Report on the Progress of Recovery Strategy Implementation for the Lake Utopia Rainbow Smelt (*Osmerus mordax*), Small-Bodied Population (sympatric with the Large-bodied Population)

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For copies of the recovery document, or for additional information on species at risk, including Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report, and other related documents, please visit the Species at Risk Public Registry.

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Preface

The *Species at Risk Act* (S.C. 2002, c.29) (SARA) requires the competent minister(s) to monitor and report on the implementation of recovery documents (that is, recovery strategies, action plans, and management plans) for species at risk. These reports must describe the progress made towards the species' recovery or conservation[1].

The Minister of Fisheries is the competent minister for aquatic species at risk. Fisheries and Oceans Canada (DFO) has prepared this progress report.

Reporting on the progress toward implementing recovery documents includes reporting on the collective efforts of the competent minister(s), provincial and territorial governments, and all other parties involved in carrying out actions that contribute to the species' recovery or conservation.

As stated in the preamble to SARA, success in the recovery and conservation of species at risk depends on the commitment and cooperation of many contributors, and will not be achieved by DFO, or any other jurisdiction, alone. All Canadians are invited to join in supporting and implementing the recovery document, for the benefit of the species and Canadian society as a whole.

Acknowledgements

The progress report was prepared by regional recovery planners within DFO. The progress toward species recovery described in this report would not have been achieved without the partnerships and contributions of many individuals and organizations.

Executive summary

This report summarizes the progress made by DFO and its partners towards implementing the recovery strategy for the Lake Utopia Rainbow Smelt, Small-bodied population (Sympatric with the Large-bodied population), between 2016 and 2023. For more information on the contents of this document, please contact the Species at Risk Program (dfo.ncrsara-leprcn.mpo@dfo-mpo.gc.ca).

[1] "Recovery" applies to species listed under SARA as threatened, endangered or extirpated, which require a recovery strategy and one or more action plan(s). "Conservation" applies to species listed under SARA as special concern, which require a management plan.

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1 Lake Utopia Rainbow Smelt (*Osmerus mordax*), Small-bodied Population, (sympatric with the Large-bodied Population), in Canada

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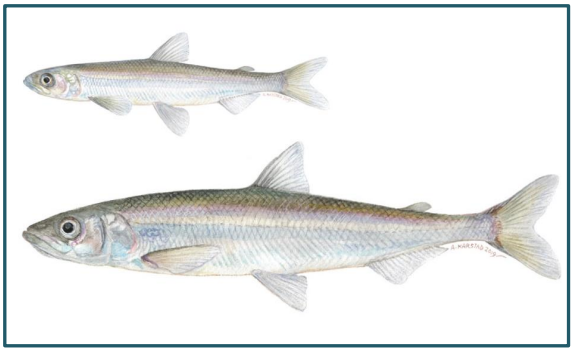

Credit: A. Karstad

Fisheries and Oceans Canada (DFO) and its partners have made progress towards the implementation of the research and management approaches identified in the "Recovery Strategy for Lake Utopia Rainbow Smelt (*Osmerus mordax*), Small-bodied Population (sympatric with the Large-bodied Population), in Canada", through the actions undertaken between October 2016 and December 2023, to support recovery of the Lake Utopia Rainbow Smelt sympatric species-pair. The recovery strategy provides detailed information on the unique species pair, its threats, its needs, population objectives (genetic, abundance and distribution), the identification of the small-bodied population critical habitat, broad strategies, and research and management activities for both populations.

The Rainbow Smelt (*Osmerus mordax*) of Lake Utopia consists of 2 co-existing (sympatric) morphologically, ecologically, and genetically differentiated populations that occur only in this single lake within the Magaguadavic watershed in southwest New Brunswick. Together the 2 populations are referred to as the Lake Utopia Rainbow Smelt sympatric species-pair, or simply Lake Utopia Rainbow Smelt (LURS).

The LURS Small-bodied population (SbP) was listed as threatened under the *Species at Risk Act* (SARA) in 2003, and a recovery strategy was published in 2016. The Large-bodied population (LbP) was listed as threatened under SARA in 2019. Following the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) 2018 status re-assessments, both populations were reclassified as endangered under SARA in October 2020. This document reports on the implementation of the 2016 recovery strategy which focused on the survival objectives of the species-pair with distinctions between the 2 interdependent populations where relevant.

This progress report is part of a series of documents for this species that should be taken into consideration together, including the recovery strategy (DFO 2016a), COSEWIC status reports (COSEWIC 2008, 2018), science advisory reports from the recovery potential assessment (DFO 2011) and updated population abundance

estimates (DFO 2016b; DFO 2018; DFO 2021; DFO 2024[2]), and the action plan (DFO 2020). Refer to the LURS species profiles for both populations on the Species at Risk Public Registry for more information and related documents.

1.1 Progress towards meeting the population objectives for the Lake Utopia Rainbow Smelt

Population objectives establish, to the extent possible, the conditions that are necessary for the recovery of the species. The population objectives for LURS are:

- **Genetic objective:**
  - Maintenance of the genetic diversity and genetic differentiation of LURS within the Lake Utopia system

- **Abundance objectives:**
  - Small-bodied population: 100,000 spawning fish distributed among Second Brook, Unnamed Brook, and Smelt Brook during nights of peak spawning
  - Large-bodied population: 2,000 spawning fish in Mill Lake Stream during nights of peak spawning

- **Distribution objectives:**
  - Small-bodied population: occupation of Lake Utopia year round and annual, synchronous occupation of Second Brook, Unnamed Brook and Smelt Brook for spawning, with no individual stream to be unoccupied for 2 consecutive years
  - Large-bodied population: occupation of Lake Utopia year round and annual occupation of Mill Lake Stream for spawning

Three broad strategies were identified in the recovery strategy to meet the population (genetic, abundance and distribution) objectives for LURS. During the reporting period, recovery actions were undertaken by DFO and its partners under each broad strategy. Some key achievements are described below.

Broad strategy 1: conduct research and monitoring

- To improve understanding of LURS critical spawning habitat, DFO evaluated biophysical characteristics of known spawning streams and found that LbP

[2] Data and analysis were available to DFO within the reporting period; the Science Response has since been published

streams were warmer than SbP streams, and that egg deposition was greatest in riffles and runs, and on sand and gravel substrate (MacDonald 2017a);

- DFO published protocols for daytime visual monitoring of LURS spawning activity (MacDonald and Burbidge 2017) and outlined nighttime mark-recapture population assessment protocols (DFO 2018) to ensure consistency in methodology and data collection;
- Eastern Charlotte Waterways Inc. and Passamaquoddy Recognition Group Inc. conducted annual monitoring of LURS spawning activity in all known spawning streams (figure 1). Annual observations included evidence of LbP spawning in Mill Lake Stream and SbP consistently using at least 2 of their 3 known spawning streams (Themelis 2018; ECW 2019; PRGI 2020, 2021, 2022b, 2023; DFO 2021; Abes 2022, 2023; DFO 2024);
- DFO and partners investigated other Lake Utopia tributaries for potential LURS spawning habitat. An unnamed stream (referred to as Big Hike Brook in MacDonald 2017a) and Little Otter Brook, both located at the north-western end of the lake, were identified for future monitoring due to characteristics consistent with known spawning habitat (Jackson pers. comm. 2020; MacDonald 2017a; PRGI 2022a);
- In collaboration with DFO, Eastern Charlotte Waterways Inc. developed (Sharman and Mawer 2022) and began implementing annual monitoring protocols for the Trout Lake Stream-Spear Brook tributary system in 2022 (Abes 2022, 2023) to evaluate its current usage in follow-up to past accounts of LURS spawning activity (Bradford et al. 2012; DFO 2011; Jackson pers. comm. 2020). No definitive evidence of LURS spawning was found within the reporting period;
- DFO, with assistance from partner organizations Eastern Charlotte Waterways Inc., Passamaquoddy Recognition Group Inc., and Dalhousie University, conducted periodic population assessments using mark-recapture techniques. Nightly spawner abundance surveys estimated approximately 30,000 SbP in Second Brook in 2019, and 12,000 LbP and 6,500 LbP in Mill Lake Stream in 2017 and 2018 respectively. This led to a proposed increased recovery target of 5,000 LbP spawners in Mill Lake Stream (DFO 2018, 2021, 2024);
- Genetic analyses undertaken by the Dalhousie University Marine Gene Probe Lab estimated the number of effective LbP spawners in Mill Lake Stream in 2023 to be 240 to 389 individuals. It was also confirmed that hybridization has continued to occur between the 2 populations, but genetic variance, as measured

by F_{ST} values[3], indicates both populations remain distinguishable (Bentzen 2024[4]);

- Analysis of the Lake Utopia food web and an eDNA survey conducted by Saint Mary's University and Eastern Charlotte Waterways Inc., respectively, indicate changes in the lake's food web between past (1998 to 2000) and more recent (2017 to 2018) sampling, and that non-native and invasive species (for example, Chain Pickerel [*Esox niger*], Smallmouth Bass [*Micropterus dolomieu*], stocked landlocked Atlantic Salmon [*Salmo salar*]) are potentially preying upon LURS (Campbell 2019; Forbes 2022).

Broad strategy 2: protect the species and its habitat

- To avoid harm to the species pair and their habitat and protect the conditions required to achieve the population objectives, DFO undertook regulatory reviews of proposed land alteration works and activities at Lake Utopia (for example, a boat launch construction and bank stabilization project), and issued authorizations, permits, or letters of advice to proponents with recommended mitigation measures and modifications (for example, erosion control) thus ensuring or promoting compliance with SARA and the *Fisheries Act*
- DFO reviewed applications for activities licensed under section 52 of the *Fishery (General) Regulations* such as fishing for scientific, experimental, educational, public display, or aquatic invasive species control purposes, to promote and enforce compliance with the *Fisheries Act* and SARA to minimize impacts to the species pair and their habitat
- To better protect the species pair and their habitat as new information became available, the LbP was listed as threatened on Schedule 1 of SARA (2019) and a Critical Habitat Order to protect SbP critical habitat was established (2019)
- In cooperation and consultation with conservation partners and others, DFO developed and published an Action Plan for SbP, in sympatry with LbP, that outlines the actions required to achieve the LURS population objectives (DFO 2020)
- DFO commenced drafting an amended LURS recovery strategy to reflect the SARA listing of the LbP, the endangered status of both populations, and include updated information

[3] F_{ST} is an index value (ranging from 0 to 1) used to quantify the degree of genetic differentiation between populations.

[4] Data and analysis were available to DFO within the reporting period; internal report has since been submitted to DFO.

- Although directed fishing for smelt in Lake Utopia as authorized under the Aboriginal Communal Fishing Licences Regulations made pursuant to the *Fisheries Act* is exempted in the recovery strategy, the New Brunswick Aboriginal People's Council continued its support for the conservation of SbP, and extended its support for the conservation of LbP upon its listing under SARA, by agreeing not to fish for smelt in Lake Utopia and its tributaries
- DFO Conservation and Protection officers regularly patrolled the Lake Utopia area and remained in contact with fishers and stewardship, research, and monitoring groups to raise awareness of LURS and enforce compliance with fishery closures, particularly during their spawning season
- DFO introduced a conservation measure to prohibit the use of eel pots by commercial American Eel (*Anguilla rostrata*) harvesters within all LURS spawning streams and Trout Lake from March 15th to June 30th thereby mitigating threats to the species pair and their habitat from foot traffic, incidental capture, and disruption to spawning

Broad strategy 3: promote, support and undertake stewardship and education activities

- The Passamaquoddy Recognition Group Inc. and Eastern Charlotte Waterways Inc. were active stewards in protecting the species pair and their habitat. They contributed to conservation research priorities, such as monitoring spawning streams (figure 1, figure 2), reporting stream blockages and spring flood conditions, and conducting education and outreach activities to inform residents and stakeholders of LURS' protected status;
- The New Brunswick Department of Transportation and Infrastructure replaced both the old primary and secondary small, cylindrical, metal culverts under Route 785 with a large, square, primary culvert and a concrete, secondary culvert, greatly improving access for LURS to the Mill Lake Stream spawning tributary;
- The Lake Utopia Preservation Association compiled historical information regarding the St. George dam, changing lake water levels, and a chronology of other events that impacted the Lake Utopia environment, publishing this information on their website to promote conservation of the lake's ecological health. They also assisted the province in collecting water quality data;

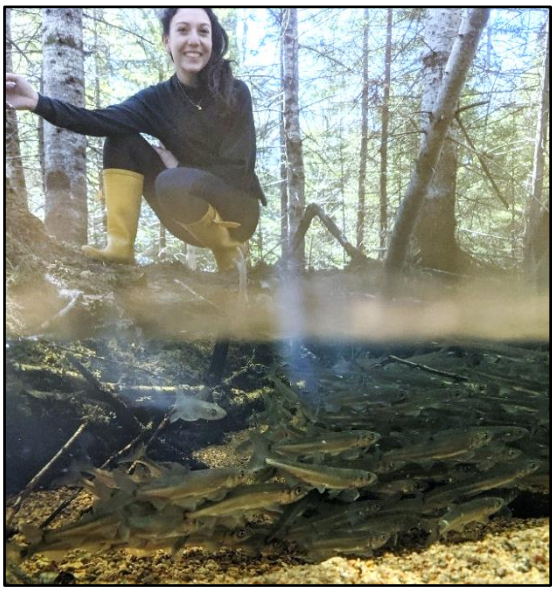

Figure 2. Monitoring the Lake Utopia Rainbow Smelt, Small-bodied population during the 2021 spawning season in Second Brook. (Photo credit: Passamaquoddy Recognition Group Inc. 2021)

Figure 1. A male small-bodied Lake Utopia Rainbow Smelt seen with nuptial tubercules during the 2021 spawning season at Unnamed Brook. (Photo credit: Passamaquoddy Recognition Group Inc. 2021)

- DFO developed and posted “Protected Species and Habitat” signs in strategic locations around Lake Utopia to inform lake users, landowners, and developers that LURS are protected by federal law and providing a contact number and website for more information;
- DFO collaborated with New Brunswick Museum to create a waterproof, pocket-sized field guide to Freshwater Fishes of Conservation Significance in Maritime Canada, which includes Lake Utopia Rainbow Smelt, and is available in English, French, Mi’kmaw and Wolastoqey-Peskotomuhkati (McAlpine and Karstad 2024[5]);
- Water levels in Lake Utopia were monitored and recorded by the dam operator, St. George Power Limited Partnership (SGPLP), and managed in an effort to maintain sufficient water levels during the LURS spawning period, specifically by minimizing drawdown so LURS are able to access their spawning streams (SGPLP 2020);

[5] Developed within the reporting period but finalized outside the reporting period. Versions of the Freshwater Fishes Guide in each language are available on the New Brunswick Museum website.

- New Brunswick Invasive Species Council helped to reduce the risk of new introductions of non-native and invasive species through their Clean Drain Dry and Don't Let It Loose campaigns and other outreach efforts;
- Wildlife Conservation Society Canada designated Lake Utopia as a Key Biodiversity Area in 2023 to raise public awareness of LURS conservation status and help inform decision-making on land and water management.

Achievement of the population objectives for LURS is evaluated using the performance indicators outlined in the recovery strategy. Table 1 provides an overview of the status of performance indicators as of the end of the reporting period (2016 to 2023). Four of the 7 performance indicators were met/ongoing, 1 performance indicator was partially met/underway, and 2 performance indicators were not met. Performance indicators that were partially met or not met are discussed in the "Knowledge gaps and future priorities" section below.

Table 1: Status of performance indicators for Lake Utopia Rainbow Smelt for the period 2016 to 2023.

Performance indicator	Status[6]	Description of progress
Genetic discreteness between the Small-bodied population (SbP) and Large-bodied population (LbP) as indicated by a F_{ST} value of no less than 0.030 estimated from the genetic variation at the microsatellite loci used in Bradbury et al. (2011).	Partially met, underway	- The genetic variation (as measured by an index known as an F_{ST} value) was found to be greatest (0.096) between LbP in 2023 and SbP in 2018. The F_{ST} between LbP and SbP sampled in 2018 was second highest at 0.072 (Bentzen 2024); - These values are above the minimum of 0.030 and above F_{ST} values from historical analyses (0.044 between SbP and LbP in 2003 [Bradbury et al. 2011]), however no SbP were sampled in 2023 to allow same-year comparison with LbP samples, and comparison to 2018 samples cannot be made due to use of different microsatellite loci (Bentzen 2024) .

[6] **Met**: the performance indicator has been met and no further action is required
Met, ongoing: the performance indicator has been met, but efforts will continue until such time the population is considered to be recovered
Not met: the performance indicator has not been met, and little to no progress has been made
Partially met, underway: the performance indicator has not been met, but there has been moderate to significant progress made

Performance indicator	Status[6]	Description of progress
No increasing trend in the frequency of hybrids among at least 3 observations.	Not met	- The frequency of hybrids has increased between 2 observations (that is, SbP were observed spawning in Mill Lake Stream in 2018 and an increase in hybrids was detected in 2023). This increase was confirmed by weakening genetic differentiation between the 2 populations and declining minimum LbP fork length (Themelis 2018; Fisheries and Oceans [DFO] 2024); - There are challenges with evaluating this performance indicator. There is no historical basis for comparison and current data is insufficient to assess the degree of hybridization between the Lake Utopia Rainbow Smelt (LURS) species pair; - Defining a trend in hybridization would require the development of a baseline with repeated, expanded sampling and genetic analyses over time (Bentzen 2024) and a better understanding of selective pressures that influence hybridization.
The average of the yearly means of the 5 highest daily summations of the SbP spawner abundance of all spawning streams over the spawning period is no less than 100,000 individuals	Not met	- Peak spawner abundance on a single night was estimated to be approximately 16,000 in Unnamed Brook and 30,000 in Second Brook in 2019 (DFO 2021); the 2019 mean spawner abundance in Second Brook across 3 nights was approximately 17,000 individuals; - The 100,000 individuals abundance target cannot be confirmed due to logistical challenges in undertaking nightly estimates in all spawning streams for years of sampling.
All 3 existing spawning streams were used by SbP for spawning	Met, ongoing	- Opportunistic observations and monitoring results over the reporting period indicated that the SbP used all 3 spawning streams, even though they were not observed in all 3 streams in all years;

Performance indicator	Status[6]	Description of progress
		- SbP were observed in at least 1 of the 3 known spawning streams in 2016 and 2017, in Unnamed and Second Brooks in 2020 and 2023, and recorded in all 3 streams in all other years (2018, 2019, 2021, 2022) (Themelis 2018; DFO 2021; PRGI 2020, 2021, 2022b, 2023).
None of the existing spawning streams went more than 1 year without being used by SbP for spawning	Met, ongoing	- Monitoring results confirm that at least 2 of 3 SbP spawning streams were used each year for spawning, and no stream went unused for 2 consecutive years; - No evidence of spawning was found in Smelt Brook in either 2020 or 2023 likely due to spring flood conditions and barriers to fish passage (trees and debris) in 2020 and a beaver dam in 2023 (Passamaquoddy Recognition Group Inc [PRGI] 2020, 2023).
The average of the yearly means of the 5 highest daily summations of the LbP spawner abundance in Mill Lake Stream over the spawning period is no less than 2,000 individuals.	Met, ongoing	- LbP abundance estimates have achieved the target of “no less than 2,000 individuals”; - Mean LbP spawner abundance in Mill Lake Stream was estimated as approximately 9000 over 2 nights in 2017 and approximately 2000 over 5 nights in 2018, for an average of approximately 5500 LbP spawners across these 2 years (DFO 2024); - LbP highest nightly spawner abundance estimates declined over 4 years from approximately 23,000 in 2014 to 12,000 in 2017 to 7,000 in 2018 (DFO 2024). This may not reflect population decline as sampling may not have occurred at the peak of spawning and other spawning areas may be in use to varying degrees from year to year.
Mill Lake Stream was used each year by LbP for spawning.	Met, ongoing	- Both direct (live, adult LbP spawners) and indirect evidence (presence of viable eggs and adult mortalities) confirmed the use of Mill Lake Stream by LbP each year of monitoring (DFO

Performance indicator	Status[6]	Description of progress
		2018; ECW 2019; PRGI 2020, 2021, 2022b, 2023)

1.2 Actions supporting the identification of critical habitat

Critical habitat provides the features and attributes necessary to support the species' life-cycle functions and achievement of the species' population and distribution objectives. Critical habitat for the SbP was identified in the recovery strategy to the extent possible, using the best available information. The identification includes detail on its geographical locations (Lake Utopia and a stretch of each of the 3 SbP spawning streams) and biophysical components (section 8 and table 3 in the recovery strategy). Legal protection of critical habitat for the SbP was achieved on September 4, 2019, through the making of a Critical Habitat Order pursuant to subsections 58(4) and (5) of SARA.

The recovery strategy includes a schedule of studies outlining 3 studies required to refine existing critical habitat for the SbP and identify new critical habitat necessary to promote the continued survival of the sympatric species pair. Table 2 provides an overview of the status of these studies.

Table 2: Status of the implementation of the schedule of studies for Lake Utopia Rainbow Smelt, for the period October 2016 to December 2023.

Study	Status[7]	Description of progress
1. Research to understand the specific attributes of the critical habitat features that provide for the Lake Utopia Rainbow Smelt (LURS) life functions	In progress	- Stream characteristics were evaluated and defined for known LURS spawning streams, such as water temperature, features, barriers to fish migration, and substrate type. Large-bodied population (LbP) streams were warmer than Small-bodied population (SbP) streams; egg deposition was greatest in riffles and runs, and

[7] **Completed**: the study has been carried out and concluded
In progress: the planned study is underway and has not concluded
Not started: the study has been planned but has yet to start
Cancelled: the planned study will not be started or completed

Study	Status[7]	Description of progress
in both tributary and lake habitat, and the mechanisms through which these life functions are provided Timeline: 2015 to 2019		on sand and gravel substrate (MacDonald 2017a); - Hydroacoustic and biological surveys conducted to define LURS' use of Lake Utopia habitat revealed fish clusters near the bottom of the north basin during the day and nighttime vertical migration in the water column; however, it was not possible to confirm these were LURS due to a lack of fish captured (MacDonald 2017b).
2. Research to identify whether there are other suitable spawning locations available and in consistent use (for example, other tributaries including Mill Lake Stream, lake shoreline) Timeline: 2015 to 2019	In progress	-Several potential spawning locations (Big Hike Brook, Little Otter Brook, Trout Lake Stream-Spear Brook) were identified for additional monitoring based on biophysical properties and accounts of past use (MacDonald 2017a; DFO 2011; PRGI 2022a; Jackson pers. comm. 2020). Annual monitoring of Trout Lake Stream-Spear Brook for LURS usage began in 2022, finding no definitive evidence of its use, but monitoring will continue over the next few years (Abes 2022, 2023; Sharman and Mawer 2022); -The use of the lake and other Lake Utopia tributary habitats by LURS continues to be evaluated by Fisheries and Oceans (DFO) and partners with advancing technology and methodology (MacDonald 2017b; PRGI 2022a).
3. Research to understand the isolating mechanisms behind the genetic differentiation observed in the LURS species pair Timeline: 2015 to 2019	In progress	-Spawning location and timing are believed to be the primary isolation mechanisms between the LURS species pair. SbP continues to spawn slightly later and in different streams than LbP, although SbP have been observed to also use Mill Lake Stream for spawning since 2014 (DFO 2016a); -Hybridization is occurring, as evidenced by genetic analysis and lower mean fork lengths in LbP sampled from Mill Lake Stream in 2018 and 2023 (Bentzen 2024); however, understanding changes in genetic differentiation

Study	Status[7]	Description of progress
		over time (that is, hybridization rate) requires more extensive genetic sampling.

1.3 Key knowledge gaps and future priorities for the Lake Utopia Rainbow Smelt

Progress has been made toward implementing the LURS recovery strategy during this reporting period (2016 to 2023). Future research priorities include ongoing annual monitoring of all known spawning streams to confirm usage and expanding periodic mark-recapture surveys to confirm achievement of abundance targets. Broadened techniques and new monitoring methodologies will aim to: improve the understanding of genetic differentiation and hybridization; estimate the contribution of each spawning stream to the total SbP spawner abundance; track individual LbP movements during spawning; and detect use of other potentially suitable spawning locations by LbP and SbP. Threats such as predation from invasive species and landlocked Atlantic salmon will continue to be evaluated. Greater consideration will be given to logistical and environmental factors that have previously limited progress on unmet performance indicators (for example, spring flood conditions, navigating remote and difficult terrain at night, human resources to simultaneously assess all 3 SbP spawning streams). Expanded sampling across all SbP spawning streams in addition to improved quantification of the use of Mill Lake Stream by SbP will strengthen future genetic analyses to assess changes in genetic variation between the SbP and LbP (DFO 2024). To overcome challenges with assessing the rate of hybridization between the 2 LURS populations, the establishment of a repeatable methodology is first required for detecting a trend in genetic variation over the long term; a more readily, measurable performance indicator by which short-term genetic change is easily detectable will also be developed.

To protect the species pair and their habitat, consideration will be given to mitigating threats to the riparian zones of spawning streams and lakeshore through increased protection and restoration. Threats caused by extreme and rapid water level fluctuations during spawning season should be mitigated through collaborations with industry, landowners, and partners in forest-watershed management to improve policies and practices. Amending the LURS recovery strategy and updating the action plan to account for new information, including the SARA listing of the LbP and status reclassification of both populations is also a priority.

Indigenous, environmental non-governmental organizations and academic partners have played a vital role in advancing research and monitoring, and these existing collaborations will continue to be strengthened. New partnerships should be explored through engagement with industries, local landowners, and lake users to better understand and minimize emergent and cumulative threats, such as habitat degradation and the spread of aquatic invasive species.

2 Concluding statement

During the reporting period, progress was made toward implementing the research and management activities identified in the recovery strategy for the Lake Utopia Rainbow Smelt.

DFO remains committed to the recovery of all aquatic species at risk. The work that has been initiated and completed to date has built a strong foundation for the continued management of the Lake Utopia Rainbow Smelt. DFO and its partners will continue to work towards the achievement of the population and distribution objectives for Lake Utopia Rainbow Smelt, and welcome the participation of additional partners.

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