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Central and Arctic Region

Canadian Science Advisory Secretariat
Science Advisory Report 2016/046

ASSESSMENT OF THE IMPACTS OF AN AGRICULTURAL DRAIN MAINTENANCE PROJECT ON AQUATIC SPECIES AT RISK IN LITTLE BEAR CREEK, ONTARIO

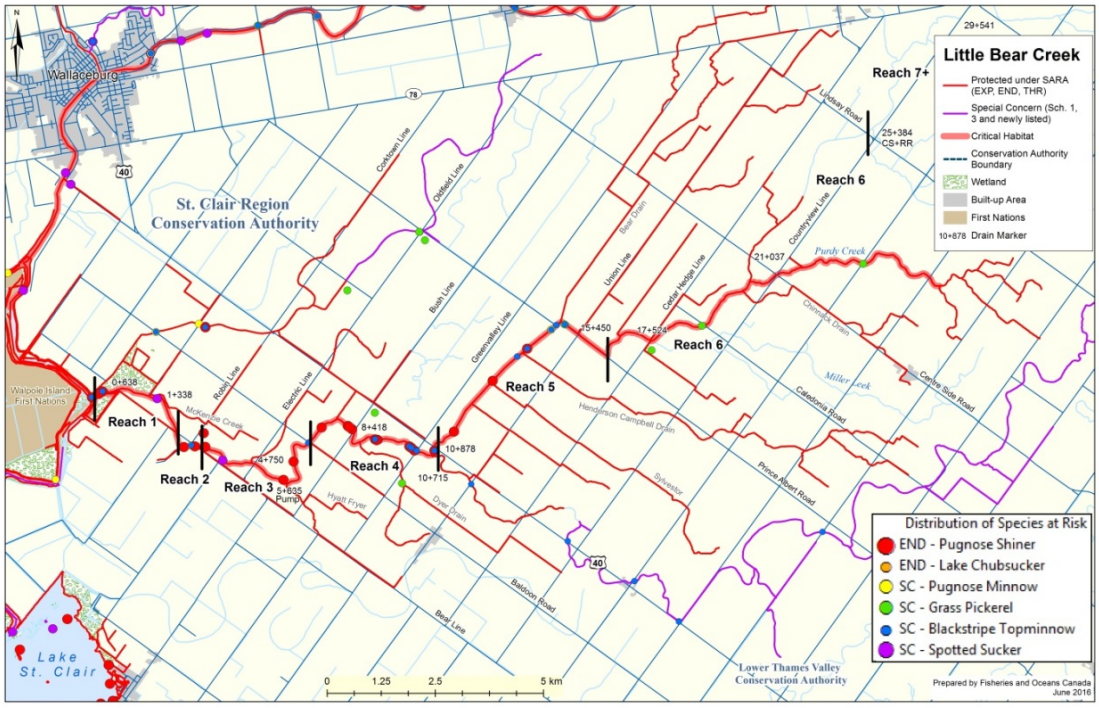

Figure 1. Little Bear Creek reaches (as defined by DFO) where drain maintenance has been proposed.

Context:

The Municipality of Chatham-Kent has submitted a Drain Maintenance request for Little Bear Creek drain, a tributary of Lake St. Clair (Figure 1). Proposed drain maintenance includes excavation via drag-line rigging and long and standard excavators, as well as the removal of accumulated sediment and riparian vegetation (i.e., small trees and large brush). Little Bear Creek is home to six species at risk fishes listed under the federal Species at Risk Act*. There is concern that the proposed maintenance will negatively affect fish species at risk and/or their habitats, including Critical Habitat for Pugnose Shiner (*Notropis anogenus*).*

Fisheries and Oceans Canada (DFO) Science has been asked to determine the impacts that proposed maintenance scenarios, and alternative scenarios, would have on fish species at risk in Little Bear Creek. In addition, DFO Science has been asked to provide mitigation measures and offsetting scenarios to minimize the impacts of maintenance on fish species at risk in Little Bear Creek.

This Science Advisory Report is from the May 11, 2016 regional peer review of Impacts of an agricultural drain maintenance project on aquatic species at risk in Little Bear Creek. Additional publications from this meeting are posted on the DFO Science Advisory Schedule.

SUMMARY

- Proposed drain maintenance in Little Bear Creek, Ontario may negatively impact fishes currently listed under the federal *Species at Risk Act* (SARA), and/or their Critical Habitat.
- A macrophyte survey, bathymetry survey, and fluvial geomorphology survey were conducted on Little Bear Creek and provide relevant information used to predict the impacts of drain maintenance on fish species at risk.
- Trawling surveys, including both benthic and pelagic trawls, were conducted in Little Bear Creek across three time periods: summer, fall, and early winter to determine the abundance of fish species at risk, and to assess the effectiveness of the proposed timing window on mitigating exposure of species at risk to direct impacts of drain maintenance.
- Based on trawling surveys of Little Bear Creek, fewer fishes are expected to be directly affected by maintenance activities during the winter than the fall. The timing window (August 1–March 15) is outside spawning and egg incubation periods, yet not likely to avoid the early-rearing period for Pugnose Shiner and Blackstripe Topminnow (*Fundulus notatus*) or direct impacts to young-of-the-year fish species at risk.
- There is 0.032 km^2 of predicted suitable habitat, which exceeds the minimum area for population viability (MAPV) of 0.015 km^2 for Pugnose Shiner and 0.003 km^2 for Blackstripe Topminnow.
- Two drain maintenance scenarios were proposed for dredging of Little Bear Creek, the initial proposal and a revised proposal that had a reduced area proposed for dredging. Under both the initial and revised drain maintenance scenarios, 19% of suitable habitat in Little Bear Creek will be permanently lost. Temporarily lost suitable habitat will be 40% and 42%for the revised and initial drain maintenance scenarios, respectively. If regrowth of temporarily lost habitat does not occur, the suitable habitat that remains will be less than the MAPV for the Pugnose Shiner.
- To minimize the impacts of drain maintenance in Little Bear Creek, the most relevant mitigation pathway from Coker et al. (2010) is the dredging pathway (link 11–1 and 11–8).
- Habitat loss should be compensated through habitat gain of suitable habitat quality, and made accessible to the species within the first 2–3 years after impact (considering a generation time of 2 years and a maximum age of 3 years).
- For timing windows to be effective, dredging should occur when risk of direct mortality to fishes is lowest and outside the timing of spawning, egg incubation, and early rearing, which occurs in spring and early summer. Timing windows should be set based on biological information as opposed to dates.
- Macrophtyes removed from areas where the post-maintenance depth will be < 1.425 m are expected to grow back 1–2 years after drain maintenance. Future research should include post-maintenance vegetation surveys to better understand regeneration trends of aquatic macrophytes following drain maintenance activities.
- Due to a lack of bathymetry farther than 11 km upstream, there are no quantitative predictions of suitable habitat in these areas. Further research should incorporate drone work (previously conducted by DFO's Fisheries Protection Program) on Little Bear Creek to supplement missing data.

INTRODUCTION

Little Bear Creek is a tributary of Lake St. Clair designated as a municipal drain under the authority of the provincial *Drainage Act*. Little Bear Creek drains into the St. Clair River via the Chanel Ecarte and passes through the geographic townships of Dover, Chatham, and Camden, within the Chatham-Kent Region. Adjacent farm land drains into Little Bear Creek through subsurface tile drains. The Municipality of Chatham-Kent has submitted a drain maintenance request to excavate 29.5 km from the mouth and upstream to Countryview Line, where the remaining drain portions are buried. Proposed drain maintenance includes excavation via drag-line rigging and long and standard excavators, and the removal of accumulated sediment and riparian vegetation (i.e., small trees and large brush). Little Bear Creek is home to six species at risk fishes listed under the federal *Species at Risk Act*: Endangered Pugnose Shiner; Endangered Lake Chubsucker (*Erimyzon sucetta*); Special Concern Pugnose Minnow (*Opsopoeodus emiliae*); Special Concern Blackstripe Topminnow; Special Concern Grass Pickerel (*Esox americanus vermiculatus*); and, Special Concern Spotted Sucker (*Minytrema melanops*).There is concern that the proposed maintenance will negatively affect fish species at risk and/or their habitats, including Pugnose Shiner Critical Habitat.

The objectives of this meeting were to:

1. Determine the impacts that the proposed maintenance would have on species at risk fishes in Little Bear Creek;
2. Provide alternative maintenance scenarios and determine the impact they may have on species at risk fishes in Little Bear Creek;
3. Provide mitigation measures that could be used to minimize the impact of maintenance on species at risk fishes in Little Bear Creek; and,
4. Provide offsetting scenarios (qualitative) for each alternative drain maintenance scenario.

This report summarizes the conclusions and advice from the Canadian Science Advisory Secretariat (CSAS) peer-review meeting, held in Burlington, Ontario on May 11, 2016. Two working papers were presented and reviewed: one that assessed the direct impacts of proposed drain maintenance on fish species at risk (Montgomery et al. 2016); and, one that assessed seasonal variation in the fish composition in Little Bear Creek (Reid et al. 2016). These research documents included technical details and a full list of citations. Potential fish-exclusion techniques (DFO 2015) and information from three supplementary surveys conducted in Little Bear Creek were also presented: an aquatic macrophyte survey (Wiklund 2015); a multibeam bathymetry survey (Milne 2015); and, an assessment of the fluvial geomorphology (Smith and Gall 2014). Proceedings documenting the discussions and conclusions of the meeting are also available (DFO 2016).

ASSESSMENT

Sampling Procedure

This project included three components to inform the impacts of drain maintenance on fishes in Little Bear Creek:

1. an assessment of the geomorphic stability and hydrology of Little Bear Creek before and after proposed drain maintenance works;

2. a modelling assessment of the direct impacts of drain maintenance on fish species at risk habitat; and,
3. an assessment of seasonal variations in Little Bear Creek fishes.

The first component included an assessment of the fluvial geomorphology, hydrology, and ecohydraulics of Little Bear Creek and the possible impacts from proposed repair and improvement works conducted by UEM consulting (Smith and Gall 2014). It also identified opportunities for drain stability enhancement and creek habitat improvement for species at risk in Little Bear Creek.

To inform the second component, macrophyte and bathymetry data were collected and used to develop a predictive vegetation model in Little Bear Creek. The macrophyte survey was conducted to determine the distribution and abundance of aquatic macrophytes throughout Little Bear Creek (Wiklund 2015) and a multibeam survey collected high-resolution bathymetry data from the mouth of the creek to Highway 40 (Milne 2015). The bathymetry data were used to make predictions of suitable habitat throughout Little Bear Creek, based on the relationship between macrophytes and depth inferred from the vegetation survey. The impacts of drain maintenance were assessed in four parts:

1. the vegetation model was used to quantify the amount of suitable habitat currently in Little Bear Creek;
2. a GIS layer was created to represent the area of proposed drain maintenance, using the initial and revised parameters provided by the proponent;
3. the amount of suitable habitat within the proposed dredged layer was measured; and,
4. the size and number of suitable habitat patches, and the distance to the nearest patch, before and after drain maintenance, were compared.

To gain an understanding of the third component, fish surveys were conducted using trawling and standard bag seines in the summer of 2013 and using benthic and pelagic trawls in the summer, fall, and early winter of 2015, to better understand the distribution and abundance of fishes in Little Bear Creek. Due to the poor detectability of rare fishes in Little Bear Creek, habitat models were used to assess the impact of drain maintenance on the Pugnose Shiner and Blackstripe Topminnow, the two fishes at risk whose abundance and distribution within Little Bear Creek are best understood.

The seasonal variation in abundance of Little Bear Creek fishes study was designed to assess whether the proposed timing window (August 1–March 15) would reduce the risk of direct mortality. A trawling survey was conducted in the summer, fall, and winter of 2015 to characterize among-season differences in the distribution and species composition of fishes in Little Bear Creek, with special consideration for fish species at risk.

Results

The results of the fluvial geomorphic assessment (Smith and Gall 2014) suggest that Little Bear Creek is in a transitional state or is stressed/unstable (the unstable reach lies between Prince Albert Road and Highway 40). Active erosion from channel widening occurs above highway 40. Decreased stream velocities from backwater resistance have created aggradation of sediments in the reaches below Highway 40. Additionally, the assessment indicated that the water levels in Little Bear Creek are influenced by the level of Lake St. Clair from the mouth of Little Bear Creek upstream to Highway 40 (Smith and Gall 2014).

Fish surveys (both trawling and seines) detected four species at risk (139 individuals) in Little Bear Creek: Pugnose Shiner; Lake Chubsucker; Blackstripe Topminnow; and, Grass Pickerel. Both macrophytes (Wiklund 2015) and species at risk fishes are more abundant upstream of Electric Line (Reach 3 and upstream; Figure 1). Regression tree modelling suggests that Pugnose Shiner and Blackstripe Topminnow have a preference for heavily vegetated waters (Montgomery et al. 2016).

The results of the Montgomery et al. (2016) vegetation model suggest that depth, specifically depth < 1.425 m, is the most important predictor of suitable habitat. The vegetation model predicted 0.032 km^2 of suitable habitat for the Pugnose Shiner and Blackstripe Topminnow in Little Bear Creek. Under the initial drain maintenance proposal submitted by the proponent, approximately 61% (0.0197 km^2) of this predicted suitable habitat will be impacted by drain maintenance (Table 1). The amount of remaining suitable habitat will be less than the minimum area for population viability (MAPV) for Pugnose Shiner (0.015 km^2), but greater than the MAPV for Blackstripe Topminnow (0.003 km^2) (Montgomery et al. 2016). The revised drain maintenance proposal, provided by the proponent, would conserve 2% more suitable habitat than the initial drain maintenance proposal (Table 1). In both the initial and revised scenarios, 19% of the suitable habitat to be impacted is predicted to be permanently lost (Table 1).

Table 1. Estimated total area of suitable habitat (ASH) for Pugnose Shiner and Blackstripe Topminnow lost and conserved under three drain maintenance scenarios. The Minimum Area for Population Viability for Pugnose Shiner is 0.015 km^2 and 0.003 km^2 for Blackstripe Topminnow.

Scenario	ASH before drain maintenance	ASH after drain maintenance							
		Permanently lost		Temporarily lost		Conserved without regrowth of temporarily lost habitat		Conserved with regrowth of temporarily lost habitat	
		km^2	%	km^2	%	km^2	%	km^2	%
No drain maintenance	0.032	0	0	0	0	0.032	100	0.032	100
Initial drain maintenance	0.032	0.0062	19	0.0135	42	0.0123	38	0.0258	80
Revised drain maintenance	0.032	0.0062	19	0.0129	40	0.0129	40	0.0268	80

Removal of suitable habitat after the initial and revised drain maintenance will result in decreased connectivity between habitat patches and a five-fold increase in the maximum distance to the nearest habitat patch (Montgomery et al. 2016). Specifically, drain maintenance will isolate a large patch of habitat (360 m^2) from the next nearest habitat patch by 152 m (Montgomery et al. 2016).

The results of the pelagic and benthic zone trawling survey suggest that there are significant seasonal differences in the number of individuals collected ($X^2 = 25.5$, $p<0.001$; $W = 326$, $p = 0.02$) and species detected ($X^2 = 36.0$, $p<0.001$; $W = 369.5$, $p <0.0001$) in Little Bear Creek (Reid et al. 2016). Specifically, 49% and 62% fewer individuals were captured in the pelagic and benthic zones, respectively, in the winter compared to the fall. Pugnose Shiner was the only fish species at risk captured using a trawl in Little Bear Creek, with the majority of individuals collected in the fall.

Sources of Uncertainty

One source of uncertainty is whether fishes are directly impacted by the dredging activities in addition to impacts due to the loss of habitat. The habitat model assumes that no individuals

are directly removed, killed, or harmed in any way that would affect survival. This assumption is best met through proper mitigation, such as seasonal timing windows. The proposed window (April 1–March 15) is outside spawning timing reported in the literature for Little Bear Creek fishes at risk (Reid et al. 2016). However, a direct assessment of the effectiveness of the timing window to protect fish species at risk during the early rearing period is not possible with the data collected in this study.

The second source of uncertainty is the recovery time for macrophytes following their removal during drain maintenance. The habitat model assumes that any aquatic vegetation removed from areas < 1.425 m deep after drain maintenance will grow back the next growing season (1–2 years). Successful regeneration of macrophytes depends on the presence of either the below ground root system or seed banks (Van Wijk 1989). If the below-ground root system is removed during drain maintenance, dispersal of seeds from seed banks upstream will play an important role in successful re-establishment of temporarily lost habitat. Very little evidence exists to quantify the recovery time of vegetation after drain maintenance. Future research on macrophyte community responses after drain maintenance would increase our knowledge on the regeneration of macrophytes following maintenance activities.

A lack of bathymetry data across the entire creek above Highway 40 and along the periphery of the creek below Highway 40 influences the ability to quantify suitable habitat in these areas. Future research should integrate drone work (previously conducted by the Fisheries Protection Program) on Little Bear Creek with the bathymetry model to address the lack of data in these areas.

Limited abundance data prevents detailed impacts assessments for the other fish species at risk (Lake Chubsucker, Grass Pickerel, Spotted Sucker, Pugnose Minnow) in Little Bear Creek.

The unknown effect of low temperatures on riverine surveys with active gear, such as trawls is an uncertainty. Future research should address winter habitat use, movements, and trawling effectiveness to improve the sampling effort and mitigation techniques for fish species at risk.

How current timing windows will be altered by climate change and associated potential increases in water temperature is uncertain. Future research should evaluate water temperature data from the watershed and modify timing windows accordingly.

CONCLUSIONS AND ADVICE

The amount of predicted suitable habitat currently available in Little Bear Creek exceeds the MAPV for both the Pugnose Shiner and Blackstripe Topminnow, which suggests both populations are viable. Drain maintenance (both the initial and revised scenarios), will initially reduce the area of suitable habitat below the MAPV for Pugnose Shiner. If recolonization of temporarily lost suitable habitats does not occur, populations will not be viable in Little Bear Creek after maintenance. If recolonization does occur, 0.0135 km^2 of suitable habitat is predicted to grow back, which would exceed MAPV estimates for Pugnose Shiner and Blackstripe Topminnow. This assumes that Pugnose Shiner and Blackstripe Topminnow can survive after drain maintenance in sufficient numbers to populate the suitable habitat after it grows back. If the recolonization of macrophytes is delayed, or mortality of species at risk fishes occurs due to maintenance activities, this assumption may not be met.

To ensure Pugnose Shiner and Blackstripe Topminnow population viability, the amount of habitat permanently lost would need to be greatly reduced. Decreasing the proposed bottom width, to maintain larger patches of suitable habitat along the creek edges where macrophyte abundance is highest, should be considered. This would preserve larger patches of habitat, and

connectivity between patches, critical for small-bodied fishes like the Pugnose Shiner and Blackstripe Topminnow.

For appropriate mitigation measures to minimize the impacts of maintenance, mitigations for in-water Pathways of Effect (PoE) should be considered (Coker et al. 2010). PoE relevant to the proposed drain maintenance are:

1. dredging pathway (11);
2. addition or removal of aquatic vegetation pathway (15); and,
3. flow management pathway (16).

Additional mitigation techniques, such as timing windows for in-water work and the application of fish exclusion methods, should be considered. The effectiveness of fish exclusion techniques suggest that removal of 80% of fishes from an isolated work area requires as little as two hauls of a well-deployed and retrieved bag seine (DFO 2015). This technique would be best deployed in narrow, shallower sections of the creek.

For timing windows to be effective, dredging should occur outside the timing of spawning, egg incubation and early rearing, and when risk of direct mortality to fishes is lowest (Reid et al. 2016). Results of the trawling survey (Reid et al. 2016) indicate that number of fishes detected was lowest in the winter, thus, timing instream works to coincide with this low density period would have the least amount of direct impact. Due to the late timing of spawning by Blackstripe Topminnow and Pugnose Shiner, the timing window for in-water works is not likely to avoid the early-rearing periods for these species. More temporally intensive sampling in the late summer and fall is recommended to allow for a more direct assessment of the August 1 to March 31 timing window for in-water works, particularly during the early portions of that period.

Timing windows should also be re-evaluated and modified to reflect increased temperatures associated with climate change. Relevant biological information (water and air temperature) should be used to identify timing windows appropriate to avoid spawning, egg incubation, and early rearing.

Regarding offsetting, habitat loss is best compensated through habitat gain of similar quality, and accessible within an appropriate time frame (McCusker et al. unpublished data). Considering a generation time of 2 years and a maximum age of 3 years for the Pugnose Shiner, habitat should be provided in the first 2–3 years after impact.

Increasing connectivity among habitat patches may be another viable offsetting option, however, its efficiency is limited by low dispersal rates of small-bodied fishes, such as the Pugnose Shiner and Blackstripe Topminnow.

Drain maintenance can also result in increased turbidity, a major threat to both the Pugnose Shiner and Lake Chubsucker (COSEWIC 2009, 2013). Increased turbidity should be offset through stabilization of the upper reaches of the system (those contributing to downstream sedimentation) through riparian seeding/Erosion Control Blanket (ECB) and live stake planting (Smith and Gall 2014). For more in-depth channel stabilization and fish habitat enhancement strategies relevant to each species at risk in Little Bear Creek refer to Smith and Gall (2014).

SOURCES OF INFORMATION

This Science Advisory Report is from the May 11, 2016 regional peer review of the Impacts of an agricultural drain maintenance project on aquatic species at risk in Little Bear Creek. Additional publications from this meeting will be posted on the DFO Science Advisory Schedule as they become available.

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ISSN 1919-5087

Correct Citation for this Publication:

DFO. 2017. Assessment of the impacts of an agricultural drain maintenance project on aquatic species at risk in Little Bear Creek, Ontario. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2016/046.

Aussi disponible en français :

MPO. 2017. Impacts du projet d'entretien des drains agricoles sur les espèces aquatiques en péril du ruisseau Little Bear (ONTARIO). Secr. can. de consult. sci. du MPO, Avis sci. 2016/046.