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Science Advisory Report 2021/012

RECOVERY POTENTIAL ASSESSMENT OF PYGMY WHITEFISH (*PROSOPIUM COULTERII*), GREAT LAKES – UPPER ST. LAWRENCE POPULATIONS (DU5)

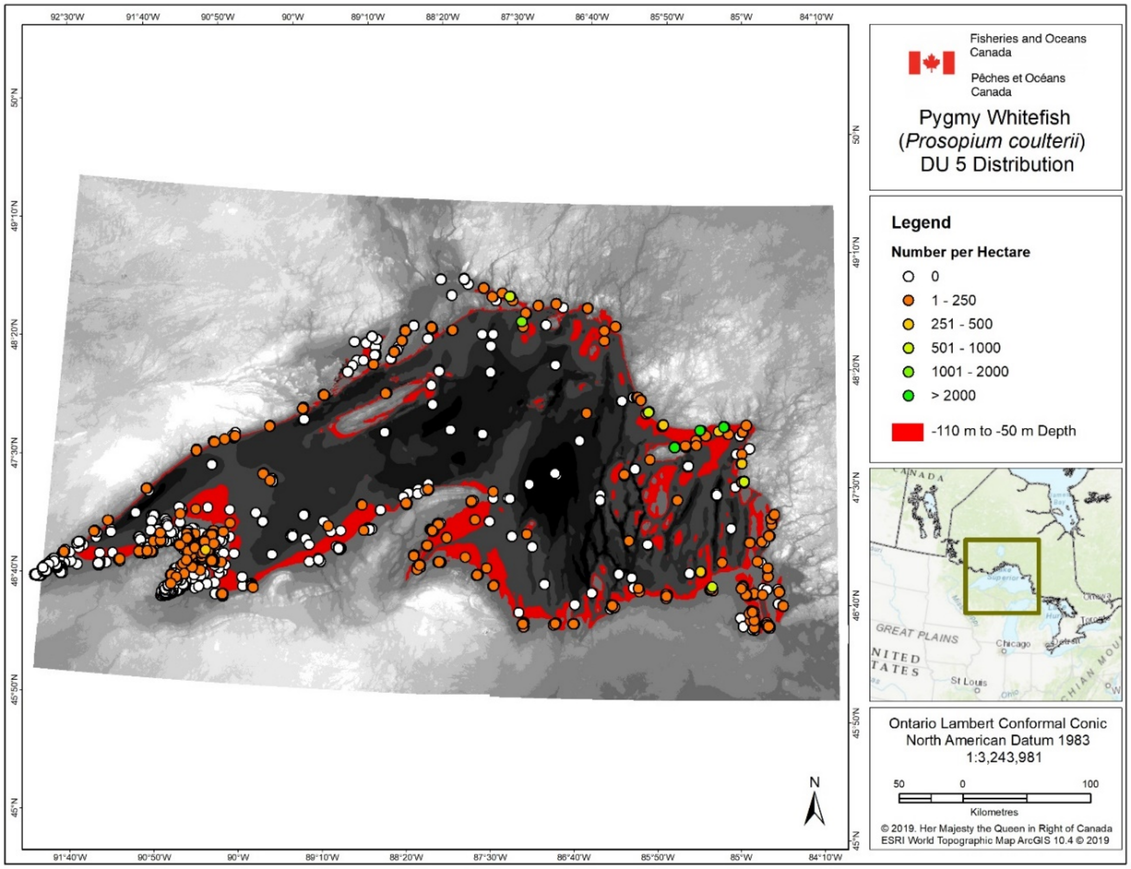

Figure 1. Detections of Pygmy Whitefish, Great Lakes – Upper St. Lawrence populations (DU5), in nearshore and offshore bottom trawls conducted by U.S. Geological Survey (USGS) from 1963–2018. Values are number per hectare. Data provided by Mark Vinson, USGS.

Context:

*In November 2016, COSEWIC assessed Pygmy Whitefish (*Prosopium coulterii*), Great Lakes – Upper St. Lawrence populations (DU5) as Threatened. The reason given for this designation was that "this small-bodied freshwater fish has experienced dramatic declines in abundance over the last several decades, with an overall estimated decline of 48% since 2000. The continued presence of invasive fishes and recovery of native predatory fishes may threaten or limit recovery, respectively." The Recovery Potential Assessment (RPA) process has been developed by Fisheries and Oceans Canada (DFO) to provide information and scientific advice needed to fulfill requirements of the federal Species at Risk Act (SARA), including the development of recovery strategies and authorizations to carry out activities that would otherwise violate SARA (DFO 2007).*

*This Science Advisory Report is from the December 10th, 2019 peer review on Recovery Potential Assessment –Pygmy Whitefish (*Prosopium coulterii*), Great Lakes – Upper St. Lawrence populations (DU5). Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada (DFO) Science Advisory Schedule](#) as they become available.*

SUMMARY

- Pygmy Whitefish DU5 individuals are found only in Lake Superior (Figure 1), where they occupy nearshore areas at depths ranging from ~50–110 m. Peak biomass occurs at 80–95 m trawl depths.
- Biomass of Pygmy Whitefish followed periodic fluctuations since 1989 but has declined since 2013 or approximately one generation. The Pygmy Whitefish biomass in 2018 was estimated to be 68,707 kg (CI: 2,465–1,357,612).
- The minimum viable population (MVP) size for Pygmy Whitefish in Lake Superior was determined to be approximately 4,000 adult females or 75 kg age-1+ biomass assuming a 99% likelihood of persistence over 100 years with a 15% catastrophe rate per generation. The minimum area required to support this population (i.e., minimum area for population viability [MAPV]) is approximately 21 km^2, which indicates that a large number of MVP-sized aggregations of the species may exist in Lake Superior.
- Population modelling demonstrated that Pygmy Whitefish populations were most sensitive to perturbations in juvenile survival.
- Threats to Pygmy Whitefish include climate change, invasive species and pollution; however, the impact of these threats is currently unknown. Predation from top predators such as Lake Trout (*Salvelinus namaycush*) and Burbot (*Lota lota*) may be limiting population growth.
- For DU5 individuals, knowledge gaps exist pertaining to reproductive ecology, habitat use by immature life stages, dispersal and genetic exchange, and factors that influence population dynamics including recruitment.

BACKGROUND

In November 2016, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed Pygmy Whitefish (*Prosopium coulterii*), Great Lakes – Upper St. Lawrence populations [Designatable Unit (DU) 5] as Threatened. This designation was based on a decline in abundance over the last several decades along with the potential for invasive species and/or native predators to threaten or limit recovery (COSEWIC 2016). When COSEWIC designates an aquatic species as Threatened or Endangered and the Governor in Council decides to list it, the Minister of Fisheries and Oceans Canada (DFO) is required by SARA to undertake a number of actions. Many of these actions require scientific information such as the current status of the population, the threats to survival and recovery, and the feasibility of recovery. This scientific advice is developed through a Recovery Potential Assessment (RPA), which allows for the consideration of peer-reviewed scientific analyses in subsequent SARA processes including permitting on harm and recovery planning. This RPA focuses on Pygmy Whitefish (*Prosopium coulterii*; DU5), and is a summary of the conclusions and advice from a Canadian Science Advisory Secretariat peer-review meeting that occurred on December 10th, 2019 in Burlington, Ontario. Three research documents, one providing background information on the species' biology, habitat preferences, current status, threats and mitigations and alternatives (Andrews et al. 2021), another assessing population trajectory, habitat characteristics, and available habitat for Pygmy Whitefish in Lake Superior (van der Lee and Koops 2020) and a third providing recovery potential modelling of Lake Superior populations (van der Lee and Koops 2021) were presented at the RPA. The three documents provide an in-depth account of the information summarized below. Proceedings that document the key discussions of the meeting are also available (DFO 2021).

ASSESSMENT

Current Species Status

The Pygmy Whitefish, Great Lakes – Upper St. Lawrence Designatable Unit (DU5) is found entirely within Lake Superior (Figure 1). Relatively little is known about population structure of Pygmy Whitefish (DU5) owing to the lack of information about reproduction and dispersal. Analyses to evaluate genetic exchange within the lake have not been conducted. Low levels of Pygmy Whitefish biomass exist throughout suitable depth ranges (See Figure 10 in van der Lee and Koops 2021), and although at least seven distinct areas of above-average Pygmy Whitefish biomass exist throughout the lake, it is likely that genetic exchange occurs among these patches.

Trends in abundance per hectare for nearshore trawls indicate that density is much higher on the Canadian side of Lake Superior in comparison to waters in the United States (Mark Vinson, USGS, pers. comm.). Empirical trawl data suggest that lake-wide median annual density has declined slightly over the last three decades.

Population Assessment

To assess the Population Status of the Pygmy Whitefish Great Lakes – Upper St. Lawrence populations (DU5), all individuals in Lake Superior were assumed to belong to a single population, owing to the lack of information about reproductive isolation. The population was ranked in terms of its population trajectory, assessed as Decreasing, Stable, Increasing, or Unknown based on the best available knowledge about the current trajectory of the population. Using only nearshore trawls conducted by USGS since 1989, van der Lee and Koops (2020) estimated biomass using a spatial depth-centered Integrated Nested Laplace Approximation (INLA) model. This model indicated that Pygmy Whitefish exist at low density (e.g., a median biomass of 0.036 kg/ha) where the species is predicted to occur (van der Lee and Koops 2021). The spatial INLA model accounted for complex covariance structures in spatial-temporal data, thereby providing lake-wide biomass estimates corrected for the changing spatial distribution of sampling locations across years. The model found that spatial correlation in biomass residuals exists up to 70 km from a trawl location and the only significant habitat predictor for occurrence and biomass was water depth. Based on the spatial model, biomass followed periodic fluctuations since 1989 and more recently there appeared to be a decline in biomass since 2013 or approximately one generation (Figure 2). The Pygmy Whitefish biomass in 2018 was estimated to be 68,707 kg (CI: 2,465–1,357,612). The spatial model was ultimately used to inform the population trajectory assessment and the trajectory is described as decreasing for this species in Lake Superior. The authors also used a non-spatial Generalized Linear Model (GLM) to make comparisons with the spatial INLA model (see Figure 2). The GLM estimates of biomass were an order of magnitude greater than the INLA model and showed a greater decline over time. However, the GLM is biased towards larger catch values.

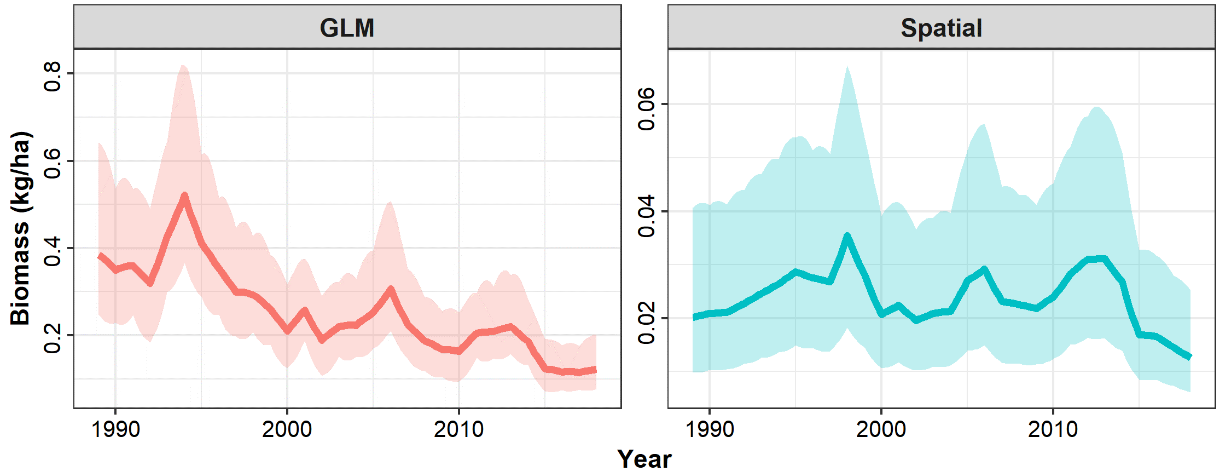

Figure 2. Predicted lake-wide biomass (kg/ha) through time. Relationships were fit to long-term nearshore bottom trawl data using a spatial model and non-spatial GLM. NOTE: y-axis scales differ by an order of magnitude between panels (reproduced from van der Lee and Koops 2020).

Habitat Requirements

Spawning

Spawning has not been observed for Pygmy Whitefish in Lake Superior. Pygmy Whitefish in western Canada and the United States has been observed to migrate one to four kilometers upstream to spawn in riverine habitats while spawning in shallow waters near shorelines has also occurred (Barnett and Paige 2014). The use of tributaries for spawning in Lake Superior has not been documented. Rather, spawning in Lake Superior is hypothesized to occur in shallow nearshore waters with eggs broadcast over coarse gravel substrate and larvae emerging in the spring (Eschmeyer and Bailey 1955, Scott and Crossman 1973). The capture of gravid female Pygmy Whitefish in Lake Superior in October and spent females in January suggest that spawning occurs in November or December in Lake Superior. Elsewhere, spawning has occurred in water temperatures ranging from 2 to 5 °C (Barnett and Paige 2014).

Juvenile

Juveniles occupy shallower areas of Lake Superior relative to adults (Eschmeyer and Bailey 1955). For example, Eschmeyer and Bailey (1955) found that all individuals caught between 18 and 26 m were young of the year. Gorman et al. (2012) indicated that ontogenetic shifts in depth distribution may occur with small fish occupying shallower depths relative to larger adults. However, the study considered fish < 100 mm to be juveniles, a size category that would also include adults according to length-at-age information from Stewart et al. (2016). Therefore, results from Gorman et al. (2012) pertain to small versus large fish but do not exclusively reflect the depth distribution of juveniles. Fish size also decreased with decreasing depth in Yule et al. (2008), who analyzed Lake Superior bottom trawl surveys to determine the effect of sampling factors on the biomass of bottom-oriented species. Analysis of juvenile Pygmy Whitefish catches (individuals < 70 mm total length) from the USGS dataset (1963–2018) indicated that the occurrence of juveniles in relation to bottom water temperature, depth, and dissolved oxygen did not differ substantially from adult Pygmy Whitefish (results not presented). In general, knowledge of juveniles in Lake Superior is poor as trawls rarely captured individuals less than 40 mm, with 20 mm as the minimum detected total length (USGS unpublished data).

Adult

Scott and Crossman (1973) indicated that Pygmy Whitefish in Lake Superior has been captured at depths ranging from 18–89 m with the majority captured from 55–70 m. Similarly, in Keweenaw Bay, Eschmeyer and Bailey (1955) reported that the majority of Pygmy Whitefish were caught at depths ranging from 46–71 m but the species was captured at all depths sampled (11–101 m). In another study, biomass of Pygmy Whitefish peaked at 60 m depth (Yule et al. 2008). Seasonality was found to have little effect on depth of capture in Lake Superior (Dryer 1966, Yule et al. 2008), while another study showed that Pygmy Whitefish inhabit deeper waters in the spring in comparison to the summer (Selegby and Hoff 1996). USGS data from 1963–2018 indicate that adult Pygmy Whitefish have been captured at mean bottom trawl depths ranging from 5–161 m. Based on van der Lee and Koops (2020), depth was the only significant predictor of biomass out of a candidate set of habitat variables that included water temperature, specific conductivity, pH, dissolved oxygen, chlorophyll a, and photosynthetic active radiation (PAR). Peak biomass occurred at 80–95 m depths, while a greater than 50% probability of occurrence was observed at trawl depths ranging from ~50–110 m (van der Lee and Koops 2020). The median depth of trawls that captured Pygmy Whitefish was slightly deeper in comparison to median depth of all trawls (USGS unpublished data).

Across the North American range, Pygmy Whitefish inhabits water temperatures less than 10 °C (COSEWIC 2016). USGS data indicate that approximately 75% of individuals collected from Lake Superior have been in waters ranging from 2.5 to 5.5 °C (USGS unpublished data). Long term data collected by the USGS show that the majority of Lake Superior individuals are found in waters with dissolved oxygen levels ranging from 12.5–13 mg/l (USGS unpublished data).

Functions, Features and Attributes

A description of the functions, features, and attributes associated with Pygmy Whitefish (DU5) habitat can be found in Table 1. The habitat required for each life stage has been assigned a function that corresponds to a biological requirement of Pygmy Whitefish. For example, individuals in the larval to juvenile life stage require habitat for nursery purposes. In addition to the habitat function, a feature has been assigned to each life stage. A feature is considered to be the structural component of the habitat necessary for the survival or recovery of the species. Habitat attributes have also been provided, describing how the features support the function for each life stage. This information is provided to guide any future identification of critical habitat for this species.

Table 1. Summary of the essential functions, features and attributes for each life stage of Pygmy Whitefish (DU5). Habitat attributes from published literature and USGS capture records have been used to determine the habitat attributes required for the delineation of critical habitat.

			Habitat Attributes		
Life Stage	**Function**	**Feature(s)**	**Scientific Literature**	**Current Records**	**For Identification of Critical Habitat**
Adult (Age 2+ [onset of sexual maturity])	Feeding Cover	Nearshore areas with deep water	• Depth of capture ranged from 18 – 89 m with the majority captured from 55 – 70 m (Scott and Crossman 1973); • Most individuals from Keweenaw Bay found at depths ranging from 46 m – 71 m, but individuals were caught at all depths sampled (11 - 101 m; Eschmeyer and Bailey 1955); • Waters with temperatures less than 10 °C (COSEWIC 2016); • Dissolved oxygen levels greater than 5 mg/L (COSEWIC 2016)	• There is > 50% probability of catch at depths ranging from 50 m – 110 m (van der Lee and Koops 2020; USGS unpublished data). • Peak biomass is predicted to occur from 80 – 95 m (van der Lee and Koops 2020); USGS unpublished data). • USGS data from bottom trawls conducted between 1963 and 2018 show that ~75% of individuals in Lake Superior inhabited waters ranging from 2.5 to 5.5 °C (USGS unpublished data) • The majority of individuals were found in waters with dissolved oxygen levels ranging from 12.5-13 mg/l (USGS unpublished data)	• Depths ranging from 50 m to 110 m
Spawn to hatch	Spawning	Shallow nearshore waters with coarse gravel substrate	• Spawning has not been observed	• No records	• Unknown
Young of Year (YOY) and juvenile	Nursery Feeding Cover	Nearshore areas with deep water	• May occupy shallower depths than adults (Gorman et al. 2012).	• Same as adults	• Presumed to be the same as adults

Recovery Modelling

The analysis consisted of three parts:

1. Information on vital rates was compiled to build projection matrices that incorporate environmental stochasticity and density-dependence

With these projection matrices:

2. the impact of anthropogenic harm to a Pygmy Whitefish population was assessed with three methods: deterministic elasticity analyses on population growth rate assuming density-independence; deterministic elasticity analyses on population abundance assuming density-dependence; and simulation analysis used to assess the effects of periodic harm; and,
3. population viability analysis was conducted to estimate recovery targets for abundance (MVP) and habitat (MAPV; i.e., the amount of suitable habitat required to support the MVP).

Harm

Generally, Pygmy Whitefish were most impacted by perturbations to juvenile survival which was consistent across analyses with assumptions of density-independence, density-dependence or periodic harm. This indicates that a population of Pygmy Whitefish would be most affected by mortality to the juvenile stage. Growth and biomass were also impacted by changes to mean steady-state and maximum YOY survival rate as well as adult survival but to a lesser extent than juvenile survival. At a harm frequency cycle of 10 years, there was no significant impact of harm to the YOY or adult stages. The impact of harm to fertility/fecundity depended greatly on the assumption around density-dependence, where with no density-dependence there were long-term impacts from perturbations while with density-dependence, impacts were reduced or non-existent depending on the assumed shape of the density-relationship.

Recovery Targets

Potential recovery targets for Pygmy Whitefish were identified based on demographic sustainability. Demographic sustainability is related to the concept of a MVP and was defined as the minimum adult population size that results in a desired probability of persistence over 100 years (~ 23 generations for Pygmy Whitefish). In the case of Pygmy Whitefish, ‘adult’ corresponds to mature females. MVP was estimated using simulation analysis, which incorporated environmental stochasticity and density-dependence. In choosing recovery targets, the risks associated with extinction probability must be balanced with the costs associated with an increased target (increased recovery effort, longer time to recovery, etc.). Recovery target values were estimated for a 5% and 1% risk of extinction using simulation criteria of populations affected by a 0.05, 0.1 and, 0.15 catastrophe rate per generation with a quasi-extinction threshold of 25 adult females. Results indicated that to achieve a 99% likelihood of persistence over 100 years, Pygmy Whitefish adult female population sizes of ~ 1,300, 2,500, and 4,000 were required for catastrophe rates of 5, 10 and 15% per generation. This corresponds to whole population (age-1+ females and males) biomass of ~ 25, 50 and 75 kg.

The quantity of habitat required to support an MVP sized population of Pygmy Whitefish can be estimated by dividing the MVP estimate by the mean population density. Mean Pygmy Whitefish biomass density was estimated to be 0.036 kg/ha. Therefore, the maximum habitat quantity required to support an MVP-sized population (1% extinction probability, 15% per generation catastrophe rate, and Ricker type density-dependence) is estimated to be ~ 21 km^2.

The spatial INLA model was used to project population size (kg/ha) across Lake Superior and locations where densities were > 0.036 kg/ha (i.e., greater than lake-wide mean) were identified (Figure 3). With this projection, all areas of approximately 21 km^2 represent potential MVP sized populations of Pygmy Whitefish. Within Lake Superior there are many (> 7) spatially distinct areas that are likely to contain populations, potentially multiple populations, that exceed MVP. If these populations are entirely uncorrelated, the extinction probability of Pygmy Whitefish in Lake Superior as a whole would decrease to $0.01^7 = 1.0 \times 10^{-14}$.

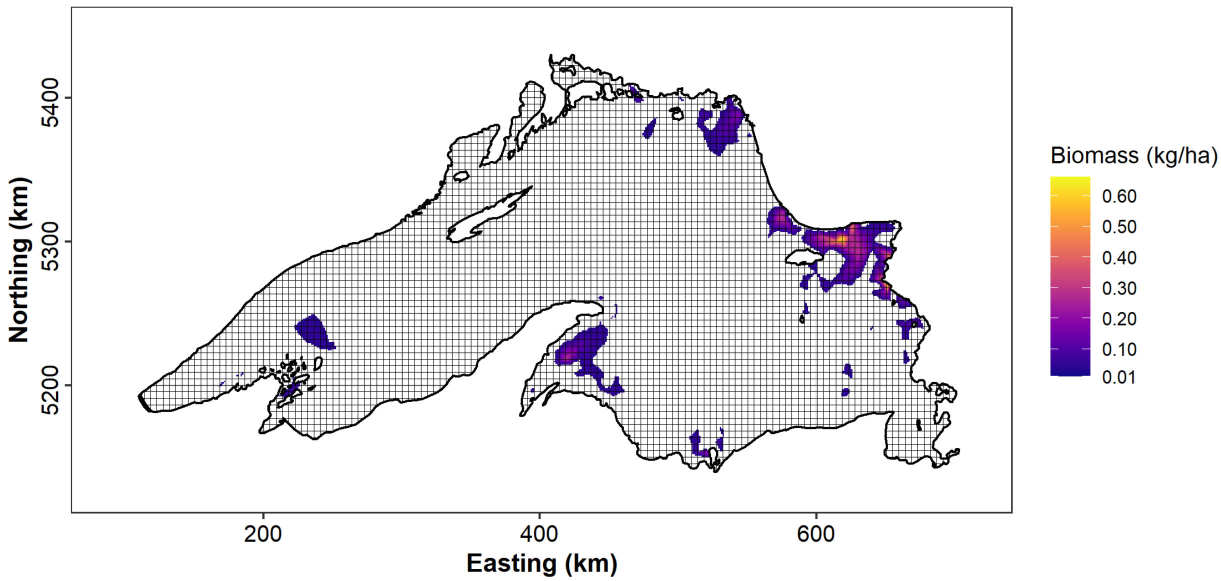

Figure 3. Locations with predicted Pygmy Whitefish densities > 0.036 kg/ha (i.e., above average densities) from the spatial hurdle model (van der Lee and Koops 2020). The grid represents ~ 21 km² squares therefore any coloured grid square represents a potential MVP population (reproduced from van der Lee and Koops 2021).

Threats

A paucity of information exists about threats to Pygmy Whitefish in DU5. COSEWIC (2016) noted the potential importance of invasive species, pollution, and climate change. However, the impact of these factors on Pygmy Whitefish is poorly understood. Factors such as predation from native fishes may be limiting population growth. Owing to the lack of definitive information about population structure, threats to Pygmy Whitefish have been summarized across the entirety of the DU5 range.

Threat Level Assessment

The threat assessment was completed at a lake-wide scale following guidelines provided in DFO (2014). Terms used to describe threat categories are described in Table 2. Each threat was ranked in terms of the threat Likelihood of Occurrence, threat Level of Impact, and Causal Certainty (Table 3). The Likelihood of Occurrence and Level of Impact for each population were subsequently combined in a Threat Risk Matrix resulting in the DU-Level Threat Risk (Table 4). As insufficient information exists about potential population structure in Lake Superior, threats were assessed at the lake-wide level; therefore, the population-level threat evaluation is similar to the DU-level threat risk.

Table 2. Definition and terms used to describe likelihood of occurrence (LO), level of impact (LI), causal certainty (CC), population level threat occurrence (PTO), threat frequency (PTF) and threat extent (PTE) reproduced from DFO (2014).

Term	Definition
Likelihood of Occurrence (LO)	
Known or very likely to occur (K)	This threat has been recorded to occur 91-100%.
Likely to occur (L)	There is 51 – 90% chance that this threat is or will be occurring.
Unlikely (UL)	There is 11 – 50% chance that this threat is or will be occurring.
Remote (R)	There is 1 – 10% or less chance that this threat is or will be occurring.
Unknown (U)	There are no data or prior knowledge of this threat occurring or known to occur in the future.
Level of Impact (LI)	
Extreme (E)	Severe population decline (e.g., 71 – 100%) with the potential for extirpation.
High (H)	Substantial loss of population (31 – 70%) or threat would jeopardize the survival or recovery of the population.
Medium (M)	Moderate loss of population (11 – 30%) or threat is likely to jeopardize the survival or recovery of the population.
Low (L)	Little change in population (1 – 10%) or threat is unlikely to jeopardize the survival or recovery of the population.
Unknown (U)	No prior knowledge, literature or data to guide the assessment of threat severity on population.
Causal Certainty (CC)	
Very high (1)	Very strong evidence that threat is occurring and the magnitude of the impact to the population can be quantified.
High (2)	Substantial evidence of a causal link between threat and population decline or jeopardy to survival or recovery.
Medium (3)	There is some evidence linking the threat to population decline or jeopardy to survival or recovery.
Low (4)	There is a theoretical link with limited evidence that threat is leading to a population decline or jeopardy to survival or recovery.
Very low (5)	There is a plausible link with no evidence that the threat is leading to a population decline or jeopardy to survival or recovery.
Population-Level Threat Occurrence (PTO)	
Historical (H)	A threat that is known to have occurred in the past and negatively impacted the population.
Current (C)	A threat that is ongoing, and is currently negatively impacting the population.
Anticipatory (A)	A threat that is anticipated to occur in the future, and will negatively impact the population.
Population-Level Threat Frequency (PTF)	
Single (S)	The threat occurs once.
Recurrent (R)	The threat occurs periodically, or repeatedly.
Continuous (C)	The threat occurs without interruption.
Population- Level Threat Extent (PTE)	
Extensive (E)	71 – 100% of the population is affected by the threat.
Broad (B)	31 – 70% of the population is affected by the threat.
Narrow (NA)	11 – 30% of the population is affected by the threat.
Restricted (R)	1 – 10% of the population is affected by the threat.

Table 3. Threat Likelihood of Occurrence (LO), Level of Impact (LI), Causal Certainty (CC), Population-Level Threat Occurrence (PTO), Population- Level Threat Frequency (PTF) and Population-Level Threat Extent (PTE) for Pygmy Whitefish, Great Lakes – Upper St. Lawrence populations (DU5).

	Lake Superior						
	LO	LI	CC	PTO	PTF	PTE	Ref
Pollution	K	U	5	H,C,A	C	E	-
Invasive and other problematic species and genes	K	U	5	H,C,A	C	E	-
Climate change and severe weather	K	U	5	C, A	C	E	-

Table 4. Threat Level Assessment for Pygmy Whitefish, Great Lakes – Upper St. Lawrence populations (DU5), resulting from an analysis of both the Threat Likelihood and Threat Impact (See Andrews et al. 2021 for details). The number in brackets refers to the level of certainty associated with the threat impact (1 = Very High; 2 = High; 3 = Medium; 4 = Low; 5 = Very Low).

Threat	Threat Risk
Pollution	**Unknown (5)**
Invasive and other problematic species and genes	**Unknown (5)**
Climate change and severe weather	**Unknown (5)**

Mitigations and Alternatives

Threats to species survival and recovery can be reduced by implementing mitigation measures to reduce or eliminate potential harmful effects that could result from works or undertakings associated with projects, or activities in Pygmy Whitefish DU5 habitat. In previous RPAs, the DFO Program Activity Tracking for Habitat (PATH) database was queried for a variety of works, undertakings, and activities that occurred within a species known distribution during the previous five years that could harm or destroy its habitat. In the case of Pygmy Whitefish, this review of activities was not provided as only a handful of projects would result and these activities would be limited almost entirely to shoreline areas and whose impacts would be largely negligible to this deep water species. In a case where an activity threatens Pygmy Whitefish (DU5) habitat, habitat-related threats can be linked to the Pathways of Effects developed by DFO's Fish and Fish Habitat Protection Program (FFHPP) in Coker et al. (2010). The document provides guidance on mitigation measures for 19 Pathways of Effects for the protection of aquatic species at risk in the Central and Arctic Region (Coker et al. 2010). Coker et al. (2010) should be referred to when considering mitigation and alternative strategies for habitat-related threats. Additional mitigation and alternative measures related to non-habitat related threats, such as invasive species can be found in Andrews et al. (2021).

Sources of Uncertainty

Few targeted studies have been conducted on Pygmy Whitefish in Lake Superior (DU5) due to its low population abundance and relatively recent discovery in the Great Lakes basin. Although the species is widespread in Lake Superior, occurrence and biomass are not fully explained by habitat variables such as depth, dissolved oxygen, and water temperature. Further research is required to determine the potential abiotic and biotic variables that influence occurrence and biomass patterns, including analyses of limnological factors that could influence recruitment and population dynamics. Lack of knowledge on life history including spawning behaviour (timing, site selection), fecundity, maturity, sex ratio, age-length relationships, and the habitat features necessary for egg and juvenile development, are key gaps in the current understanding of this species. Knowledge gaps surrounding reproductive behavior necessitated the inference of habitat requirements for larvae and juveniles from the adult life stage. Given the small physical size of this species, the potential for multiple, reproductively isolated populations of Pygmy Whitefish exists within Lake Superior. However, targeted research about dispersal and genetic exchange within DU5 has not been conducted. The factors that influence population growth, whether top-down effects of predators or bottom up-effects of prey availability, require further study. Threats such as pollution, invasive species, and climate change have the potential to impact population growth of Pygmy Whitefish, but very little empirical information exists about how these threats are currently influencing Pygmy Whitefish in Lake Superior.

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SOURCES OF INFORMATION

This Science Advisory Report is from the December 10th, 2019 peer review on Recovery Potential Assessment –Pygmy Whitefish (*Prosopium coulterii*), Great Lakes – Upper St. Lawrence populations (DU5). Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

Andrews, D.W., van der Lee, A.S., Pratt, T.C., and Drake, D.A.R. 2021. Information in support of a Recovery Potential Assessment of Pygmy Whitefish (*Prosopium coulterii*), Great Lakes – Upper St. Lawrence population (DU5). DFO Can. Sci. Advis. Sec. Res. Doc. 2021/027. iv + 28 p.

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