-Stocking management options

- Allow remnant population to increase
- Do nothing = maintain status quo
- Restore Habitat
- Reduce mortality through:
  - Predator control
  - Fishing restrictions
  - Management of goby populations
  - Management of lamprey populations
  - Egg protection from predators

Stocking management options

- Source
  - Lake Michigan
  - Grand Traverse Bay
  - Lake Superior single source
  - Multiple sources
- Life stages
  - Stock with eggs
  - Stock with smolts

Hybrid options

- Stock eggs and provide predator protection for eggs
- Stock smolts and enlist help from fishing clubs to protect stocked fish

While IA workshop participants identified options for cisco restoration, there was no apparent level of consensus on a preferred option emerging from the discussions. There were deep roots of disagreement, already noted through interviews and previous meetings, which remained to be resolved. Nevertheless, the afternoon session with a smaller number of participants provided outcomes conducive to alleviate some obstacles. Stakeholder interviews before the workshop had revealed that among main points of disagreement affecting the restoration efforts were the perceived size of the GTB Cisco population and current close to shore - offshore distribution relative to that before population(s) collapse and we discussed ways of addressing these issues. Thus, our meeting focused on finding "low hanging fruits," namely low investment activities to decrease population uncertainties. To that extent IA collaborators from federal and state agencies agreed to add a survey to the Lake Michigan annual monitoring program to evaluate Cisco abundance, and also offered to expand a project on historical survey data to characterize Cisco distribution. The additional survey, conducted in Little Traverse Bay by LTBB and USGS using hydroacoustics, indicated a population of 15,620 Cisco (1.93 fish per hectare) (Supporting Cisco (*Coregonus artedi*) Restoration in the 1836 Treaty Waters of Lake Michigan https://deepblue.lib.umich.edu). Due to methodological shortcomings, results were not published in agency reports and were not helpful to address the question on Cisco status. The historical data analysis produced maps of Cisco distribution through data mining of historical fishery independent surveys (Kao et al 2020). The maps indicated higher CPUE in coastal than in offshore areas but were inconclusive given survey design.

Discussion

Interviews were invaluable to understand stakeholder perspectives on cisco restoration and guide the IA. The role of these personal interactions to provide insights on the thought process of stakeholders and to build trust, cannot be stressed enough. The ultimate benefits of these undertakings are hard to quantify and will materialize in unpredictable ways beyond the IA.

Public presentations allowed us to disseminate information relevant to Cisco restoration and the IA, and provided opportunities for insightful conversations about the process and for ongoing interpersonal dynamics among stakeholders. Feedback from the presentation at the LRFW and the spirited discussion after the presentation was revealing in many aspects. One recommendation made by a stakeholder was that before the IA went too far there should be a completed NPTG White Paper report. Waiting for the completed report was not practical because the date was beyond the IA control. Another point of contention was that a number of survey respondents, much attuned to subtle differences in wording, expressed concern about the need for formulation of the questions being very precise. This is paradoxical as the survey was to learn about stakeholder perceptions. Attending to the criticism implied that to conduct surveys would have required that each question be prefaced by an entire slide of text explaining the context and definition of terms used. That type of exercise was also impractical. The feedback clearly indicated a high sensibility about the topic triggered by the level of disagreement that existed among stakeholders about restoration options.

Surveys were instrumental in assessing that a large fraction of stakeholders of the Lake Michigan fisheries were still not aware about restoration efforts in Lake Michigan, thus that undertaking outreach activities

such as our IA are necessary. While the majority of respondents expressed support of restoration through management intervention, we cannot assert the basis for such support, in particular because those able to characterize the GTB population trend perceived it as increasing. Perhaps they perceived the increase being too slow or only in particular areas, such as in Grand Traverse Bay. Survey results corroborated what we learned over interviews and conversations at meetings in that the main perceived restoration impediments were the Cisco population status and population genetics and also conflicting agency goals. Thus, while more research is needed to address biological uncertainties, it is also necessary to continue addressing the decision making process. Survey results also showed that stakeholders of the Lake Michigan fishery will support Cisco restoration if that provides for fishing opportunities either as a prey for target species or as a target species.

Workshop

The restoration options identified by stakeholders were within those that had been previously articulated and can be categorized as monitoring the GTB remnant population(s), engage in fish culture and habitat restoration, establish regulations-harvest limits, and use indirect methods to reduce competition and predation. Although proposals were not novel, the event provided an opening for a robust discussion and participants appreciated the opportunity to voice their perspectives and hear the perspectives of others. On the other hand, the interactions prompted continuation of the current circular discussion that had been causing the restoration process to founder. While the notion of an inclusive conversation is desirable, we experienced that this open forum had become a debate between opposing "sides" and concluded that a scenario where stakeholders are asked to express preferences in the face of conflict among scientists and managers will not likely advance progress towards sound management decisions on Cisco management. Thus, the second IA workshop was cancelled and replaced with a later round table instead.

In contrast, the afternoon discussion was quite productive. Whether it was the smaller number of participants or the composition of the group, it felt like a more constructive vetting of perspectives in which people were actually listening to one another and asking clarifying questions rather than challenging each other's comments.

The round table meeting carried out in Ann Arbor with team members and collaborators allowed the conversation initiated during the workshop to continue but the outcome was disappointing. The results from the Little Traverse Bay assessment and the creation of historical Cisco maps were discussed. In the absence of peer-reviewed publications, the information was considered uncertain and was still subjected to interpretation. The discussion suggested that there would be little agreement on how new information would be used, other than to make a case for the already established positions.

Although we had planned a second IA Workshop to develop a decision tree to guide the decision-making process, conditions in the Lake Michigan fisheries changed in ways that made the meeting irrelevant if not impractical. In fact, given the experience during the first Workshop and the increased level of distrust among managers and fishers, a second workshop would have resulted in repeating positions towards restoration efforts. Interviews with stakeholders and collected position statements from organizations involved in the process allowed us to document the situation and to corroborate that the decision to suspend the second workshop was appropriate.

Conclusions

By the end of the IA, managers did not agree on a recommended course of action but the IA helped to identify roots of disagreement that need to be addressed before recommendations can be developed. While most stakeholders were in support of a restored Cisco population in Lake Michigan, there has been ongoing disagreement in investing resources into restoration efforts and about the kind of management actions to carry out. Changes in the lake and fisheries exacerbated these issues and took away support for restoration efforts. Stakeholder disagreements resulted in the Lake Michigan Technical Committee not taking action on Cisco restoration upon reception of the NPTG White Paper report. Paradoxically, this is the de facto equivalent to embrace the option of allowing the Grand Traverse Bay Cisco population to recover with no new interventions. This option satisfied the positions of MDNR and the LTBB with respect to achieve Cisco restoration by allowing time for the population(s) to recover.

Although evaluating the influence that our IA work had on the restoration decision-making process is impractical, it is clear that managers did not achieve a desirable level of consensus as they continued to differ in their views. Nevertheless, the project certainly disseminated relevant information and promoted discussions. The IA identified critical data required to make informed decisions and highlight the need for explicit measurable objectives to guide the process. It became clear that the perspectives of managers and other stakeholders on appropriate restoration option(s) was and will continue to be influenced by economic and political factors as well as by personal dogmas.

Recommendations

Advancing the decision making process on Cisco restoration in Lake Michigan will continue to be a difficult task. Our experience indicates that improving data availability and articulating measurable restoration objectives would be helpful. With respect to data needs, besides those already prioritized by the White Paper on genetics, different views on Cisco restoration are influenced by incomplete data on population abundance. Much of the uncertainty could be resolved if reliable robust stock assessment were conducted and published. There is a real need for integrated and coordinated Cisco abundance monitoring and for reliable estimation of fish removals. We recommend establishing a multi-agency, lake-wide Cisco routine assessment including larval stages. In addition, the IA process and discussions during the workshop made clear that in order to move forward with Cisco restoration there should be explicit, achievable and measurable restoration objectives on the table, articulated by managers. Further, actions towards restoration could be taken that do not involve the controversial issue of stocking, such as controlling Cisco harvest to protect the existing population. While a proposal to decrease the Cisco daily bag limit (from 12 to 10 fish in any combination of Cisco, Lake Whitefish and Round Whitefish) for the recreational fishery in waters of the State of Michigan was approved, such a measure is not contemplated for the commercial fishery. Finally, during the IA it became evident that human nature and personal relationships among stakeholders, intertwined with differing organizational agendas, are main determinants that are stalling the decision making process. Recommendations on that subject are beyond the IA scope.

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