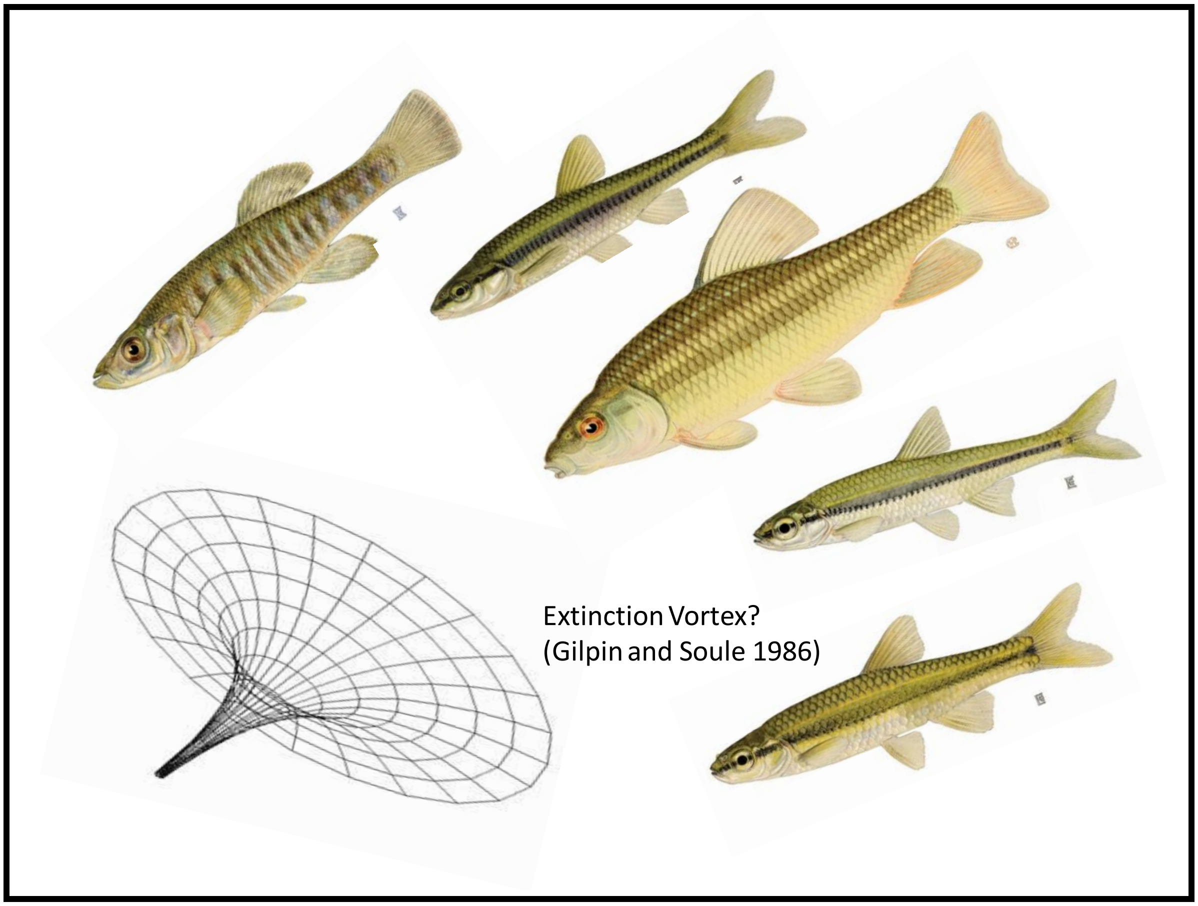
Feasibility of Restoring Nongame Fish Populations in Lake Ripley, Jefferson County, Wisconsin



Prepared by:

David W. Marshall, Underwater Habitat Investigations LLC

Paul Dearlove, Lake Ripley Management District

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Summary

Since the 1970s, several native fish species had declined or disappeared from Lake Ripley in Jefferson County, Wisconsin. This is consistent with similar trends reported throughout southern Wisconsin for decades. As elsewhere, the declines in Lake Ripley coincided with habitat degradation, habitat fragmentation and environmental pollution. We reviewed literature and interviewed fish geneticists, fishery ecologists, limnologists and aquaculturists to assess the feasibility of using conservation aquaculture to reintroduce locally extirpated species back into Lake Ripley. This analysis also considered significant habitat and environmental improvements in the lake following two decades of proactive lake and watershed management. While the collection and artificial propagation of rare fish are not without risks, natural recruitment and re-colonization will not occur given the current status and distribution of these rare nongame fish populations. Consequently, a lack of intervention can represent an even greater risk to the regional success and sustainability of these species.

We assessed the status of five nongame species that appear to have disappeared or became very rare in Lake Ripley. From that list, we identified the State Special Concern banded killifish (*Fundulus diaphanus*), blackchin shiner (*Notropis heterodon*) and blacknose shiner (*Notropis heterolepis*) as the best options for propagation and reintroduction. Since these species are not presently listed as Threatened or Endangered in Wisconsin, fish distribution data suggests that a sufficient number of genetically-unrelated breeders can be found within the basin. By using the best available science and technology in concert with established fish-propagation and reintroduction guidelines, the potential risks of genetic drift associated with this type of fish conservation can be minimized. Furthermore, we believe the odds for achieving conservation recovery goals for these species are favorable given that: 1) habitat has improved and continues to improve in the lake; and 2) propagation, translocation, reintroduction and augmentation (PFRA) guidelines would be followed for both state-of-the-art aquaculture facilities and pond culture.

Introduction

During the mid-1970s, diverse nongame fish populations existed in Lake Ripley based on nearshore fish surveys that were performed as part of the Fish Distribution Study (Fago 1992). These survey methods were replicated in 2004 as part of the Fishes of Wisconsin Project (Lyons 2013), and then expanded in 2012 as part of a Lake Ripley Management District-sponsored lake planning grant project. Other nearshore fish-collection surveys were performed, including a study on the impacts of shoreline habitat modifications on fish assemblages (Jennings et al. 1999), and baseline monitoring surveys performed by the Wisconsin Department of Natural Resources. The cumulative findings demonstrated that many environmentally intolerant and regionally rare species had disappeared from the lake since the 1970s (see Appendix A). These species include the State Threatened pugnose shiner (*Notropis anogenus*), blacknose shiner (*Notropis heterolepis*), blackchin shiner (*Notropis heterodon*), State Special Concern least darter (*Etheostoma microperca*), and State Special Concern banded killifish (*Fundulus diaphanus*). State Special Concern lake chubsuckers are occasionally collected during baseline boomshocking surveys but have not been found through nearshore collection efforts since the 1970s.

The nongame fish declines coincided with the loss of nearshore habitat linked to a number of factors including development, Eurasian watermilfoil (EWM) invasion, large-scale herbicide treatments, and cultural eutrophication (Dearlove 2009). Declines of environmentally-sensitive and rare, nongame fish species had also occurred throughout southern Wisconsin and the upper Midwest in recent decades (Becker 1983, Lyons et al. 2000, Pierce et al. 2001, Marshall and Lyons 2008). Nongame fish declines often reflect changes in environmental conditions that favor more tolerant species, as well as fragmentation of aquatic plant habitat that can isolate populations (Walsh et al. 2009). For example, eight nongame fish species (including pugnose shiner, blacknose shiner, blackchin shiner and banded killifish) disappeared from Lake Mendota as EWM expanded in the lake (Lyons 1989). Nearshore habitat changes associated with development of seawalls and piers can also have a negative impact on nearshore fish populations (Jennings et al. 1999, Garrison et al. 2005, Radomski et al. 2010). Littoral zone habitat quality can also be affected by motorboat traffic (Asplund and Cook

1997). It is noteworthy that nongame fish declines in southern Wisconsin usually involved species that display strong affinities for native aquatic plant habitat.

A variety of anthropogenic activities ranging from cultural eutrophication to nearshore habitat disturbances can contribute to declines in the diversity and spatial coverage of native aquatic plants. Direct physical disturbances such as herbicide treatments, shoreline armoring and piers can be more detrimental than the indirect reduction of aquatic plants linked to eutrophication. Among a group of southeast Wisconsin lakes where nearshore fish populations were sampled in 2004, Camp Lake was the most eutrophic but also supported the greatest number of rare fish species. Camp Lake was also the least developed lake sampled as part of that effort (Marshall and Lyons 2008, Lyons 2013).

While maintaining freshwater biodiversity and ecosystem functions are of critical importance, human activities continue to threaten these freshwater ecosystems at unprecedented levels (Dudgeon et al. 2006). The loss of biodiversity can negatively affect lake food webs and nutrient cycling (Vaughn 2010). Forty percent of freshwater fish in the United States are currently imperiled to some degree, mostly due to habitat degradation and nonindigenous species introductions (Jelks et al. 2008, Walsh et al. 2009). The losses that occurred in Lake Ripley are perhaps a microcosm of declining freshwater biodiversity that is occurring nationally and globally.

Since the early 1990s, the Lake Ripley Management District has taken a progressive approach to lake management, including watershed nutrient loading reduction, environmental monitoring, mechanical harvesting of EWM, and nearshore habitat improvement projects (Dearlove 2009). Lake water quality has improved over this time based on Trophic State Index metrics (chlorophyll, total phosphorus and clarity). Lake rehabilitation has also coincided with a decline in EWM and resurgence of native aquatic plants. Ongoing habitat improvements, such as the installation of nearshore tree-falls and native lakeshore buffer plantings, could ultimately benefit rare and declining fish populations.

Rehabilitation differs from restoration since the former often lacks a return of many ecosystem functions and biodiversity that represent pre-disturbance conditions (Cooke 2005).

Rehabilitation goals are often defined as achieving desired TSI benchmarks or reducing nuisance macrophyte levels, but do not address native biodiversity and associated ecosystem functions. The recent nearshore habitat improvements in Lake Ripley do not represent a restoration without addressing pre-disturbance conditions and biodiversity, including the littoral zone fish assemblage and associated ecosystem functions. Furthermore, restoration is important since traditional or mainstream environmental management will not likely stem the tide of freshwater extinctions (Hughes and Noss 1992, Strayer and Dudgeon 2010). As perhaps the last stage of lake rehabilitation and transition toward restoration, the Lake Ripley Management District is evaluating the potential to reintroduce several locally-extirpated nongame fish species and hopefully recapture some of the lost biodiversity in the lake.

The Lake District is considering conservation aquaculture as a method to reintroduce regionally rare or declining fish species to repopulate the lake. Conservation aquaculture is defined as the use of fish rearing to recover endangered or imperiled fish populations (Anders 1998, Ireland et al. 2002). The collection and propagation of wild and rare fish species is not without risks, but the potential for the natural recolonization of rare fish species in Lake Ripley is extremely remote. The rare fish populations that were previously found in the lake are already rare and declining across the Rock River Drainage Basin (Marshall and Lyons 2008). Declining population sizes, habitat fragmentation, and population isolation across the basin significantly reduce the potential for recolonization. When coupled with habitat restoration, conservation aquaculture is considered essential for recovery for many imperiled fish species (Anders 1992, Shute et al. 2005). The Lake District hopes that this feasibility analysis will prove useful in the design and implementation of a pilot project that can guide other potential species restorations across Wisconsin. If implemented, the reintroduction of rare nongame fish species into Lake Ripley may play a small part in preventing the further decline of these species in Wisconsin and throughout the region.

Proposed Restoration Site

Lake Ripley is a 169.2-hectare (418 acres) calcareous drainage lake located in Jefferson County, Wisconsin. It lies at the terminus of an 18.9-square kilometer (7.3-sq. mi.) watershed that is predominantly agricultural. The lake is classified as mesotrophic based on standard Trophic State Index (TSI) parameters, but values occasionally exceed Lake District goals of less than TSI 50. The shoreline is characterized by moderately-dense residential development, with a relatively high pier density of 70.8 per kilometer (44 per mile) of shoreline. Undeveloped shorelines include extensive riparian wetlands that lie along the south side of the lake.

Although a 1993 shoreline inventory identified 31% of the total lakeshore as exhibiting moderate to severe erosion, a 2012 inventory revealed that overall shoreline erosion had been greatly reduced. Over that 19-year period, the Lake District helped protect and restore 1,909 meters (6,261 feet) of eroding shoreline through its landowner cost-sharing initiative. The 2012 inventory also showed that about 13% of the total shoreline (within 35 feet of the lake edge) was at least 25% covered with hard-surface development. Lawns represented the most prevalent type of non-impervious land cover, with 30% of the total shoreline characterized as having at least 50% turf within 35 feet of the lake edge. Predominantly natural and heavily-vegetated shorelines represented about 36% of the overall shoreline. Looking strictly at the shoreline edge, roughly 46% of Lake Ripley is lined with rock or seawall, 36% is natural, and the remaining 18% is either beach sand or “other” (i.e., boat ramps, wet boat houses, etc.).

Approximately 25 percent of the immediate littoral zone (within 35 feet of the lake edge) was found to be nearly devoid of rooted aquatic plants. This was most likely due to a combination of natural substrate limitations and manmade factors (e.g., sand dumping and raking). Most of the plant-deficient areas were found within or near beaches, and in variable patches along the northwest and east shorelines. Conversely, just over half the shoreline (51%) supported moderate to high levels of rooted aquatic plant growth. These higher-growth areas were mostly found along the south and southeast shoreline areas, and generally corresponded with wetlands and Wisconsin DNR-mapped Critical Habitat Areas.

Figure 1 shows the locations of nearshore fish survey sites from 1975, 2004 and 2012. Figure 2 demonstrates the decline of rare and environmentally-intolerant, nongame fish species in Lake Ripley.

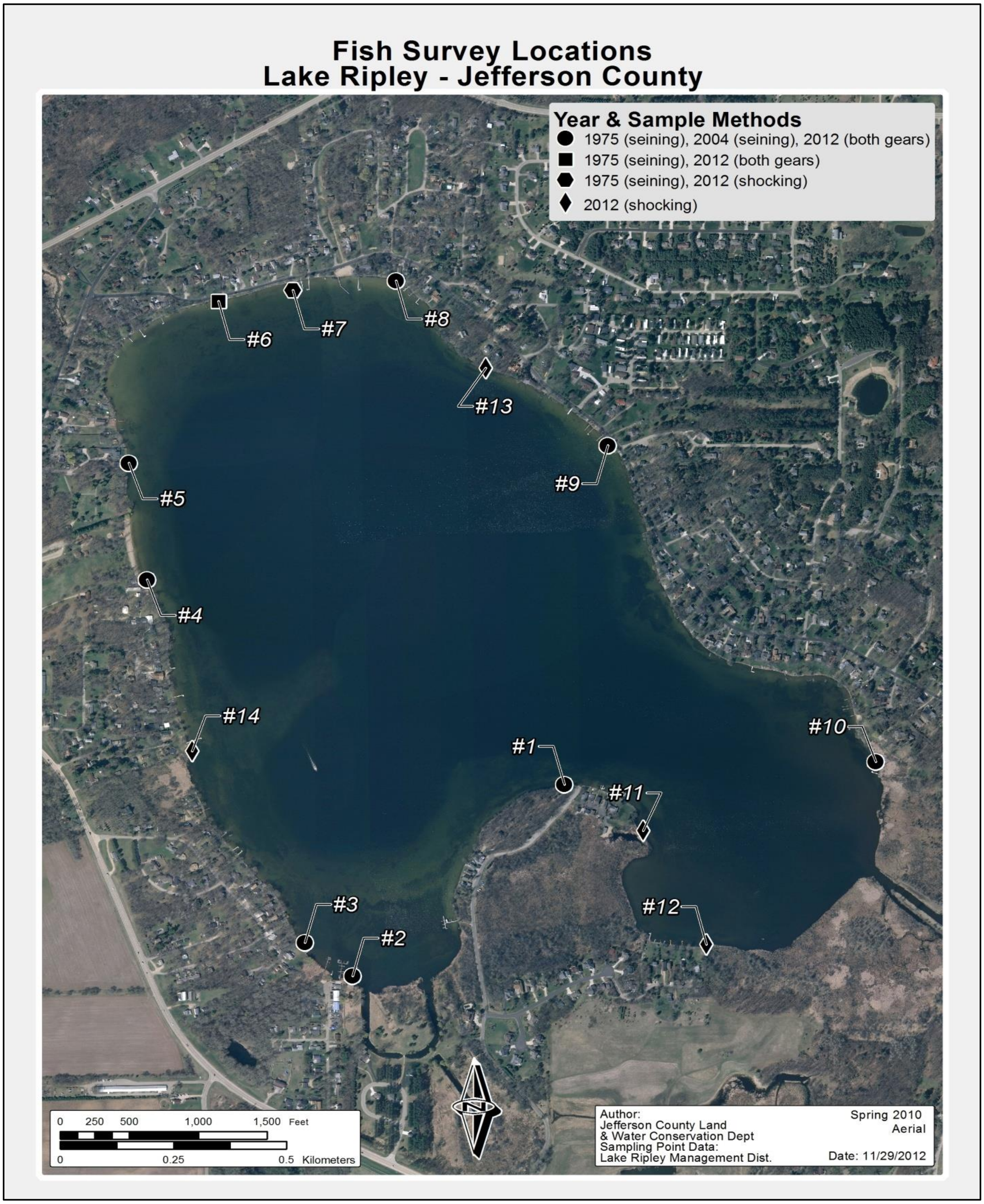

Figure 1: Aerial photo of Lake Ripley showing locations of nearshore fish-sampling sites

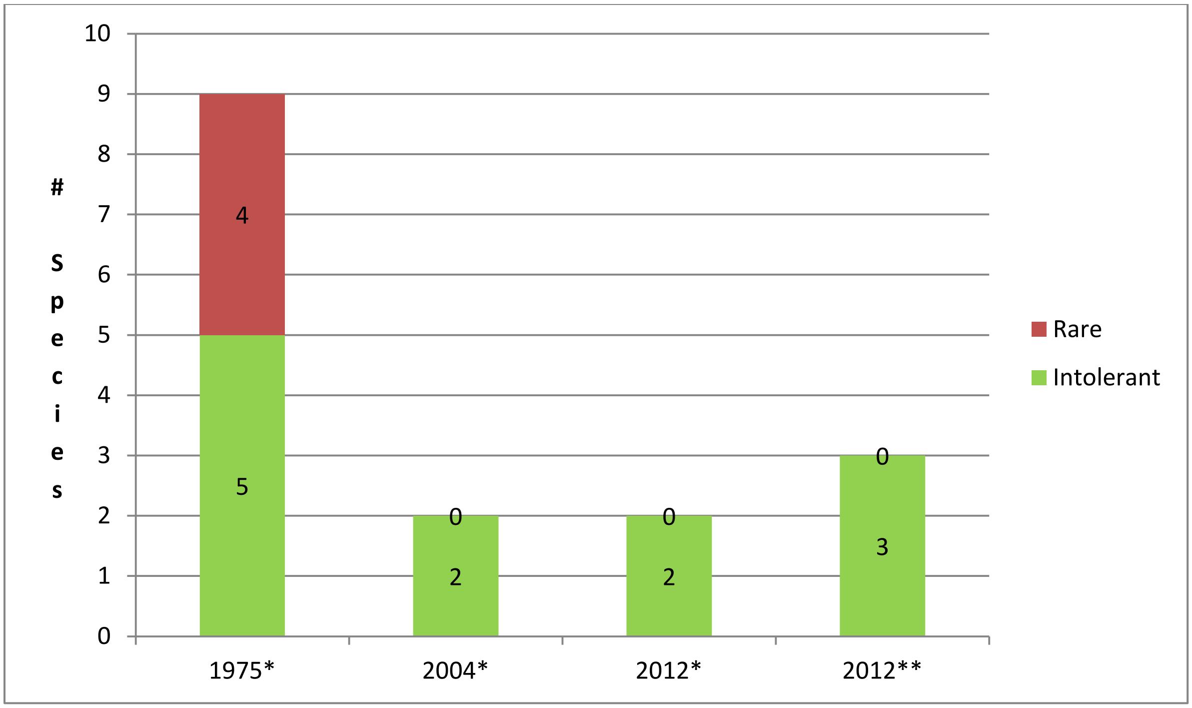

Figure 2: Rare and intolerant nongame fish species documented in Lake Ripley in 1975, 2004 and 2012

*Small-mesh seining only
** Small-mesh seining and towed electroshocking.

Opportunities

Most recovery plans for threatened and endangered fishes involve introductions (Williams et al. 1988). Propagation, translocation, reintroduction and augmentation (PTRA) programs have been expanding in the U. S. as needed for the recovery of imperiled fishes (George et al. 2009). The PTRA definitions follow:

<u>Propagation</u> is rearing fish within a captive environment for reintroduction into the wild.
<u>Translocation</u> involves artificially moving fish species within their natural range.
<u>Reintroduction</u> is the release of fish species within their former range.
<u>Augmentation</u> involves supplemental stocking into an existing population.

Three federally endangered fish species were successfully propagated and reintroduced into a small Tennessee stream where their populations later expanded (Shute et al. 2005). In

Wisconsin, the reintroduction of the State Special Concern lake chubsucker, among other common species, was successful following a rotenone treatment and fishery reclamation project on Big Muskego Lake, Waukesha County (Beyler et al. 2003). Perhaps more applicable for a potential Lake Ripley species recovery, blackchin shiners, blacknose shiners and State Special Concern banded killifish were collected and successfully introduced into a rotenone treated stormwater detention pond in northern Illinois. The pond was used as a source stock for fish that were later successfully introduced into a small lake managed for bluegills and largemouth bass (Schaeffer et al. 2012). The nongame fish species have been thriving in the low impact stormwater pond (Sanctuary Pond) since 1998, when they were first introduced.

In addition to the use of passive pond culture as a potential source of fish species for reintroduction, the University of Wisconsin-Milwaukee's School of Freshwater Sciences operates a state-of-the-art aquaponics/aquaculture facility that could be particularly useful for managed propagation designed to prevent genetic drift. Other state-of-the-art aquaculture facilities in Wisconsin include the University of Wisconsin-Stevens Point's Northern Aquaculture Demonstration Facility.

Risks

One of the greatest risks of conservation aquaculture or PTRA programs is the potential erosion of genetic diversity that can undermine the evolutionary adaptive change of a population (Meffe 1986). Inbreeding depression can occur when low numbers of founders or consanguineous founders are used for aquaculture (Doyle et al. 2001). Even though the Sanctuary Pond experiment demonstrated promising results from a short-term perspective, modest reduction of allele diversity and founder effects suggested that larger numbers of founders were needed for both blackchin shiners and blacknose shiners (Ozer and Ashley, In Press). In addition to potential founder effects, homogenization of genetically divergent populations can also undermine evolutionary fitness (Meffe 1986).

Detailed genetic analysis cannot always be performed as part of fish reintroductions, particularly when the recovery effort focuses on populations that are severely depleted or endangered (Meffe 1986, Schute et al. 2005). Essentially, there are not enough individuals that can be sacrificed for genetic analysis. However, the American Fisheries Society (AFS) has developed guidelines to reduce inherent risks associated with imperiled fish recovery programs. The guidelines extend beyond issues related to genetic drift (Williams et al. 1988, George et al. 2009).

Potential impacts of predator stocking should also be considered. Native minnow populations declined following introductions of largemouth bass and smallmouth bass in Adirondack lakes (Findlay et al. 2000, Jackson 2002).

Implementing a species recovery program is not risk free, yet the risks of doing nothing can be far greater, resulting in genetic bottlenecks and ultimately extinction (Anders 1998). Without PTRA programs, the rare and declining fish populations in southern Wisconsin will likely continue to shrink and become increasingly isolated due to environmental degradation and habitat fragmentation; perhaps displaying the characteristics of "extinction debt" (Tilman et al. 1994). Table 1 below lists the PTRA guidelines established in 2009 and how a Lake Ripley fish recovery effort could apply.

Evaluation of Potential Species for PTRA

The recent nongame fish declines in Lake Ripley includes the State Threatened pugnose shiner, State Special Concern least darter, State Special Concern banded killifish, State Special Concern lake chubsucker, blackchin shiner and blacknose shiner. The lake chubsucker is a low priority since the population status in Lake Ripley is uncertain despite the apparent decline. A local recovery project focusing on the State Threatened pugnose shiner and State Special Concern least darter poses more obstacles than the other species due to scarcity and therefore potential problems associated with founder effects. The State Special Concern banded killifish, blacknose shiner and blackchin shiner may be more suitable for an experimental propagation and translocation effort based on previous propagation and translocation experiences. The blackchin shiner and blacknose shiner are listed as "secure" in Wisconsin but they have been declining within their range (Lyons et al. 2000, Marshall and Lyons 2008). These species are generally found in greater numbers and at more locations than the pugnose shiner and least darter based on the Fishes of Wisconsin survey results (Lyons 2013). The banded killifish, blackchin shiner and blacknose shiner are part of the fish assembly that includes pugnose shiners and least darters (Lyons 2013, Harper et al. 2006, Carlson 1997). If the banded killifish, blacknose shiner and blackchin shiner can be successfully reestablished in Lake Ripley, least darter and pugnose shiner recovery may be a future option given their close association with the former three indicator species.

Table 1: AFS Guidelines for Propagating and Translocation of Freshwater Fish Conservation (George et al. 2009) and issues related to a Lake Ripley recovery project

Guideline	Lake Ripley
DO NO HARM	Project could reestablish locally extirpated species and restore ecosystem functions. Do not threaten existing stocks.
DETERMINE THAT PTRA IS NECESSARY	Natural or unassisted recovery is extremely remote. Existing aquaculture programs do not include these species.
GET APPROVAL AND ADVICE	Complete feasibility study, seek DATCP and WDNR permits, and seek expert advice. Planning is important.
CHOOSE THE SOURCE WISELY	Goal to collect enough founders to avoid founder effect, and within the Rock River Basin where historic gene flow likely occurred. Use available models to determine appropriate number of founders.
PROPAGATE NATURALLY AND CAREFULLY	Use Sanctuary Pond model coupled with state of the art aquaponics/aquaculture facility. Use available models to determine appropriate number of founders.
PREPARE FOR RELEASE	Habitat has improved and will improve more. Release sites would be undeveloped areas with best habitat and at night during spring/summer. Evaluate potential impacts of predator stocking. Nearby Rock Lake could be considered for recovery plans.
EVALUATE AND ADOPT	Nearshore fish population surveys will continue to assess status and project effectiveness.
THE PUBLIC NEEDS TO KNOW	Project would include educational element. Document results and present results at lake and fishery meetings.
RECORD IT AND SHARE IT	Documentation is critical for source collections, introductions and monitoring since an objective of this project and may serve as a pilot study.

Profiles of Species Recommended for Reintroduction

Table 2 describes the conservation status of the three species recommended for reintroduction in Lake Ripley: banded killifish, blackchin shiner and blacknose shiner. This is followed by descriptions of species characteristics.

Table 2: Conservation status of species recommended for Lake Ripley recovery.

Species	State Status	Federal Status in Wisconsin	Global Rank	State Rank
Banded killifish	SC	None	G5	S3
Blackchin shiner	None	None	G5	S4
Blacknose shiner	None	None	G5	S4

G5 Considered secure globally, though it may be quite rare in parts of its range, especially at the periphery. S3 = Rare or uncommon in Wisconsin (21 to 100 occurrences). S4 = Appears to be secure in Wisconsin, with many occurrences.

<u>Banded killifish</u> (*Fundulus diaphanus*): The banded killifish is a member of the Fundilidae Family that includes five genera and 48 species. In Wisconsin, two other Fundilidae members include the blackstripe topminnow (*Fundulus notatus*) and the State Endangered starhead topminnow (*Fundulus dispar*).

Two decades ago the banded killifish was considered "secure" in Wisconsin as a common species of nearshore habitats, backwaters and sluggish streams (Becker 1983). It has declined in southern Wisconsin and is now listed as State Special Concern (Lyons 1989, Lyons et al. 2000, Marshall and Lyons 2008, Wisconsin DNR Bureau of Endangered Resources 2013). The banded killifish is also listed as special concern in Newfoundland, state threatened in Illinois, and state endangered in Ohio.

Throughout its range, banded killifish typically inhabits clear weedy lakes, ponds and sluggish streams. It can have high reproductive rates and short population doubling times in the right environmental conditions (Fisheries and Oceans Canada 2011). In Wisconsin, spawning typically occurs from June through August (Becker 1983). Females can become sexually active at age 1 and fish can live up to 4 years (Phillips et al. 2007). *Total fecundity increased with both size and age, and mean total number of eggs produced was ~526 at age 1,*

~744 at age 2, ~1062 at age 3 (Phillips et al. 2007). Sexually mature males and females can be easily distinguished due to their prominent sexual dimorphism.

Banded killifish and other Fundilidae members have been the focus of artificial propagation and research. Banded killifish are often successfully propagated by aquarium enthusiasts (Hunt 1981, Torreano – personal communication). Introduced populations can also expand rapidly in ponds (Becker 1983, Schaeffer et al. 2011). Similarly, starhead topminnow populations can rapidly expand in managed ponds or in isolated Wisconsin floodplain ponds with abundant aquatic vegetation and limited predation (Marshall 2012, Johnson 2012). Elsewhere in the United States, bull minnows (*F. grandis*) have been propagated for the bait industry while the mummichog (*F. heteroclitus*) is often sold as bait and also propagated for genetic and physiological research. As a group, banded killifish and other Fundilidae species appear to be favorable PTRA program candidates. Banded killifish recovery efforts could be conducted at both Lake Ripley and nearby Rock Lake. Littoral zone associates blackchin shiners, least darters, lake chubsuckers and pugnose shiners still thrive in Rock Lake.

<u>Blacknose shiner</u> (*Notropis heterolepis*): The blacknose shiner is a member of the Cyprinidae Family with 43 native species in Wisconsin. It is considered "secure" in Wisconsin but has been declining within its southeastern Wisconsin range (Becker, 1983, Lyons et al. 2000, Marshall and Lyons 2008). Its status is less secure elsewhere in the Midwest where it is listed state endangered in Illinois and Ohio. The blacknose shiner occurs in either lakes or sluggish streams with habitats consisting of clear water and abundant aquatic vegetation. It has declined where these shallow littoral habitats have been degraded (Becker 1983, Lyons 1989, Roberts et al. 2007, Marshall and Lyons 2008).

The blacknose shiner appears to be a favorable species for a Lake Ripley PTRA program. First, it has not yet declined to critical levels in southern Wisconsin, meaning a sufficient number of founders may be found. Second, it can reproduce rapidly under favorable conditions (Roberts et al. 2007, Schaeffer et al. 2012). Blacknose shiners also disappeared from nearby Rock Lake, another potential recovery site for this species.

Blackchin shiner (*Notropis heterodon*): The blackchin shiner is another member of the Cyprinidae Family, is considered "secure" in Wisconsin, but has been declining in the southeast part of the state (Becker 1983, Lyons 1989, Lyons et al. 2000, Marshall and Lyons 2008). Elsewhere in the United States, it is listed as Special Concern in New York, Threatened in Illinois, and Endangered in Ohio and Pennsylvania. It is another member of the shallow littoral zone assemblage that often includes banded killifish, pugnose shiner, least darter and blacknose shiner. Blackchin shiners are still found in nearby Rock Lake along with pugnose shiners and least darters. It appears to be a good candidate for a Lake Ripley recovery project given the favorable Sanctuary Pond/ Lake Leopold introductions in northern Illinois (Schaeffer et al. 2012).

Regulatory Summary

Under Wisconsin State Statutes 29.614, a WDNR scientific collector's permit or research license (Form 9400-379) is required for the collection and possession of fish that are not threatened or endangered. If the PTRA program is ultimately expanded to include a protected species, such as the State Threatened pugnose shiner, then a permit is required from the WDNR Bureau of Endangered Resources (Form 1700-001). A permit is not required for the three recommended species.

To hold and raise species for later stocking, a Fish Farm Registration through the Wisconsin Department of Trade and Consumer Protection (DATCP) is required for the hatchery/holding facility under ATCP 10.61. Under Wisconsin State Statutes 29.733 and Administrative Code NR 19, a Natural Waterbody Permit would be required from WDNR if the propagation operations are proposed for "naturally occurring springs, ponds or streams or ponds constructed in natural springs, wetlands, streams, or lakes or ponds formed by damming a stream". Unconnected constructed ponds and closed facilities are generally exempt from the natural waterbody permitting process (Form 3600-227).

Finally, fish health certification and a WDNR stocking permit are required before live fish can be transported from the aquaculture facility/pond and released into another waterbody.

Conclusions and Recommendations

Reintroducing banded killifish, blacknose shiners and blackchin shiners into Lake Ripley represents a progressive lake management shift as the Lake Ripley Management District's long-term stewardship of the lake evolves from lake rehabilitation to lake-ecosystem restoration. As mentioned earlier, a lake rehabilitation goal for a certain TSI parameter does not constitute an ecosystem restoration goal. Conservation aquaculture and PTRA programs are needed for this effort to responsibly collect rare and declining fish from the wild and produce enough individuals sufficient to sustain/restore populations in Lake Ripley and elsewhere. Our goal is to collect enough unrelated founders from multiple sources within the Rock River Basin to reduce the potential for genetic drift (see Table 3). The PTRA efforts would likely include a combination of low-intensive pond culture and the aquaponics/aquaculture facility at the University Of Wisconsin-Milwaukee's School Of Freshwater Sciences. Other conservation aquaculture options may become available if this project advances. This project could ultimately serve as a pilot or template for similar rare fish recovery efforts in Wisconsin and help expand conservation aquaculture in the state. We recommend implementation of this project under Wisconsin's Lake Protection Grant Program.

Based on comments received from aquaculture, limnology and fisheries experts from around Wisconsin, the following implementation objectives are recommended:

1. Provide a detailed plan that identifies potential source stocks of banded killifish, blacknose shiners and blackchin shiners within the Rock River Basin and establish one time or annual collection targets that will not threaten existing populations. Include detailed collection, transportation, rearing and stocking methodologies.

2. Carefully follow regulations and permits pertaining to fish collection, holding, disease prevention and stocking. Maintain accurate and detailed records.

3. Use the best available science and technology, including models, to maintain genetic diversity.

4. Develop and implement a detailed reintroduction monitoring plan to document project success or failure.

5. Complete a project-evaluation report and present findings at public Lake District meetings and professional conferences.

Table 3: Potential Rock River Basin sources of blackchin shiners, blacknose shiners and banded killifish based on the USGS Great Lakes Gap and WDNR Fish Mapping Application (Lyons) as well as 2004 lake survey results (Lyons 2013)

Waterbody	County	WBIC	Blackchin shiner	Blacknose shiner	Banded killifish
Goose Lake	Dane	823700		X	X
Unnamed stream	Dane	810100	X	X	X
Chub Lake	Dodge	837300			X
Rock Lake	Jefferson	830700	X		
Pike Lake	Washington	858300	X	X	X
Lake Four	Washington	777400	X		
Nagawicka Lake	Waukesha	828000		X	
Lower Nashota L.	Waukesha	827000		X	
Golden Lake	Waukesha	775900		X	
Lower Genesee L.	Waukesha	778100			X
Oconomowoc Lake	Waukesha	849600	X	X	X
Pine Lake	Waukesha	779200	X	X	X
Lac La Belle Lake	Waukesha	848800			X
Okauchee Lake	Waukesha	850300	X		X
Beaver Lake	Waukesha	774400		X	

Garvin Lake	Waukesha	850700	X		
Ottawa Lake	Waukesha	822200	X	X	
Silver Lake	Waukesha	779800			X
Crooked Lake	Waukesha	826800			X
Lower Nemahbin	Waukesha	827000	X	X	X
Upper Nemahbin	Waukesha	827100			X

Comments and Statements of Interest from Fishery Experts

Fred Binkowski, Senior Scientist, UW-Milwaukee School of Freshwater Sciences

"The native species restoration project that the Lake Ripley Management District is proposing certainly presents some new and interesting challenges for fisheries sciences. Native species restoration in North America has been practiced for more than a century using aquaculture methodologies. The proposed native fisheries restoration in Lake Ripley could be better defined by the words "conservation aquaculture" which represents a more advanced approach. This takes into consideration biosecurity, genetic principles, and using the state-of-the-art aquaculture tools to culture these fish for this rehabilitation program.

I believe that the UW-Milwaukee School of Freshwater Sciences has the infrastructure, resources, knowledge, and expertise in this more advanced approach of conservation aquaculture. Consequently, we feel we are in an excellent position to cooperate in this project."

Jim Bland, Adjunct Professor, UW-Milwaukee School of Freshwater Sciences

"I think that it is highly desirable to set up additional attempts to conserve nongame fish which are experiencing reductions across their range. North America has the most diverse temperate freshwater fish fauna in the world. At present, nearly 20 percent of the native freshwater fishes in North America are imperiled, meaning that they are endangered, threatened, or of special concern.

Determining the Minimum Viable Population (MVP) is important to minimize loss of genetic variability. The MVP is usually estimated as the population size necessary to ensure between 90 and 95 percent probability of survival between 100 to 1,000 years into the future. The MVP can be estimated using computer simulations for population viability analyses (PVA). PVA models populations using demographic and environmental information to project future population *dynamics. The probability assigned to a PVA is arrived at after repeating the environmental simulation thousands of times.*

The Lake Ripley Management Plan is one of the best and most detailed lake management plans that I have seen. I wish it were a bit shorter but it is clearly a multiuse blueprint for the community and almost all of it is well thought out and well documented. The question is begged however as to whether Lake Ripley can return to being the habitat that once supported the targeted non-game species. Things that work against the proposed introduction include: limitation of density and distribution of aquatic plants, poor diversity of plant populations, zebra mussel impact on plankton populations, high number of potential predators at a number of different spatial scales, influence of carp on turbidity, high recreational boating use, and variable secchi disc and TSIs. WDNR characterized its typical water clarity as "low". Zebra mussel infestation is likely to impact macroinvertebrate populations both in the lake and immediately downstream."

<u>Brian J. Torreano, Owner of BTDarters; Southeastern Wisconsin Regional Representative of North American Native Fishes Association; former Senior Editor and current Associate Editor of American Currents</u>

"I believe that the current proposal to return extirpated fish species to an aquatic system that is being actively restored is a very worthy one, and I support it wholeheartedly! As is mentioned in the study, fish species have been generally declining across the southern portion of the state for decades. The fact that the Management District is being presented with an opportunity to return some of these species to a lake that is rebounding from environmental perturbation is fantastic! I also believe that this activity has a great potential for success. In Tennessee, Conservation Fisheries, Inc. (http://conservationfisheries.org), an organization devoted to rearing rare native fishes of the southeastern U.S. for release, has had great success doing just the kind of activity proposed here (Shute, Rakes and Cox 2012.) Also, there is evidence that translocation efforts have met with success in other areas (Schmidt 2013.) Additionally, literature suggests that at least one species that we wish to propagate, the Banded Killifish, can be raised in outdoor ponds at a density of 80,000 fish per acre (Becker 1983.) If we are able to raise the fish in question with such success, I believe that it would be a great step toward returning these fish to Lake Ripley.

With regard to captive indoor propagation of species mentioned in the proposed study, I have some personal experience. I have a population of Banded Killifish in my care that have been propagated to three generations from the wild. The third-generation fish will, hopefully, be producing another generation in the near future. I have also captive-propagated other Wisconsin-native species, including: Spotfin Shiners and Blackstripe Topminnows. These experiences make me ideally suited to work on this project. Additionally, I have garnered the support of a local land-preservation organization. The Ozaukee Washington Land Trust (www.owlt.org) has agreed to allow us to use some ponds on their properties for the outdoor propagation of fish to be used in this proposed restoration effort (Hoffer 2013.)

Finally, I would like to say that I am happy to offer my resources, talents and abilities to support this restoration effort."

<u>Gregory Fischer, University of Wisconsin-Stevens Point, Northern Aquaculture Demonstration Facility</u>

"Overall, the project seems to be well written and offers a very interesting, proactive approach with conservation aquaculture as a tool. While I definitely agree with the concept of utilizing aquaculture methodology to produce fish for this recovery, it will be very important to provide enough individuals to contribute a large genetic pool to the founding fish population. Remember that even the simple act of rearing fish in different systems can cause genetic selection. I would recommend that you develop and identify how the project plans to accomplish this and how it will be applied throughout the propagation efforts.

Regarding the actual rearing of the fish that have been identified for this project (banded killifish, blacknose shiner, and blackchin shiner), I am not familiar with rearing these species, although it appears the banded killifish has been reared successfully in captivity. I would caution that it likely will take several years to develop a broodstock and rearing systems for all lifestages of these species, so plan your project to accommodate that possibility. We have had good success with rearing some other baitfish species, such as spotfin shiners, but it took several years to develop the protocols and systems that led to success. Additionally, while indoor rearing presents many positive aspects for fish rearing, I would caution leaning that way for conservation aquaculture and fish that will likely be reintroduced into the wild. Reasons for this caution include genetic selection, fish health and development of immune systems, feeding preferences and selection of prey items, and overall success especially for larval stages. Potentially, utilizing both indoor and outdoor (ponds) systems to achieve success would be recommended.
" I was also curious if the water quality and pollution issues mentioned have been adequately addressed?

By partnering with UW-Milwaukee School of Freshwater Sciences and Fred Binkowski, I am sure they will be able to help you address the questions and comments that I have presented above. I wish you good luck with your project and please feel free to let us know if there is any way we can be of further assistance with this project."

<u>John Janssen, Professor, UW-Milwaukee School of Freshwater Sciences</u>

"I am really excited to read and review your plans for "Feasibility of Restoring Nongame Fish Populations in Lake Ripley, Jefferson County, Wisconsin." Based on the work we did at Prairie Crossing (Sanctuary Pond and Lake Aldo Leopold) I have no doubt that what you have outlined will work and be a model for future restoration efforts. When it comes to project execution I will be pleased to lend advice and, if time permits, help with the collections."

John Lyons, Adjunct Curator of Fishes at the University of Wisconsin Zoological Museum and NR Research Scientist at Wisconsin Department of Natural Resources Bureau of Integrated Science Services

"This is an exciting and important effort to restore non-game fishes to a former habitat. The authors have done a good job of describing the challenges and risks associated with the project, but, like them, I think the potential benefits far exceed the potential costs and support their efforts to move forward. And as they state, if this project is successful it can serve as a template for future non-game fish introductions throughout the state. The biggest challenges will be capturing, maintaining, and breeding sufficient numbers of the target fishes for the restoration effort and insuring that genetic diversity is maintained in the captive populations. A more detailed proposal must be prepared before the project actually begins, and I recommend development of a detailed plan that describes where and how many individuals of each species will be collected, where and how they will be maintained and bred, specific guidelines for protecting genetic diversity and avoiding disease or parasite transmission, procedures for restocking the captive individuals and monitoring their status in Lake Ripley, a specific timeline for each phase of the project, and a budget with likely sources of funding. I would also like more information on how each of the state permit requirements will be met and on the public outreach and education aspects of the project."

Patricia Cicero, Water Resources Management Specialist, Jefferson County Land and Water Resources Department

"I am in support of efforts to re-introduce extirpated or dwindling fish species in Lake Ripley. Similar declines in intolerant and rare species have also been documented at Rock Lake in Jefferson County. If a re-introduction effort was to go forward, I would support the implementation in both Lake Ripley and Rock Lake".

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Appendix A: Lake Ripley nearshore fish population surveys results 1975, 2004 and 2012.

Species	Status	Environmental Sensitivity*	1974-75	2004	2012	2012 expanded sites/gear
Golden shiner		Tolerant	17	3	4	255
Pugnose shiner	Threatened	Intolerant	17	0	0	0
Blackchin shiner		Intolerant	15	0	0	0
Blacknose shiner		Intolerant	3	0	0	0
Bluntnose minnow		Tolerant	152	1833	7	10
Fathead minnow		Tolerant	1	1	0	0
Common carp		Tolerant	0	0	0	1
Lake Chubsucker**	Special Concern		18	0	0	0
Central mudminnow		Tolerant	1	0	0	11
Grass pickerel			1			
Yellow bullhead		Tolerant	0	0	0	33
Tadpole madtom			0	0	0	1
Banded killifish	Special Concern		45	0	0	0
Blackstripe topminnow			0	0	0	1
Brook silverside			19	69	0	0
Rock bass		Intolerant	1	0	1	13
Green sunfish		Tolerant	3	0	0	6
Bluegill			171	324	226	217
Pumpkinseed			64	0	4	0
Hybrid sunfish			0	0	0	1
Smallmouth bass		Intolerant	0	44	7	2
Largemouth bass			153	783	715	76
Black (or unspecified) crappie			58	6	0	0
Iowa darter		Intolerant	1	25	0	2
Least darter	Special Concern	Intolerant	3	0	0	0
Johnny darter			2	17	7	15
Fantail darter			4	0	0	15
Yellow perch			316	89	22	4
Total Rare Species			**4**	**0**	**0**	**0**
Total Intolerant Species			**6**	**2**	**2**	**3**
Total Native Species			**22**	**11**	**9**	**16**