APPENDIX D

Re-Establishment Strategy

Re-Establishment Strategy

Objective: Re-establishment of reproducing populations of native fish species currently present in the treatment area

Overview: The re-establishment strategy is based on the advice provided in the DFO science CSAS review (DFO 2019), on feedback and discussion with Miramichi Lake camp owners, and on anticipated food base recovery timing from research on other treated lakes (e.g., Eilers 2008, McGann 2018).

In previous eradication projects throughout North America, where the goal has been to re-establish a fishery (usually native trout), the typical approach has been to restock fish the following spring post-treatment when zooplankton and macroinvertebrate abundance and diversity has rebounded to provide a food source. Results from studies on multiple lakes (e.g., Eilers 2008, McGann 2018) demonstrate that both plankton and macroinvertebrates recover to establish an adequate food source for fish by the following spring post-treatment and typically recover to pre-treatment levels (or greater) within 1 year. Using the existing research, we anticipate there will be an abundant food base in Miramichi Lake by the next spring after treatment.

Our objective is to restore self-sustaining fish populations of species currently in the lake, with the exception of SMB. This is in-keeping with Miramichi Lake camp owners' interests in seeing rapid ecosystem recovery (not the establishment of a fishery).

DFO's CSAS review indicated that none of the species present in the lake are unique to the lake, and recommended natural recolonization post-treatment. Our re-establishment strategy combines monitoring for natural recolonization, but also takes a pro-active approach to re-establishing non-migratory fish species into the lake to accelerate recovery. This approach eliminates the need for fish holding on-site for several weeks, as proposed in the original AIS application to DFO. The preferred approach and performance measures are summarized below and in Table D1.

The re-establishment plan will provide each species currently present in the lake (exception: SMB) the opportunity to recolonize; however, community composition in the short and long term will likely differ from its present state because each species will recolonize at different rates and relative abundances. Recovery will also occur in the absence of the invasive species and DFO's control efforts to remove them, which has had collateral impact on other species in the lake since 2008 when control efforts began. We do not expect or aim for the resulting fish community to be the same as the pre-treatment state, but we do expect overall rapid recovery of the ecosystem, consisting of (but not limited to) a food base of plankton and macroinvertebrates, mussel assemblages, and reproducing fish populations.

Re-establishment Approach

- Fish species recovery will be monitored for 5 years post-treatment (see Monitoring Plan in Appendix C)
- Migratory species: no action will be taken to transplant or actively re-establish migratory species, as they are anticipated to recolonize naturally relatively quickly

- Non-migratory species: monitoring will assess presence/absence and reproduction. If there is no evidence of both adults and juveniles by two years post-treatment in Miramichi Lake, 100 individual adults of the species will be collected from a nearby lake within the watershed (e.g., McKiel Lake, Beaver Brook Lake) and transplanted into Miramichi Lake with the appropriate Introductions & Transfers permit.
- The treatment reach of the SW Miramichi River is open-ended at both the upstream and downstream end, and both migratory and non-migratory species are expected to recolonize rapidly through natural movements and colonization of vacant habitat in the river and in Lake Brook. This will be monitored at a variety of sites throughout Lake Brook and the SW Miramichi River as explained in Appendix C.
- Brook Floater: mussels in general are expected to survive given their high toxicity thresholds to rotenone; however, monitoring will assess presence/absence of Brook Floater adults and juveniles post treatment. Based on discussions with and advice from DFO, DNR and the NB Museum, there are no plans to transplant brook floater because transplanting from known assemblages in the river may cause more harm than good since those assemblages are already limited in numbers. Again, brook floater are expected to survive the treatment given high toxicity thresholds in freshwater mussels.
- The performance measure for successful fish re-establishment will include presence of adults and juveniles, indicating successful reproduction
- If any number of both adults and juveniles are present of a given non-migratory native species, we will not transplant and will allow the species to recolonize naturally. Note that the presence of even a small number of fish caught in a sampling procedure is indicative of many more in the unsampled areas of the lake. Therefore, the indicator to transplant or not will be based on a binary presence or absence in the sampling.
- Monitoring will continue for 5 years post-treatment, providing at least 3 years to assess re-establishment of transplanted species.
- After the first transplantation, if there is no evidence of establishment of a given non-migratory native species (i.e., no adults and juveniles present) by year 5, we will conduct another round of transplantation during year 5, the final year of the monitoring plan. Note that because 100 individuals are planned for transplantation in year 2, this low abundance may result in species not being captured in the sampling within a year or two after introduction. This is why we propose to wait until year 5 before making the decision on a second transplantation effort if certain species are still not present.

Other Considerations

- Golden shiner and brown bullhead – expected to be present immediately post-treatment given their high toxicity threshold to rotenone
- Alewives (migratory/anadromous) - adult alewives at sea during treatment will be unaffected and will enter the lake and spawn the following spring after treatment (as occurs naturally). Juvenile alewives to be present in the lake during summer months, emigrating in late summer (as occurs naturally).

- Atlantic salmon (migratory/anadromous) - the following summer post-treatment, young of the year juvenile Atlantic salmon are expected to be present in Lake Brook at similar densities compared to pre-treatment since spawning adults holding in the river during the fall (October/November) are not anticipated to be impacted by the lake treatment (August/September). Resulting juvenile densities will depend on a variety of factors that are independent of the application (e.g., adult spawner abundance, spawning conditions, overwintering conditions/survival, etc.).
- American Eel (migratory/panmictic) – juveniles arriving from sea are anticipated to be present in Lake Brook and Miramichi Lake the following year after treatment
- Sea Lamprey (migratory/anadromous) – adults at sea during treatment will be unaffected and are anticipated to enter Lake Brook and/or Miramichi Lake the following spring after treatment

Table D1. Re-establishment strategy and performance measures.

Category	Species	Action	Performance Measure
Migratory	Atlantic salmon *Salmo salar*	Monitor* natural recolonization	Presence of adults and juveniles indicating successful reproduction**
	American eel *Anguilla rostrara*		
	gaspereau *Alosa sp*		
	sea lamprey *Petromyzon marinus*		
	white sucker *Catostomus commersoni*		
Non-Migratory	banded killifish *Fundulus diaphanous*	Monitor* and if not present after 2 years post-treatment, 100 adults transplanted from nearby lakes within the watershed (McKiel Lake, Beaver Brook Lake, SW Miramichi or its tributaries) with appropriate Introductions & Transfers permit	Presence of adults and juveniles indicating successful reproduction
	blacknose dace *Rhinichthys atratulus*		
	brook trout *Salvelinus namaycush*		
	common shiner *Luxilus cornutus*		
	creek chub *Scardinius atromaculuatus*		
	fallfish *Semotilus corporalis*		
	lake chub *Couesius plumbeus*		
	pearl dace *Margariscus margarita*		
	white perch *Morone Americana*		
	yellow perch *Perca flavescens*		
	brown bullhead *Ameiurus nebulosus*	High toxicity threshold to rotenone and expected to survive treatment; will be monitored and transplanted as required according to the same criteria as listed above	Presence of adults and juveniles indicating successful reproduction
	golden shiner *Notemigonus crysoleucas*		
Mussels	brook floater *Alasmidonta varicosa*	High toxicity threshold to rotenone and expected to survive treatment; will be monitored. To avoid risk of impact on known assemblages in the region, no individuals will be removed for transplantation to Miramichi Lake.	Presence of adults and juveniles indicating successful reproduction

*Monitoring plan provided in Appendix C

**Exceptions: American Eel is panmictic and spawns at sea; eel presence via immigration will be captured in the monitoring program. Adult Atlantic salmon spawn in late fall and are expected only to be present in Lake Brook for a short period of time; therefore, the measure of recolonization will be juveniles in Lake Brook during summers following treatment.

References

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