United States Department of the Interior

FISH AND WILDLIFE SERVICE

Lake Champlain Fish and Wildlife Conservation Office
11 Lincoln Street
Essex Junction, Vermont 05452

RECEIVED
3/10/2020
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION

March 10, 2020

Misha Cetner, Permit Analyst
Lake & Shoreland Permitting
1 National Life Drive, Davis 3
Montpelier, VT 05620-3522

Dear Mr. Cetner:

The following pages comprise our complete application for a Vermont Aquatic Nuisance Control Permit. This application is for our proposed lampricide treatment of the Missisquoi River, scheduled for the fall of 2020.

One notable change to this application from previous years is that we included and referenced our Vermont Endangered & Threatened Species Takings permit application as an appendix to address effects on those species as part of the section on *acceptable risk to the non-target environment*.

In coordination with the ANR Secretary's Legal Counsel, we are working to keep operational methods in one location for both permit applications to ensure one common set is approved for use by both permits. For that reason, methods and techniques only appear in the ANC application, but are open for comment as part of the E&T application review process. The ANR Secretary's Legal Counsel will coordinate comments on treatment methods and strategies.

To facilitate the review process and eliminate the need for submission of multiple files, we produced this application as a single PDF file. It contains this cover letter, the application form, and 3 appendices. To aid in navigation of the PDF document, we used section bookmarks. To open and view the bookmark pane, first save this file to your computer, then open it with the standalone Adobe Reader or Adobe Acrobat program (opening it directly from the attachment in an Adobe web-browser add-on viewer may cause problems). With the PDF file open in Adobe Reader or Adobe Acrobat, click on the rightward-facing arrow in the left screen margin to open the bookmark pane. Sections of the document are listed there and can be clicked on to navigate back and forth as needed.

Thank you for considering our application,

Bradley A. Young
Lake Champlain Sea Lamprey Control Program, Manager

Application for use of **Pesticides**
under an **Aquatic Nuisance Control Permit**
Per 10 V.S.A. Chapter 50, § 1455

For Aquatic Nuisance Control Permit Program Use Only
Application Number:

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION
LAKES & PONDS PROGRAM

Submission of this application constitutes notice that the entities listed below intend to use pesticides in waters of the State to control aquatic nuisance plants, insects, or other aquatic life; and that the entities below have demonstrated that (1) there is no reasonable nonchemical alternative available; (2) there is acceptable risk to the nontarget environment; (3) there is negligible risk to public health; (4) a long-range management plan has been developed which incorporates a schedule of pesticide minimization; and (5) there is a public benefit to be achieved from the application of a pesticide or, in the case of a pond located entirely on a landowner's property, no undue adverse effect upon the public good. Submit a permit review fee of $75 for a private pond or $500 for all other waterbodies, made payable to the State of Vermont. All information required on this form must be provided, and the requisite fees must be submitted to be deemed complete.

A. Applicant Information

1. Entity's Name: Bradley Young, United States Fish and Wildlife Service

2a. Mailing Address: 11 Lincoln St.

2b. Municipality: Essex Junction	2c. State: VT	2d. Zip: 05452

3. Phone: 802-662-5304	4. Email: bradley_young@fws.gov

B. Pesticide Applicator Information (Check box if same as above in Section A: ☒)

1. Entity's Name:

2a. Mailing Address:

2b. Municipality:	2c. State:	2d. Zip:

3. Phone:	4. Email:

C. Application Preparer Information (Check box if same as above: Section A ☐ and/or B ☐)

1. Preparer's Name: Christopher Mason

2a. Mailing Address: 11 Lincoln St.

2b. Municipality: Essex Junction	2c. State: VT	2d. Zip: 05452

3. Phone: 802-662-5317	4. Email: christopher_mason@fws.gov

D. Waterbody Information

1. Name of waterbody: Missisquoi River 2. Swanton, Highgate-Franklin County

3. Are there wetlands associated with the waterbody? ☒ Yes ☐ No
Contact the Vermont Wetland Program: (802) 828-1535 for additional information.

4. Are there rare, threatened or endangered species associated with the waterbody? ☒ Yes ☐ No
Contact the Vermont Fish & Wildlife Natural Heritage Inventory: (802) 241-3700 for additional information.

5a. Is this waterbody a private pond (per 10 V.S.A. 5210)? ☐ Yes ☒ No If No, skip to Question D6.

5b. Is this private pond totally contained on landowner's property? ☐ Yes ☐ No

5c. Does the private pond have an outlet? ☐ Yes ☐ No
If yes, what is the name of the receiving water from this outlet?

5d. Is the flow from this outlet controlled? ☐ Yes ☐ No
If yes, how and for how long?

6. List the uses of the waterbody – check all that apply:
☒ Water supply ☒ Irrigation ☒ Boating ☒ Swimming ☒ Fishing ☐ Other:

E. Treatment Information

1a. Proposed start date: 09/8/2020

1b. Proposed end date (if known): 11/30/2024

2. Aquatic nuisance(s) to be controlled:
Plant/Algae/Animal: Sea Lamprey
Submit additional information as needed.

3. Pesticide(s) to be used[1]:
Trade Name: TFM-HP and TFM-BAR
EPA Registration #: 6704-45 and 6704-86
Submit a copy of the Product Label & Material Safety Data Sheet.

4. Provide a map of control activity area.
Provide location of (each) treatment area in waterbody.

5. Application rate (ppm): see Appendix A
Explain the above application rate & provide calculations.

6. Attach a narrative description of the proposed project to include the following items:
a) Reason(s) to control the aquatic nuisance;
b) Brief history of the aquatic nuisance in the waterbody;
c) Reason why no reasonable nonchemical alternatives are available; and,
d) Description of the proposed control activity.

7. If you answered "no" to D5b above, then a Long-range Management Plan[2] (LMP) is required:
a) Describe how control of the nuisance species will be conducted for the duration of the permit (must be at least a 5 year time span and incorporate a schedule of pesticide minimization); and,
b) Explain how the LMP will be financed; include a budget and funding sources for each year.

F. Adjoining Property Owner Certification (For additional information, please see the APO Notification Guidance)

BAY

I certify, by initialing to the left, that I have notified adjoining property owners of the proposed project using the DEC Adjoiner Form template letter that was sent by U.S. Mail.

G. Applicant/Applicator Certification

As APPLICANT, I hereby certify that the statements presented on this application are true and accurate; guarantee to hold the State of Vermont harmless from all suits, claims, or causes of action that arise from the permitted activity; and recognize that by signing this application, I agree to complete all aspects of the project as authorized. I understand that failure to comply with the foregoing may result in violation of the 10 VSA Chapter 50, § 1455, and the Vermont Agency of Natural Resources may bring an enforcement action for violations of the Act pursuant to 10 V.S.A. chapter 201.

Applicant/Applicator Signature: Bradley Co. Young Digitally signed by BRADLEY YOUNG Date: 2020.03.10 12:26:43 -04'00' Date: _____

H. Application Preparer Certification (if applicable)

As APPLICATION PREPARER, I hereby certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Application Preparer Signature: CHRISTOPHER MASON Digitally signed by CHRISTOPHER MASON Date: 2020.03.10 11:46:44 -04'00' Date: _____

I. Application Fees

Refund Policy:
Permit Review Fees are non-refundable unless an application is withdrawn prior to administrative review.

Print Form

Submit this form and the $75 or $500 fee to:

Vermont Department of Environmental Conservation
Watershed Management Division
Aquatic Nuisance Control Permit Program
1 National Life Drive, Davis 3
Montpelier, VT 05620-3522

Municipalities are exempt and do not need to submit fee.

Direct all correspondence or questions to the Aquatic Nuisance Control Permit Program at: ANR.WSMDShoreland@vermont.gov
For additional information visit: https://dec.vermont.gov/

1 The application fee for the aquatic pesticide Aquashade® and copper compounds used as algaecides is **$50** per application.

2 Any landowner applying to use a pesticide for aquatic nuisance control on a pond located *entirely* on the landowner's property is exempt from the Long-range Management Plan requirement, as per 10 VSA §1455(e)

Appendix A

Proposed Lampricide Treatment of the Missisquoi River in 2020 and 2024

Detailed Project Description and Supporting Narrative

March 10, 2020

Reasons to Control the Aquatic Nuisance

Parasitic Sea Lamprey Population of Lake Champlain

Programmatic targets of 15 lamprey wounds per 100 Atlantic salmon (*Salmo salar*) and 25 lamprey wounds per 100 lake trout (*Salvelinus namaycush*) were set in 1990 (FSEIS, page 4). These targets are based on experience and historic data that indicated these species could withstand and persist at those levels of lamprey wounds. Because these targets are the maximum level of lamprey parasitism believed to be consistent with healthy and sustainable populations of each host species, the FSEIS identifies ideal targets for lamprey wounds as 5 for Atlantic salmon and 10 for lake trout.

Our most recent lamprey wounding data (November 2019) are 20 for Atlantic salmon and 57 for lake trout (Figure 1). While lamprey wounds have been reduced substantially since their high mark in 2006, the 2019 data and data from recent years show that we are not meeting our programmatic goals. For this reason, it is important that we continue to control all known sea lamprey populations as we continue to identify sources of sea lamprey production that contribute to the unacceptable levels of parasitism on these and other host species in Lake Champlain.

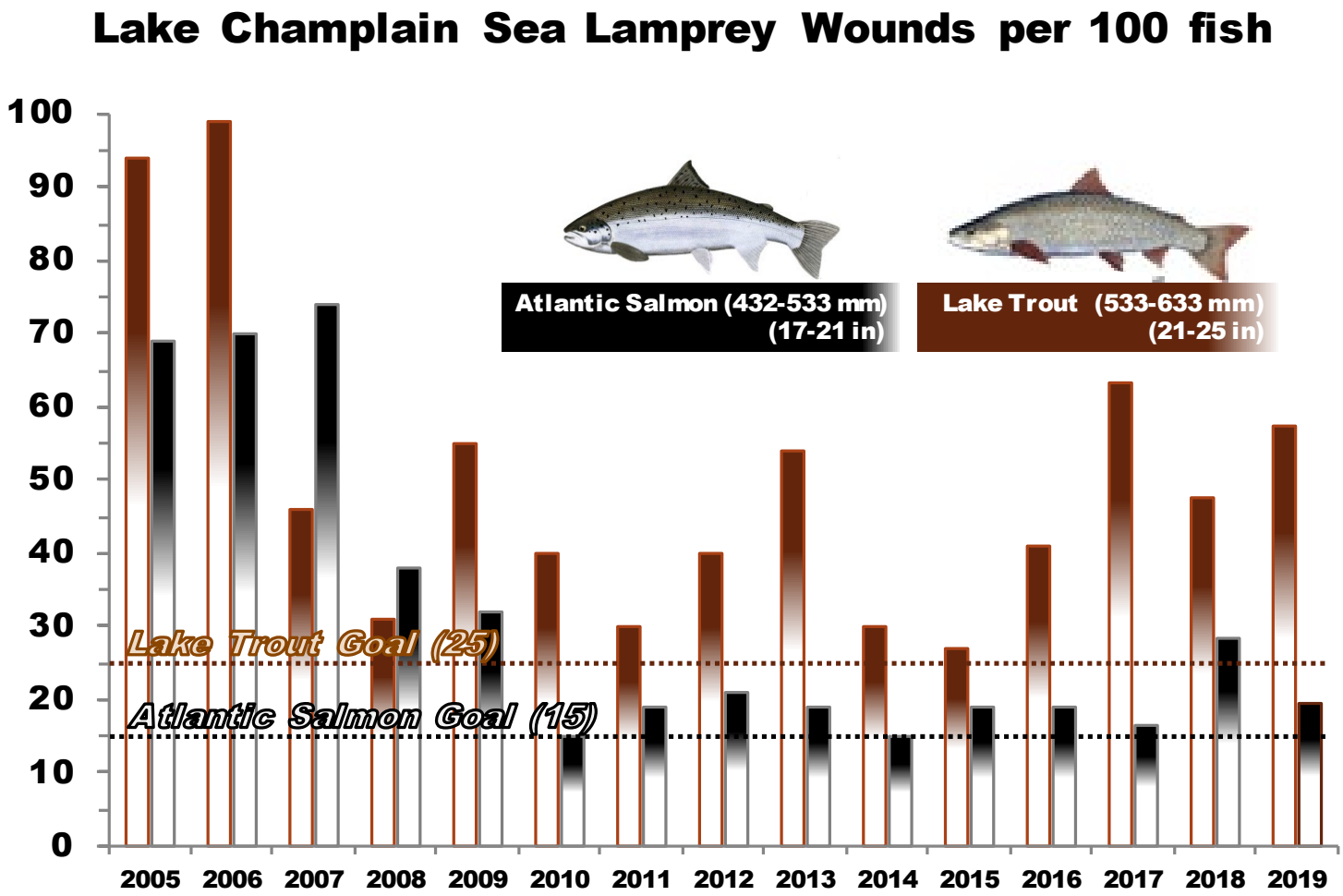


Figure 1. Sea lamprey wounding rates on Atlantic salmon and lake trout in Lake Champlain from 2005-2019.

Larval Sea Lamprey Population of the Missisquoi River

Sea lamprey larval population assessments conducted by the United States Fish and Wildlife Service, Lake Champlain Fish and Wildlife Conservation Office (Service) are used to identify the distribution and density of larval sea lamprey in Lake Champlain tributaries and their associated deltas. When larval lamprey are located, methods to control those populations are evaluated and implemented based on the characteristics of each tributary.

Sea lamprey annual reproduction in the Missisquoi River gradually increased from the commencement of the sea lamprey control program (1990) until a thorough and successful 2012 lampricide treatment. After the 2012 treatment, larval densities did not rebound to pre-treatment levels as measured by the 2015 larval assessment survey that yielded 10 larvae.

Our 2019 survey data spanned the entire length of Missisquoi River inhabited by larval sea lamprey (Figure 2). We positioned 24 equidistant transects in the Missisquoi River and its Dead Creek distributary from the Swanton Dam to the mouth of each branch in Missisquoi Bay. We electrofished 15 m^2 of preferred lamprey habitat at each even-numbered transect and 15 m^2 of less-preferred habitat at every fourth transect when available. This produced 17 sampled plots totaling 251 m^2 of habitat sampled. As we have found in previous surveys, the population is more concentrated below Swanton Dam. Of the 19 larvae collected in 2019, 15 were collected within the first mile below the dam. While these numbers may appear relatively low, it is important for context to consider the size of the Missisquoi River relative to the fraction (0.02%) of sampled habitat. As explained in the previous section, it is important to control populations of larvae where we can as we continue to focus our efforts in ways that will reduce the parasitic population of the lake.

Figure 2. Number (N) of sea lamprey collected in preferred (white callout boxes) and less-preferred (gray callout boxes) larval lamprey habitat in the Missisquoi River during the 2019 QAS survey. Associated densities reported as larvae per square meter sampled.

Brief History of the Aquatic Nuisance in the Waterbody

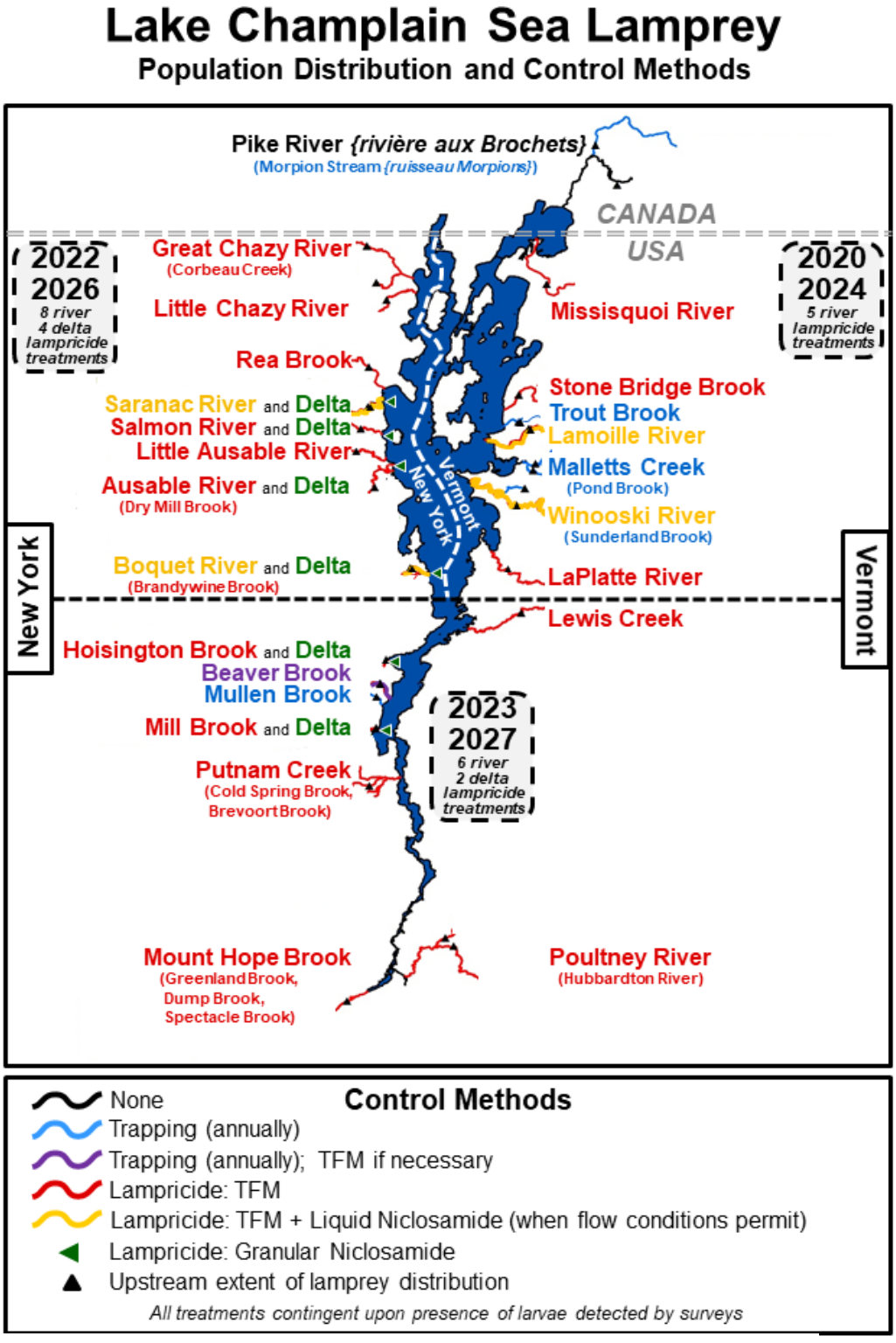


Figure 3. Lake Champlain tributaries included in the sea lamprey control program.

The Lake Champlain Fish and Wildlife Management Cooperative (Cooperative) comprises the Vermont Fish and Wildlife Department (VTFWD), New York State Department of Environmental Conservation (NYSDEC), and U.S. Fish and Wildlife Service (Service) and serves to manage the aquatic resources of Lake Champlain. The Cooperative conducted an experimental program from 1990-1997 to determine the feasibility of controlling sea lamprey *(Petromyzon marinus)* in Lake Champlain to support the restoration of native lake trout and Atlantic salmon and promote a sport fishery (Fisheries Technical Committee 1999). A Final Supplemental Environmental Impact Statement (FSEIS), titled *A Long-term Program of Sea Lamprey Control in Lake Champlain* (2001) defines purpose and need: pp. 3-10; history of the problem: pp. 27-31; lampricide methodologies: pp. 34-36; and other aspects of the program that have been in place from then

until present. There are currently 24 tributary systems controlled as part of the long-term program: 14 in New York, 8 in Vermont, the border-forming Poultney River, and the Pike River in Quebec (Figure 3).

Between the conclusion of the experimental program (1997) and commencement of the long-term program (2002), the sea lamprey wounding rate returned to and exceeded pre-control levels as the population rebounded. With the effects of not maintaining aggressive and continuous control made clear, the Cooperative has committed to suppressing sea lamprey populations in Lake Champlain to enable the protection of existing fishery resources, the restoration of native fishes, and the promotion of recreational sport fisheries. By assessing populations and using multiple techniques, methodologies, and technologies as part of an integrated pest management approach, the Cooperative has succeeded in lessening the effects of sea lamprey parasitism in Lake Champlain and produced measurable benefits to populations of Atlantic salmon, lake trout, lake sturgeon, walleye, and other species. We intend to continue implementing the long-term program of sea lamprey control to maintain the gains achieved thus far while increasing and improving efforts that move us closer to our goals.

The Missisquoi River was previously treated with lampricide in 2008 and 2012. The 2008 treatment was the first treatment on this river and presented unanticipated challenges. We successfully eliminated a large number of larval lamprey from the Missisquoi River in 2008, but the lateral distribution of chemical across the channel was not even and led to sub-optimal results. The 2012 treatment benefitted from the experience of 2008 and led to technological improvements that ensured a more even application of lampricide and a successful treatment that year. We planned a treatment for 2016, but our submitted ANC Permit application was withdrawn after a change to Vermont State human health advisory conditions was made in June 2016. The Vermont Department of Health lowered the advisory threshold for 3-trifluoromethyl-4-nitrophenol (TFM) from 35 ppb to 3 ppb, which made monitoring lampricide concentrations in Missisquoi Bay logistically infeasible. Data from a new TFM toxicology study provided to the Vermont Department of Health in 2019, allowed them to calculate and establish a new human health advisory threshold at 100 ppb. We are now able to resume lamprey control in the Missisquoi River under this established threshold.

Treatment Strategy and Methodology

Proposed Treatment Strategy

The proposed treatment strategy is designed to provide an effective sea lamprey control treatment while providing a margin of safety for listed species in the Missisquoi River. A 14-hour treatment duration may be required under certain flow and water chemistry conditions in order to achieve a minimum 9-hour lethal exposure duration in all areas of larval habitat. The Service will coordinate with the Village of Swanton and Missisquoi LLC, owners of the Highgate Falls and Sheldon Springs hydropower stations, respectively, to assure that these upstream facilities are operated to maintain stable flows during TFM application. There are no maintenance (boost) application points proposed for this treatment. Given the need for an effective treatment while mitigating potential risks to certain listed non-target species, the specific proposed treatment strategy for the Missisquoi River is as follows:

1. *The primary TFM application point (AP) is less than 100 meters upstream of Swanton Dam (river mile 7.8). Applicators will attempt to spread the applied lampricide evenly from bank to bank in order to quickly and thoroughly mix the target TFM concentration into the River. Applying upstream of the dam will facilitate mixing due to the uniform water depth and velocity at the head of the dam and the turbulence created on the drop.*

2. *Application rate: TFM will be applied for 12 to 14 consecutive hours to achieve a target in-stream treatment concentration of no greater than 1.2 x Minimum Lethal Concentration (MLC).*

3. *MLC will be determined by the results of an on-site toxicity test in conjunction with pH/alkalinity prediction charts. Diurnal stream pH and alkalinity analysis in the days prior to treatment will be used to calculate target TFM concentration. Concentration will be adjusted during treatment to compensate for shifts in pH or alkalinity that differ from pre-treatment conditions to maintain the MLC.*

4. *TFM Bars and/or adjustable rate pumps may be used as supplemental applications (SAP) on up to 4 small tributaries (SAP 1-4 on Figure 4, Table 1) near their confluences with the Missisquoi River, concurrent with passage of the mainstem lampricide block at those points, to block lamprey escapement into untreated water from these streams. Flows on the day of treatment will determine the need for these supplemental applications.*

5. *Liquid TFM may be used as supplemental (secondary) applications on up to 2 selected backwater areas (SAP 5 and SAP 6 on Figure 4, Table 1) of larval habitat where the primary TFM block cannot penetrate effectively. TFM will be applied to these areas to achieve a target concentration of no more than 1.0 x MLC. Flows on the day of treatment will determine the need for these supplemental applications.*

Treatment Methodology

Treatment planning and execution will be like that of previous treatments. Two lampricide products, TFM-HP and TFM Bar are proposed for use (Safety Data Sheet = TFM-HP TFM-Bar). All lampricides will be applied according to the Standard Operating Procedures (TFM-HP TFM-Bar). Results of an on-site toxicity test in conjunction with pH/alkalinity prediction charts will be used to determine the sea lamprey MLC prior to treatment. The MLC may change during treatment in response to shifts in pH or alkalinity that differ from pre-treatment conditions, target concentration will be adjusted accordingly.

Lampricide(s) will be applied at concentrations equivalent to a factor of up to 1.2 x MLC for a period of 12 to 14 hours. Amount of chemical applied and application rate is based on measured stream conditions at the time of treatment (i.e. discharge, pH, and alkalinity). The toxicity of lampricides varies depending on stream water pH and total alkalinity levels. The Service estimates that between 700 to 1,500 gallons of TFM-HP formulation may be applied to the Missisquoi River over a 12-14 hour period based on anticipated river discharge rates between about 700 and 1,500 cubic feet per second (cfs). Up to approximately 20 TFM Bars may be used in up to 4 supplemental application points (Figure 4).

Pre-treatment and Treatment Water Chemistry Monitoring

Pre-treatment: Monitoring the daily fluctuations in stream pH and total alkalinity is necessary to determine corresponding changes in lampricide toxicity. Diurnal pH fluctuations will be monitored for at least 24 hours prior to treatment, and usually for a longer period. Total alkalinity will also be measured periodically over the same time frame. The pH and alkalinity data will be considered with the results of the pre-treatment toxicity test to determine the stream MLC (SMLC) which is the instantaneous concentration (mg/L) of TFM needed to achieve 1.0 x MLC for lamprey at any given time or place in the

river. This value fluctuates over time and space due to many factors. Water chemistry will be monitored at stations with pH/temperature data recorders, supplemented by periodic hand sampling for lab measurements; total alkalinity will be measured at least at the times of deployment and retrieval of the data recorders at these stations. Based on these data, lampricides may be applied at less than the maximum proposed treatment concentrations (but not lower than 1.0 x MLC) if conditions forewarn that the SMLC may drop (toxicity goes up), downstream of the application.

Treatment: Water samples collected at the most upstream sampling station below the AP, to control the application rate, will also undergo water chemistry analysis. Water chemistry will be monitored at least once every 2 hours at downstream stations during the periods that the lampricide block is present at each station, as well as immediately below each supplemental application point, if used. Adjustments will be made to the application rate and target concentration to compensate for unexpected changes in pH and/or total alkalinity at the most upstream sampling station (or at downstream stations if applicable) during the treatment. Water chemistry will be monitored at stations with pH/temperature data recorders, supplemented by periodic hand sampling for lab measurements; total alkalinity will be measured at least at the times of deployment and retrieval of the data recorders at these stations.

Lampricide Monitoring

Treatment: Lampricide concentrations will be monitored during the treatment to precisely measure the efficacy of the application throughout the treated reach and to regulate the application rate in response. TFM concentrations are measured with accuracy to within 0.1 mg/L (0.1 ppm). Locations of application points and analysis stations are shown in Figure 4, Table 1. Water samples may also be collected at other points on the stream to track progress of the block.

Table 1. Description of the location of each application and analysis site on the Missisquoi River

Analysis Station	Description of Location
M1	Approximately 1,000 to 1,500 ft downstream of Swanton Dam (river mile 7.5 to 7.6)
M2	At the Missisquoi main stem-Dead Creek Fork (river mile 5.4)
M3	Mac's Bend Access (river mile 3.0)
M4	Missisquoi main stem middle mouth (river mile 0.0)
D4	Dead Creek Mouth (river mile 0.0)
SAP 1	Small tributary on river left ~.5 miles downstream of dam (river mile 7.3)
SAP 2	Small tributary on river right ~ 0.85 miles downstream of dam (river mile 6.95)
SAP 3	Small tributary on river left ~ 1.1 miles downstream of dam (river mile 6.7)
SAP 4	Small tributary on river right ~ 1.8 miles downstream of dam (river mile 6.0)
SAP 5	Large backwater area adjacent to Rt. 78, centered at river mile 4.8
SAP 6	Large backwater area at river mile 3.5

Station M1, will be monitored every 30 minutes to meet permit condition requirements. TFM concentrations will be monitored hourly at Stations M2 and M3, and at least every 2 hours at Stations M4 and D4, to assess concentrations and duration of the TFM block passing each point. Automatic water samplers will be deployed at Stations M3, M4, and D4. Automatic water samplers may also be deployed at Station M2 after lampricide application has ceased at the AP. Water sampling below supplemental application points using TFM bars is less frequent since the bars release the active ingredient at a constant rate. Once the target concentration is achieved with a TFM Bar application, at least two additional water samples will be collected over the duration of the dissolution period.

Supplemental, liquid TFM applications by backpack sprayer may be required in backwater areas within the Missisquoi River channel that are isolated from treatment level exposure to the passing TFM block. Supplemental applications using liquid TFM applied with a metered pump or TFM-Bars may also be necessary near the mouths of small tributaries entering the passing treatment TFM block to eliminate untreated refuge areas created by these freshwater inputs. Procedures for supplemental application of TFM and TFM-Bar and potential locations for supplemental applications are shown on Figure 4. The need for supplemental applications will vary depending on lake level, flow, and weather conditions.

A lampricide plume transport modeling study for the Missisquoi River and bay was conducted by Applied Science Associates, Inc. (Sabbayya et al. 2008). The study has the dual purpose of estimating in-stream time of travel and attenuation of a TFM block, as well as estimating the extent and duration of a TFM plume into Missisquoi Bay under various simulated TFM concentrations, river flows, wind patterns, lake levels, and application durations. Results of the in-stream modeling indicate that there may be considerable downstream TFM block attenuation (i.e. concentration strength gradually decreases as distance from the application point increases in response to uncontrollable variables). If TFM was applied for 12 hours at a 1.0 x MLC target concentration, the predicted effects of attenuation could result in sub-lethal exposure to sea lampreys in most of the Missisquoi main stem and Dead Creek and failure to meet the 9-hour period of lethal exposure necessary to achieve a successful treatment. The loss of downstream control effectiveness can be minimized by applying TFM at a slightly higher concentration, applying for a longer duration, or employing both methods in combination. It is for these reasons that we have proposed to treat at 1.2 x MLC for up to 14hrs.

Post-Treatment: Lampricide concentration will be measured and monitored at low levels in the lake following the treatment. Monitoring will continue and advisories will remain in place until 24 hrs. after measured levels fall below the Vermont Department of Health's Advisory threshold value of 100 ppb. The low-level lake monitoring strategy and methodology is detailed in the *Water Use Advisory Zone Monitoring Plan for Lampricide Treatments in Lake Champlain* (Smith 2019a).

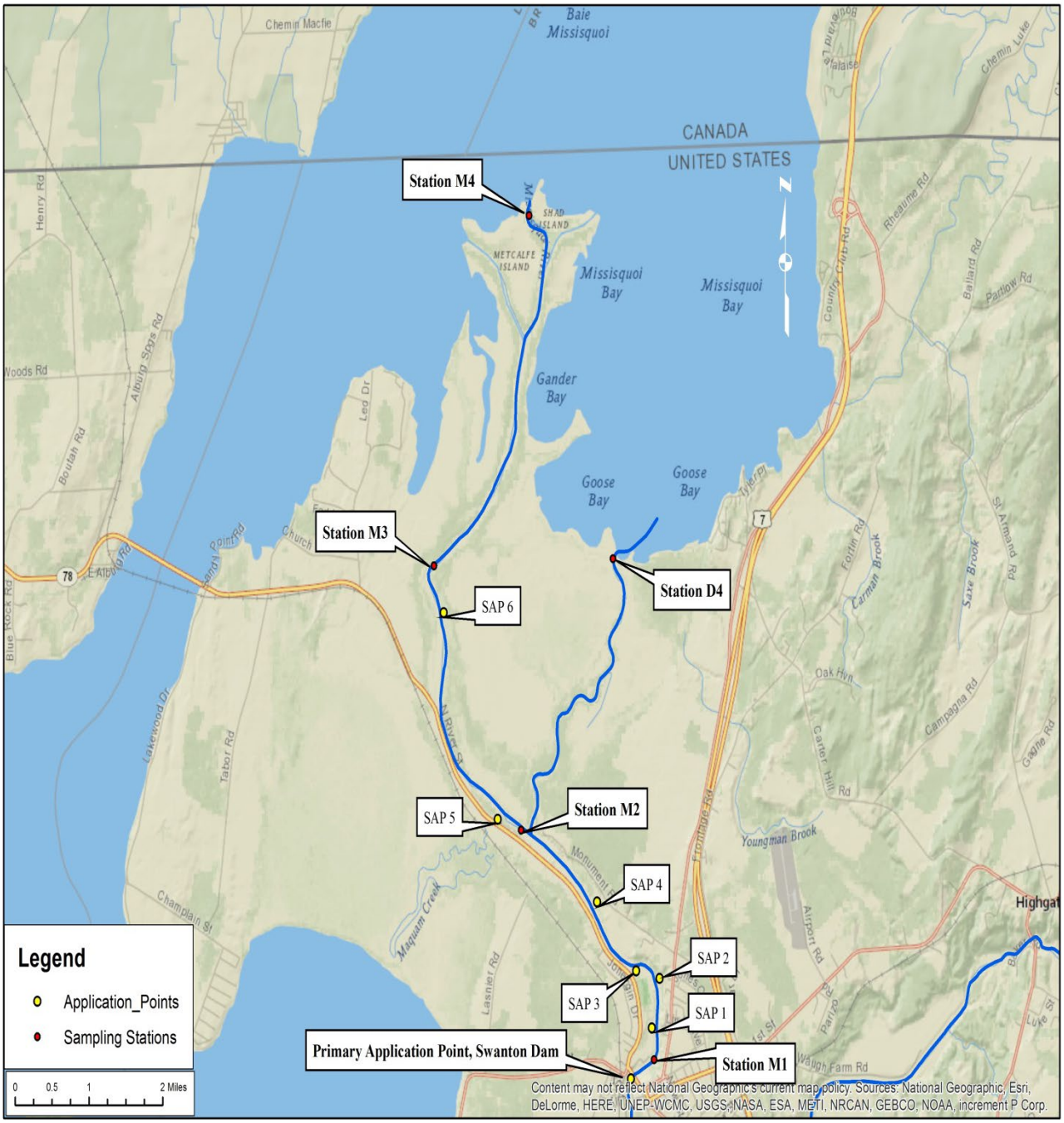


Figure 4. Missisquoi River TFM Application Point, Analysis Stations (M1-4 and D4), potential tributary mouth supplemental TFM application sites (SAP1-4), and potential backwater supplemental liquid TFM application sites (SAP 5-6).

Target/Non-target Species Mortality Monitoring

Post-treatment mortality assessment crews will survey systematically, pre-defined sections of each treated stream reach within 36 hours of the lampricide block passage. All visible river-bottom in each section will be inspected and observations of non-target organism mortalities, except lamprey, will be recorded. Non-target assessment sections comprise 23% of the treated reaches and are defined based on the locations of sea lamprey assessment transects as follows: One section will start immediately below

each lampricide application point, equal in length to the distance between two transects. Four additional sections will be assessed on each stream reach between transects 3-4, 8-9, 13-14, 18-19, 23-AP. Transect locations and assessment sections are presented in Figure 5.

All dead fish (excluding lampreys), amphibians, mussels, and other large invertebrates encountered will be identified and enumerated, if possible. Organisms not identified in the field will be collected, if possible, and retained for identification. As noted above, dead lamprey larvae will not be counted during the post treatment mortality survey, but the first 30 encountered in each transect will be retained and identified. Assessment of treatment effects on lamprey populations will instead be accomplished by means of a larval survey completed within one year following the treatment. Larval surveys following treatments provide a more direct and statistically sound means of comparison with pre-treatment population surveys. Results of non-target mortality surveys will be submitted to the VTDEC by May 1 of the year following the treatment. The post-treatment larval survey results will be submitted by December 31 of the year following the year of treatment.

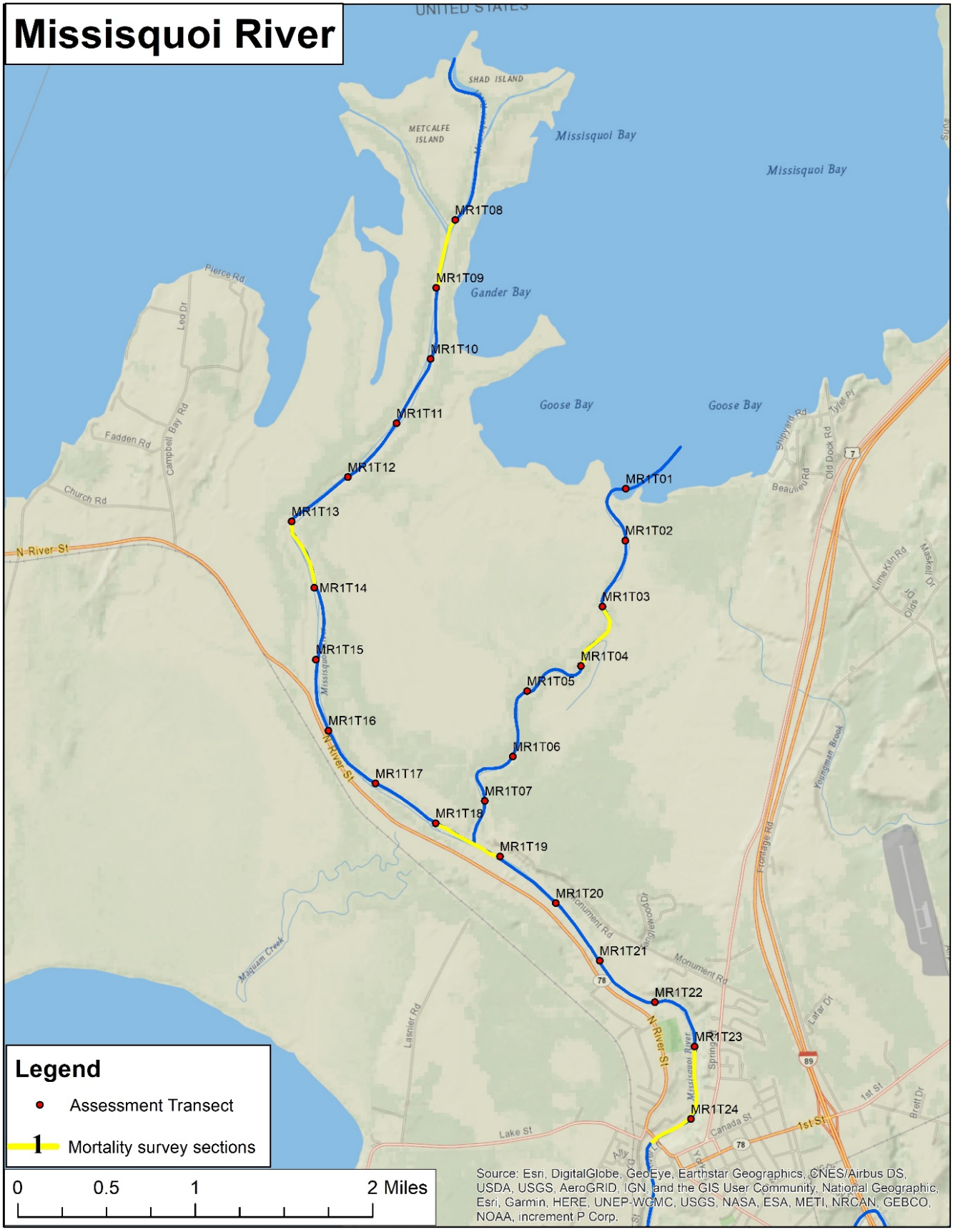


Figure 5. Missisquoi River assessment transects and post-treatment non-target assessment sections.

Fulfillment of 10 V.S.A. Chapter 50, § 1455 (d), 5 Statutory Criteria

(1) There is no reasonable non-chemical alternative available

The Service uses an integrated pest management approach to determine appropriate long-term control strategies on a stream-specific basis (FSEIS pp. 41-47).

The most recent and comprehensive review of all sea lamprey control techniques and methods can be found in Chapter 5 of Docker (2019). Additionally, the Great Lakes Fishery Commission (Commission) lists over 400 lamprey research publications accessible in their database, underscoring the attention and resources that have been committed to finding ways to better control lamprey. A brief summary and overview of the wide variety of new and emerging non-chemical alternative control techniques that are being investigated and invested in can be found on the Commission's Future of Sea Lamprey Control website. The Lake Champlain program does not have the resources to engage in the level of research done by the Great Lakes, but we work closely with them and benefit from their findings.

A 5-year concerted effort made by the Lake Champlain program to investigate non-chemical alternatives locally is summarized in the *Status Report for the Lake Champlain Sea Lamprey Alternatives Workgroup* (USFWS 2006) which summarizes nine studies conducted from 2002 through 2006 that assess potential alternatives to lampricide. Since then, projects such as Pheromone-assisted trapping, Microelemental natal stream statolith signatures, and identifying cross-sectional flow patterns in streams to target the trapping of out-migrating transformers have been undertaken. To date, these efforts have not resulted in development of additional, feasible alternative control methods. In addition, recent studies conducted in Lake Champlain and the Great Lakes, focusing on the use of pheromones as attractants to manipulate spawning runs, have not progressed to the point of an applicable management technique.

A barrier in Quebec was put into use in 2014 that can be installed and removed annually during lamprey migration season. While this is a creative and innovative technique for blocking sea lamprey from reproducing, it can only work on the smaller streams in the Lake Champlain Basin. Additionally, the project cost over $1.3M on a stream that could have been controlled safely with TFM for $8K once every 4 years. The use of this technology is not only cost-prohibitive in most cases, it also becomes difficult to justify the expense when a safe, chemical alternative is available at a fraction of the cost.

Non-chemical alternatives are being used in Vermont tributaries now and more are in development. We use seasonally installed barriers and traps on Pond Brook, Trout Brook, and Sunderland Brook as described in our Vermont ANC permit #2014-S01. We are working on another innovative barrier and trap at Malletts Creek to improve on the ineffective barrier and trap that has been used there for years.

Despite the completed and ongoing research on non-chemical control methods, the use of barriers and traps to block and intercept spawning-phase sea lamprey remains the only currently feasible, non-pesticide control alternative in the Lake Champlain Basin. The use of barriers (both seasonal and permanent) is limited to streams where suitable sites are available and where significant adverse impacts of barriers on other aquatic organisms can be mitigated. The only feasible method of control for large tributaries remains chemical lampricide application.

(2) There is acceptable risk to the non-target environment

The FSEIS (pp. 104-170; 188-197; and 307-311) and data post-treatment data from the last 30 years of Lake Champlain sea lamprey control efforts provide an extensive record of the successful use of TFM. Except for silver lamprey and American brook lamprey, non-target species have been protected through the careful application of TFM at appropriate concentrations that eliminate sea lamprey, yet limit, if not completely avoid, impacts to non-target species. Because TFM is a lampricide, it does result in the mortality of other lamprey species.

Table 2 presents post-treatment mortality survey data from the previous two Missisquoi River treatments in 2008 and 2012. The 2008 survey included the entire length of the river while the 2012 surveys used the transect sampling method and covered 23% of the length of the river at equal intervals. In both cases, the data show few non-target species found following treatments. The 531 leopard frog mortalities found in 2008 were confirmed by state biologists as being attributed to "red-leg syndrome" not lampricide mortality.

There are no federally listed species in the Lake Champlain Basin affected by lampricide treatments. There are 7 mussel species and 4 fish species in the Missisquoi River that are listed by the State of Vermont as having an endangered or threatened conservation status. We address these 11 species in detail in *Appendix C (Vermont Endangered and Threatened Species Takings permit application)* being submitted simultaneously.

Mussels

Black Sandshell	(Endangered)
Fragile Papershell	(Endangered)
Fluted-Shell	(Endangered)
Pocketbook	(Endangered)
Pink Heelsplitter	(Endangered)
Giant Floater	(Threatened)
Cylindrical Papershell	(Threatened)

Fish

Lake Sturgeon	(Endangered)
Stonecat	(Endangered)
Eastern Sand Darter	(Threatened)
American Brook Lamprey	(Threatened)

Table 2. History of lampricide post-treatment mortality surveys of the Missisquoi River.

	2008	2012	TOTAL
River Miles Treated	10.4*	10.4*	
River Miles Surveyed	10.4*	1.9	
% of Survey Area Visible	5.0	6.0	
% Sea Lamprey Reduction	41	100	
% Lamprey Spp. Comp.			
Sea Lamprey	37.6	55.5	
Silver Lamprey	61.9	44.1	
American Brook Lamprey	0.5	0.3	
FISH (non-lamprey)			**TOTAL**
Golden shiner	2		2
Bridle shiner	1		1
Mimic shiner	3		3
Unid. Cyprinid	1		1
Brown bullhead	6	5	11
Channel catfish	4		4
Stonecat	22	1	23
Pumpkinseed	2		2
Bluegill	5	2	7
Smallmouth bass	1		1
Tessellated darter	13	13	26
Yellow perch	5		5
Logperch	23	6	29
Unidentified fish		1	1
AMPHIBIANS			
Mudpuppy	1		1
Leopard frog adult	531		531
Green frog adult	6		6
Green frog tadpole	4		4
Bullfrog	1		1
Unid. Frog adult	1		1
INVERTEBRATES			
Crayfish	2		2

* Missisquoi River mileage includes 2.6 miles of the Dead Creek fork.

Two non-listed species of concern (silver lamprey and mudpuppy) in the Missisquoi River may be adversely affected by the proposed treatment. Silver lamprey are effectively equal to sea lamprey in their susceptibility to lampricide. We have no expectation that their survival during a treatment would differ from sea lamprey. Research and previous treatment data on mudpuppies show that they are more tolerant of TFM at the concentrations we apply. Mudpuppy mortality is expected, but we do not expect population level effects.

Silver Lamprey

The impacts of TFM on silver lamprey are discussed in pp. 136-140 of the FSEIS. Lampreys of the genus *Ichthyomyzon* (which includes silver lamprey *I. unicuspis* and northern brook lamprey *I. fossor*) are known to be slightly more resistant to TFM than sea lamprey (King and Gabel 1985), but substantial losses of silver lamprey larvae are unavoidable during TFM treatments. It has been suggested that reductions in larval sea lamprey abundance may benefit silver lamprey because invasive sea lamprey are highly adaptable and have a competitive advantage. When sea lamprey populations are suppressed, that decrease in competition may allow native lamprey species to reestablish their numbers (Schuldt and Goold 1980).

Silver lamprey have persisted in all Lake Champlain lampricide treated tributaries. In the Missisquoi River, silver lamprey numbers are currently at their highest sampled densities (Table 3). Although we cannot confidently conclude that sea lamprey control directly results in an increase in silver lamprey numbers, we can confidently conclude that despite lampricide treatments, silver lamprey have persisted in the Missisquoi River.

Table 3. Missisquoi River Silver Lamprey population estimates

Year	# (N)	Density (N/m^2)
2007	101	.374
2008 Treatment		
2011	69	.256
2012 Treatment		
2015	32	.142
2019	107	.426

Mudpuppy

The effects of lampricides on the mudpuppy and other amphibia are discussed in the FSEIS on pp.153-159. Four laboratory studies have been conducted on mudpuppies of different ages to specifically identify the effects of TFM on the species (Table 4).

Table 4. Summary of toxicity test results for TFM tests conducted on mudpuppies. No observed effect concentrations (NOEC) and lowest observed effect concentrations (LOEC) expressed as factors of sea lamprey minimum lethal concentration (MLC).

Species	TFM		Data Source
	NOEC	LOEC	
Mudpuppy (adult)[a]	1.6	2.0	Boogaard et al. 2003
	1.6	1.9	M. Boogaard unpub. data
Mudpuppy (age 1-4)[b]	1.0	1.3	Neuderfer et al. 2004
Mudpuppy (1 year-old)[c]	0.8	1.0	Durfey and Neuderfer 2009
Mudpuppy (young of year)[d]	0.8	0.9	Neuderfer et al. 2004

[a] Average total length = 304 mm
[b] Total length range = 60-150 mm
[c] Average length = 60 mm
[d] Total length range =32-41mm

Results from the toxicity studies indicate a trend of increasing resistance to lampricides with increasing mudpuppy age. This is consistent with reported field observations where Breisch (1996, 2000a, 2000b) reported larger proportions of juvenile than adult mortalities were observed in post-treatment assessments in the Great Chazy River and Ausable River which were treated with TFM at concentrations up to 1.5 x MLC. Weisser et al. (1994) reported that 100% of caged mudpuppies greater than 50 mm Total Length (TL) survived the 1987 TFM treatment of the Grand River, Ohio at TFM concentrations up to 1.3 times MLC, but no caged mudpuppies less than 50 mm survived. There was no mortality of juvenile mudpuppies (86 - 165 mm TL) caged in Lewis Creek, Vermont during a 2002 TFM treatment targeted for an average of 1.3 x MLC, but reached as high as 1.6 x MLC for short periods (Chipman 2003). All the 29 dead mudpuppies observed following 2004 Winooski River TFM treatment as well as the 19 individuals noted following the 2008 Winooski River treatment were juveniles ranging from 34 to 169 mm TL. Lampricide was targeted at a concentration of 1.0 x MLC for those treatments with small areas exposed to 1.1 x MLC in 2004 and 1.3 x MLC in 2008 due to pH shifts (Chipman 2005 and 2009). Seven mudpuppies were collected in the Poultney River after the 2007 TFM treatment at 1.2-1.3 x MLC (Durfey and Chipman 2008) where five were juveniles ranging from 72 to 87 mm TL (VTDFW unpublished data).

In 2011, the Service's Marquette Biological Station conducted a cage study with captive, reared mudpuppy juveniles that were approximately 40 mm in length. The study resulted in 3 mortalities among 63 test organisms for an overall mortality rate of 4.8%. The mudpuppies were held at 3 separate locations during a TFM treatment that ranged in concentration from 1.3 x MLC to 1.5 x MLC (Fodale et al. 2012).

Mudpuppies are a species that is notoriously difficult to sample. In the absence of population survey data, much of the species population status in lampricide-treated rivers has been inferred from post-treatment mortality surveys. However, the 30-year record of post-treatment mortality survey data in Lake Champlain tributaries provides ambiguous evidence for the effects of lampricide treatments on

mudpuppies. Using post-treatment mortality survey data, rivers such as Lewis Creek and the Winooski River show a trend of declining mudpuppy numbers collected in those rivers following lampricide treatments. In the Great Chazy and Poultney rivers, post-treatment mortality survey data show no evidence of decline or impact from lampricide treatments over time. Rather than reflecting the response of mudpuppy populations to lampricide treatments over time, these post-treatment mortality data reveal the inherent inability of these type of surveys to provide meaningful information on the species' population status. Because many variables can contribute to mudpuppy population persistence and abundance and because not every river and lampricide treatment are identical, using post-treatment mortality survey data as indication of any trend or status of the population is untenable and of limited value at best. The best way to assess the impact of a lampricide treatment on a population is to conduct a replicated survey before and after a treatment. This is how we evaluate the effectiveness of treatments on larval sea lamprey populations. The same approach is applicable to the assessment of other species and populations and is defensible and informative in judging the effects of a lampricide treatment on a population.

Despite the challenges associated with collecting mudpuppies, this before and after a lampricide treatment survey approach was conducted in the Lamoille River by the Vermont Cooperative Fish and Wildlife Research Unit (Chellman and Parrish 2010). They trapped and released 80 mudpuppies from December 2008 through May 2009; 75 of these were tagged. The Lamoille River was treated with lampricide on October 1st, 2009. The post-treatment mortality survey found 508 dead mudpuppies of which juveniles (25-200 mm TL) represented 77% of the collection (VTDFW unpublished data). Following the treatment, with the objective to assess the population-scale impact from the treatment, the trapping effort was repeated from December 2009 through May 2010. This replicated post-treatment survey effort resulted in the collection of 81 mudpuppies. Ten of these mudpuppies were tagged recaptures from the previous effort conducted in the winter of 2009.

Post-treatment mortality survey data show conflicting trends of long-term effects on the numbers of mudpuppies in lampricide-treated rivers and are unreliable as an assessment technique. In the Lamoille River (2009) where localized high mortality occurred during the treatment, a before and after study showed no appreciable effect on mudpuppy population numbers. The above evidence and experience in treating rivers with lampricide show that a proposed treatment concentration of 1.2 x MLC may cause young-of-year and yearling mudpuppy mortalities but would have limited impacts on older breeding-age classes.

(3) There is negligible risk to public health

The risk of human exposure to lampricides and measures to mitigate exposure are discussed on pp. 101-104 and 178-187 in the FSEIS, based on information available in 2001. A history of the State of Vermont's interpretation and guidance on the risk of TFM exposure to human health can be found throughout the span of ANC permits issued for sea lamprey control from that point through 2018. In 2019, the Vermont Department of Health participated in developing parameters and later reviewed the findings of a study commissioned to establish a new, better-informed human health advisory threshold value for TFM (Murphy and Goodnight 2019). A human health advisory value of 100 ppb was empirically derived by the Vermont Department of Health using the results of the study and in accordance with accepted toxicology practices as detailed in the State's Drinking Water Guidance document. Page 12 of the Drinking Water Guidance document, now lists 100 ppb as their established human health advisory value for TFM.

The following steps will be taken to protect public health and inform the public on how to avoid exposure to concentrations of TFM above the advisory threshold.

- Adherence to all requirements printed on the lampricide product label.
- Adherence to the *Prior Notification, Posting, and Water Supply Plan for Lake Champlain Lampricide Applications* (Smith 2016)
- Adherence to the *Water Use Advisory Zone Monitoring Plan for Lampricide Treatments in Lake Champlain* (Smith 2019a)
- Adherence to the *Contingency Plan for Accidental Spillage of Lampricides during Lake Champlain Sea Lamprey Control Operations* (Smith 2019b)
- Coordinate with the Federal, Provincial, and Municipal governments in Canada to ensure awareness and notifications are provided to all parties deemed appropriate by those authorities.

(4) Long-range Management Plan

The entire FSEIS constitutes a long-range management plan for sea lamprey control. When the need arose, an additional EA was written to incorporate the Lamoille River into the control program as well. A commitment to pesticide minimization over time through an integrated pest management approach is detailed in the FSEIS. Lampricide is applied at levels necessary to effectively kill the target organism (sea lamprey), but great care is given to use no more than is necessary thereby limiting the impacts on the non-target environment to the greatest extent possible. Our proposed long-term control strategies include non-chemical control methods in 4 of the 12 Vermont tributaries inhabited by sea lamprey (Figure 3). We will continue to support and participate in research and investigations into new technologies and methodologies that seek to develop ways to reduce the amount of lampricide needed to control sea lamprey effectively.

(5) Public Benefits

Substantial public benefits of sea lamprey control in Lake Champlain were demonstrated during the 8-year experimental program (Fisheries Technical Committee 1999). At the end of the experimental program, fishery benefits and angler satisfaction increased. Responses from surveyed anglers showed that they planned to spend an estimated additional 1.2 million angler days annually fishing Lake Champlain. This additional effort was estimated to generate an additional $42.2 million in fishing-related expenditures if sea lamprey control was fully implemented and its resulting benefits were to accrue and continue. This value increases to an estimated $59.2 million when all water-based recreational activity is considered (Gilbert 1999; Marsden et al. 2003). Further details of public benefits can be found on pp. 198-202 of the FSEIS.

While more recent empiric data are not available, the results of the large, lake-wide fishing derbies, the numbers of participants, increased fishing in Lake Champlain, angler satisfaction, and wide-spread public support of the lamprey control program point to many increased public benefits for the citizens of Vermont.

Conclusion

Considering the 5 Vermont statutory criteria discussed above, the Service requests an Aquatic Nuisance Control Permit to conduct a controlled application of the lampricide TFM at a concentration of up to 1.2 x MLC to control the population of larval sea lamprey present in the Missisquoi River. Proposed permit conditions are presented in Appendix B.

We seek this ANC permit to become effective in the fall of 2020 and remain effective through the fall of 2025. This would allow the Missisquoi River to be treated twice under this permit (2020 and 2024). The span of 2020-2025 would accommodate the potential need for a postponement of the first treatment due to environmental conditions while maintaining our 4-year cyclical schedule. We recognize that a postponement of the second treatment would necessitate submission of a new permit. If new issues arise, we understand the permit can be reopened. We understand this does not guarantee permission to conduct two treatments; instead, it allows a second treatment in 2024 if all contingencies and conditions in the permit continue to be fulfilled. The applicant will notify the Agency of Natural Resources at least 6 months prior to a planned second treatment to allow time for any questions or concerns to be raised and addressed.

References

Boogaard, M. A., T. D. Bills, and D. A. Johnson. 2003. Acute toxicity of TFM and a TFM/niclosamide mixture to selected species of fish, including lake sturgeon (*Acipenser fulvescens*) and mudpuppies (*Necturus maculosus*), in laboratory and field exposures. Journal of Great Lakes Research. 29 (Supplement 1):529–541.

Breisch, A.R. 1996. Effects of lampricides on amphibians: Little Ausable and Ausable Rivers and deltas, Lake Champlain, NY (1990 - 1995) [L. Nashett, ed.]. Bureau of Fisheries. New York State Department of Environmental Conservation, Ray Brook, NY. 23pp.

Breisch, A.R. 2000a. Non-target amphibian mortality associated with the 1999 lampricide treatment. New York State Department of Environmental Conservation Administrative Report. Delmar, NY. 6pp.

Breisch, A.R. 2000b. Non-target amphibian mortality associated with the 2000 lampricide treatment. New York State Department of Environmental Conservation Administrative Report. Delmar, NY. 2pp.

Chellman, I.C., and D.L. Parrish. 2010. Developing methods for sampling mudpuppies in Vermont tributaries of Lake Champlain. Final Report. State Wildlife Grants Program, Vermont Fish and Wildlife, Waterbury.

Chipman, B. D. 2003. Lake Champlain sea lamprey control program chemical treatment summary: Lewis Creek, Vermont, 2002. Vermont Department of Fish and Wildlife, Essex Junction, VT. 20 pp.

Chipman, B. D. 2005. Lake Champlain sea lamprey control program, chemical treatment summary: Winooski River, Vermont, 2004. Vermont Dept. of Fish and Wildlife, Waterbury, VT. 33 pp.

Chipman, B. D. 2009. Lake Champlain sea lamprey control program chemical treatment summary: Winooski River, Vermont, 2008. Vermont Department of Fish and Wildlife, Essex Junction, VT. 20 pp.

Docker, M. F. (ed.) 2019. Lampreys: Biology, conservation and control, Volume 2. Dordrecht, The Netherlands: Springer (Fish & Fisheries Series, volume 38). 577 pp.

Durfey, L. E. and B. D. Chipman 2008. Chemical treatment summary: Poultney River and Hubbardton River. New York State Department of Environmental Conservation, Ray Brook, NY. 27 pp.

Fodale, M., C. Kaye, and J.V. Adams. 2012. *In situ* determination of mudpuppy mortality from exposure to TFM. U.S. Fish and Wildlife Service Marquette Biological Station. Marquette MI. pp. 14.

Fisheries Technical Committee. 1999. Comprehensive evaluation of an eight-year program of sea lamprey control in Lake Champlain. Lake Champlain Fish and Wildlife Management Cooperative. 209 pp. plus appendices.

Gilbert, A. H. 1999. Benefit-cost analysis of an eight-year experimental sea lamprey control program on Lake Champlain. Federal Aid Job Performance Report. Final Report. Revised 2000. F-23-R, Job 5. Vermont Department of Fish and Wildlife, Waterbury, VT. 40 pp.

King, E. L. Jr., and J. A. Gabel. 1985. Comparative toxicity of the lampricide 3-trifluoromethyl4-nitrophenol to ammocetes of three species of lampreys. Great Lakes Fisheries Commission Technical Report 47. Ann Arbor, MI. 5 pp.

Marsden, J. E., B. D. Chipman, L. J. Nashett, J. K. Anderson, W. Bouffard, L. Durfey, J. E. Gersmehl, W. F. Schoch, N. R. Staats, and A. Zerrenner. 2003. Sea lamprey control in Lake Champlain. Journal of Great Lakes Research 29 (Supplement 1):655-676.

Murphy, C. and S.Y. Goodnight. 2019. Final Report: 4-Nitro-3-(trifluoromethyl)phenol (TFM): 90-Day Oral Toxicity Study Following Administration via Drinking Water to Sprague Dawley Rats with a 28-Day Recovery Period. Study Number 2410-14374. Smithers Avanza Toxicology Services. Gaithersburg, MD.

Neuderfer, G. N., B. D. Chipman and L. Durfey. 2004. Acute toxicity of TFM and a TFM-1% niclosamide mixture to juvenile mudpuppies. Draft report. New York State Department of Environmental Conservation, Ray Brook, NY. 17 pp.

Sabbayya, S., C. Swanson and A. Vidal. 2008. Missisquoi River and lampricide plume modeling. Great Lakes Fishery Commission Project Completion Report. Applied Science Associates, Narragansett, RI. 85 pp.

Schuldt, R. J., and R. Goold. 1980. Changes in the distribution of native lampreys in Lake Superior tributaries in response to sea lamprey (*Petromyzon marinus*)) control, 1953-77. Canadian Journal of Fisheries and Aquatic Sciences 37:1872-1885.

Smith, S. 2016. Prior Notification, Posting, and Water Supply Plan for Lake Champlain Lampricide Applications. USFWS Lake Champlain Fish and Wildlife Conservation Office. Essex Junction, VT. 10 pp. plus attachments.

Smith, S. 2019a. Water use advisory zone monitoring plan for lampricide treatments in Lake Champlain. USFWS Lake Champlain Fish and Wildlife Conservation Office. Essex Junction, VT. 34 pp.

Smith, S. 2019b. Contingency plan for accidental spillage of lampricides during Lake Champlain sea lamprey control operations. USFWS Lake Champlain Fish and Wildlife Conservation Office. Essex Junction, VT. 12 pp. plus attachments.

U. S. Fish and Wildlife Service. 2006. Status report for the Lake Champlain Sea Lamprey Alternatives Workgroup. U. S. Fish and Wildlife Service, Essex Junction, VT. 12 p.

Weisser, J. W., G. A. Baldwin, and R. J. Schuldt. 1994. Effect of the lampricide 3-trifluoromethyl-4-nitrophenol (TFM) on fish, aquatic insects, and an amphibian in the Grand River in Lake County, Ohio, 1987. USFWS Project Completion Report. Marquette, MI. 18 pp.

Appendix B

Proposed Aquatic Nuisance Control Species Permit Specific Conditions
for the 2020 and 2024 Missisquoi River TFM Treatments

Proposed Permit Conditions

March 10, 2020

Part II. Pesticide Application Conditions

1. Pesticide Use. The Permittee is authorized to use TFM-HP Sea Lamprey Larvicide (EPA Reg. No. 6704-45), and TFM Bar (EPA Reg. No. 6704-86) in the Missisquoi River. These pesticides shall be registered with the U.S. Environmental Protection Agency and the Vermont Agency of Agriculture, Food and Markets at the time of use and handled, applied, and disposed of in conformance with all state and federal regulations. The lampricide products used must be produced using the same manufacturing process as those batches previously examined by the Vermont Department of Health, and noted in the Analytic Perspectives report dated August 28, 2009, or its replacement.

2. Certified Applicator. All applicators of the authorized pesticide shall be certified by the Vermont Agency of Agriculture, Food and Markets (VT AAFM) in Category Five – Aquatic Pest Control. All applicators shall conform to the restrictions established in 6 V.S.A. Chapter 87 Vermont Regulations for Control of Pesticides and shall report the amount of each pesticide used to the VT AAFM Pesticide Management Program.

3. Procedure. The Permittee shall apply lampricide in accordance with the following:
   A. Standard Operating Procedures for Application of Lampricides in the Great Lakes Fishery Commission Integrated Management of Sea Lamprey (*Petromyzon marinus*) Control Program, Marquette Michigan. SLC 04-001.10.
   B. Contingency Plan for Accidental Spillage of Lampricides during Lake Champlain Sea Lamprey Control Operations (Smith 2019a)
   C. Water Use Advisory Zone Monitoring Plan for Lampricide Treatments in Lake Champlain (Smith 2019b)
   D. Prior Notification, Posting and Water Supply Plan for Lake Champlain Lampricide Applications (Smith 2016)

4. Concentration & Duration. As determined by an on-site toxicity test conducted on or after September 1 of the year of the treatment, the Permittee shall apply lampricide to maintain a 9-hr lethal concentration (1.0 x MLC or greater) in all downstream areas from the primary application point. Lampricide will be applied at both the Primary Application Point and at up to 6 supplemental application points at a rate that shall not exceed 1.2 x MLC. The Permittee shall not apply TFM into the Missisquoi River at a single location for longer than 14 consecutive hours.

5. Treatment Dates. The Permittee is authorized two applications of lampricide under this permit; the first between Labor Day and December 31 of 2020 and the second between Labor Day and December 31 of 2024 unless authorized otherwise by the Secretary during the effective period of this permit. If the 2020 treatment must be postponed until 2021, that rescheduled treatment must occur during the same date range. In the case of a postponement, the next treatment shall remain on its original schedule. The second treatment shall not occur if the Permittee has not fulfilled condition 17. of this permit.

6. Location. The Permittee is authorized to apply TFM only in the authorized areas of the Missisquoi River as shown in Appendix A of the Approved Application and identified as follows:
   A. The primary TFM application point (AP) less than 100 meters upstream of Swanton Dam (river mile 7.8).
   B. Supplemental application points (SAPs) in up to 4 tributaries of the Missisquoi watershed, downstream of the AP, using TFM-BAR or adjustable rate pump for the purpose of negating the effects of incoming freshwater. The SAPs shall be placed no further than 100 meters upstream of a tributary's confluence with the main stem Missisquoi River.
   C. Supplemental application by backpack sprayer of 2 backwaters adjacent to the river to reach areas where regular flow will not penetrate during a treatment.

7. Water Temperature. The Permittee shall ensure the water temperature at the primary application point (prior to application) during the day of scheduled treatment is at or above 2° C.

8. Stream Flow. The river flow rate shall be monitored from the USGS 04294000 MISSISQUOI RIVER AT SWANTON, VT Stream Gauge No. 04282795. No treatment shall occur if the flow of the Missisquoi River is more than 1,500 cubic feet per second (CFS). The Gauge will be monitored while the TFM application is in progress.

9. Lake Level. No TFM use shall occur unless the surface elevation of Lake Champlain is at or below 98.0 feet National Geodetic Vertical Datum (NGVD) as measured at the USGS 04294500 LAKE CHAMPLAIN AT BURLINGTON, VT.

10. Secretary Notification. The Secretary shall be notified one week in advance of any pesticide use.

11. Treatment Monitoring. The Permittee shall monitor for pH, alkalinity, and adjust TFM application concentrations accordingly during the treatment duration in order to ensure the 1.2 x MLC is not exceeded in accordance with the *Treatment Strategy* (as indicated in Appendix A of the Approved Application) and in accordance with the following:
   A. The Permittee shall collect and analyze (for pH and lampricide concentration) water samples every ½ hour at the most upstream sampling station (M1) below the primary application point (AP), as well as below supplemental application points (as indicated in Appendix A) where lampricide is applied with an adjustable rate pump. Samples shall be analyzed for alkalinity at least every 2 hours.
   B. The Permittee shall collect and analyze (for pH and lampricide concentration) water samples every hour from the following stations (as indicated in Appendix A) during treatment by hand or pH logger. Samples shall be analyzed for alkalinity every two hours or at least at the time pH loggers are deployed and retrieved:
      i. Station M2: At the Missisquoi-Dead Creek Fork (river mile 5.4)
      ii. Station M3: Mac's Bend Access (river mile 3.0)
   C. The Permittee shall collect and analyze (for pH and lampricide concentration) water samples every 2-hours from the following stations (as indicated in Appendix A) during treatment by hand or pH logger. Samples shall be analyzed for alkalinity every two hours or at least at the time pH loggers are deployed and retrieved:
      i. Station M4: Missisquoi middle mouth (river mile 0.0)
      ii. Station D4: Dead Creek Mouth (river mile 0.0)
   D. The Permittee shall take samples at Station M1 at three locations along a transect at the one-quarter, one-half, and three-quarters points between the river banks if:
      i. TFM concentration measurements along this transect are within 0.1 MLC of each other and at or below the 1.2 MLC target, then sampling may be reduced to the midstream location only.

ii. TFM concentration measurements along this transect are NOT within 0.1 MLC of each other and at or below the 1.2 MLC target, then sampling shall continue at all the locations until subsequent measurements along this transect are within 0.1 MLC and at or below the 1.2 MLC target.

E. The Permittee shall conduct all monitoring, surveys and reporting of the water use advisory zone in accordance with *the Water Use Advisory Zone Monitoring Plan for Lampricide Treatments in Lake Champlain* (Smith 2019b).

F. Except for samples collected for water use advisory purposes, the Permittee shall determine TFM concentrations with a photospectrometer accurate to within 0.1 parts per million (ppm).

12. Water Treatment Facility Notification. No use of TFM in the Missisquoi River shall take place until the following occurs:

A. The Permittee shall develop a communications plan with the Town of Phillipsburg/Bedford water treatment facilities. The communications plan shall include the following:

i. the proposed date of the treatment;
ii. the lampricide(s) to be used;
iii. the recommended start-up date and time of the PAC system based on monitoring data;
iv. Vermont DOH Drinking Water Guidance;
v. and the contact name(s), address(es), and telephone number(s) for the Permittee.

B. On the day of the proposed treatment, the Permittee shall notify the Phillipsburg facility and the Secretary that treatment will be initiated or if any treatment rescheduling is deemed necessary.

13. Public Water Use Advisories and Recommendations. To minimize unnecessary exposure, the following conditions to all water use advisories apply:

A. For the use of TFM, the public uses of the waterbody downstream of the primary application location shall proceed as follows:

i. Public Water Supplies: The water should not be used for drinking or food or beverage preparation until measurements of TFM are below the reporting limit of 100 parts per billion (ppb) in any public water supply finished water sample.
ii. Private Water Supplies: The water should not be used for drinking or food or beverage preparation until measurements of TFM are below the reporting limit of 100 ppb in areas where there may be private water supplies.
iii. The water should not be used for swimming and recreational activities until measurements of TFM are below 100 ppb.

B. The Permittee shall inform the public of the water use advisories and recommendation contained in this section in accordance with the plans as identified under Specific Conditions 3.C. and 3.D. of this permit.

C. All laboratory analyses for TFM regarding public use advisories and notifications shall be conducted with a minimum detection limit of 5 parts per billion (ppb) or less.

D. The Permittee shall maintain a website (https://www.fws.gov/lcfwro/sealamprey/lamprey_control_information.html) and a toll-free phone line (1-888-596-0611) for the public to check on the current status of the public water use advisories and recommendations.

15. Post-Treatment Surveys.
    A. The Permittee shall conduct a post-treatment nontarget mortality survey in the 5 zones between the following survey transects 3-4, 8-9, 13-14, 18-19, 23-AP. This survey shall be conducted in accordance with the following and shall include the following information:
        i. Post-treatment nontarget mortality survey shall be conducted within 36 hours of the lampricide clearing each zone;
        ii. All visible bottom sections will be inspected and observations of nontarget organism mortalities, except lampreys, shall be recorded;
        iii. At each survey zone, the first 30 lampreys (all species) encountered will be collected and brought back to the lab for identification;
        iv. Preliminary results shall be made available to the Aquatic Nuisance Control Program within 24 hours of completion;
        v. If preliminary results indicate a significant level of impact on nontarget organisms, then a full reach survey may be requested by the Secretary;
        vi. All mudpuppy (*Necturus maculosus*) mortalities shall be recorded and reported to the Secretary. All specimens shall be collected and preserved in a manner to ensure continued study, such as for ongoing environmental DNA (eDNA) research. The Permittee shall participate in developing standardized methodologies to assess and monitor mudpuppy population distribution in Vermont; and
        vii. Final results shall be submitted to the Secretary by May 1st of the year following the treatment.
    B. The Permittee shall conduct a post-treatment survey to estimate the relative abundance of sea lamprey and other lamprey species in the Missisquoi River using the standard Larval Assessment Sampling Protocol, or an approved equivalent, within one year after treatment. The post-treatment larval survey results will be submitted by December 31 of the year following the year of treatment.

16. Annual Treatment Report. A final report shall be submitted to the Secretary by May 1st of the following year and shall include at a minimum:
    A. Batch numbers and the quantity used of TFM HP and TFM Bar;
    B. Results from the on-site toxicity test and MLC determination;
    C. Total treatment duration;
    D. Summary of water chemistry monitoring data;
    E. Summary of stream flow data;
    F. All nontarget, non-lamprey post-treatment mortality survey data;
    G. A proportional representation of each lamprey species in post treatment collections; and,
    H. Other observations, corrective actions taken; and recommendations (if any).

17. Annual Meeting. The Permittee shall meet with the Secretary annually during the life of this permit to discuss the surveys, annual reports, level of control achieved, long-term management plans, and a summary of alternatives to chemical treatments and the feasibility of implementing them.

18. Approved Application. The project shall be completed as shown on the application, plans, and support documents as submitted by the Permittee, and approved by this permit

Reference

Smith, S. 2016. Prior Notification, Posting, and Water Supply Plan for Lake Champlain Lampricide Applications. USFWS Lake Champlain Fish and Wildlife Conservation Office. Essex Junction, VT. 10 pp. plus attachments.

Smith, S. 2019a. Contingency plan for accidental spillage of lampricides during Lake Champlain sea lamprey control operations. USFWS Lake Champlain Fish and Wildlife Conservation Office. Essex Junction, VT. 12 pp. plus attachments.

Smith, S. 2019b. Water use advisory zone monitoring plan for lampricide treatments in Lake Champlain. USFWS Lake Champlain Fish and Wildlife Conservation Office. Essex Junction, VT. 34 pp.

VERMONT

Agency of Natural Resources
1 National Life Drive, Davis 2
Montpelier, VT 05620-3702
802-828-1294

Application for Endangered & Threatened Species Taking Permits

Statutory Authority: 10 VSA §5408

Application Fees

$50 for permits issued for scientific, educational and noncommercial cultural or ceremonial purposes, to enhance the propagation or survival of a threatened or endangered species and for special purposes consistent with the federal Endangered Species Act.

$250 for each listed animal/plant taken up to a maximum of $25,000 for zoological and botanical exhibition purposes, and for incidental take. The Secretary may also require the implementation of mitigation strategies and may collect mitigation funds, in addition to the permit fees, to mitigate the impacts of a taking.

For research and survey projects for listed bats, please download the application form specifically for such projects from our endangered species permits page: https://vtfishandwildlife.com/conserve/conservation-planning/endangered-and-threatened-species/threatened-endangered-species-takings-permit

1. **Permittee/Applicant Name:** U.S. Fish & Wildlife Service
   Institution (if applicable): Lake Champlain Fish & Wildlife Conservation Office
   Principal Officer (CEO) of Institution: Bradley A. Young
   Physical Address/Town/St/Zip: 11 Lincoln Street, Essex Junction, VT 05452
   Telephone: 802-662-5304 **E-Mail:** **Bradley_Young@FWS.GOV**

2. **Name(s) & affiliation of subpermittee(s)**

   Staff from U.S. Fish & Wildlife Service and the Vermont Fish & Wildlife Department

3. **Which species, and how many of each, will be collected or impacted**?

Common Name	Scientific Name	# of individuals to be collected/ impacted	% of population to be collected/ impacted
Black sandshell mussel	*Ligumia recta*	**Not Expected**	**0**
Pocketbook mussel	*Lampsilis ovata*	**Not Expected**	**0**
Pink heelsplitter mussel	*Potamilus alatus*	**Not Expected**	**0**
Fluted shell mussel	*Lasmigona costata*	**Not Expected**	**0**
Fragile papershell mussel	*Leptodea fragilis*	**Not Expected**	**0**
Cylindrical papershell mussel	*Anodontoides ferussacianus*	**Not Expected**	**0**
Giant floater mussel	*Pyganodon grandis*	**Not Expected**	**0**
Eastern sand darter	*Ammocrypta pellucida*	**Not Expected**	**0**
Lake sturgeon	*Acipenser fulvescens*	**Very low or no mortality expected**	**<1%**
Stonecat	*Noturus flavus*	**Very low or no mortality expected**	**<10%**
American brook lamprey	*Lethenteron appendix*	**Mortality expected**	**>90%**

4. **Purposes for which you are applying for a takings permit** *(must meet one of the following)*:

___ Scientific Purposes
___ Educational Purposes
___ Zoological Exhibition
_X_ Incidental Take
_X_ Enhancing the propagation of a threatened or endangered species
___ Special purposes consistent w/ the federal Endangered Species Act

Incidental Take

All species will be exposed to a controlled concentration of the lampricide TFM for the purpose of controlling sea lamprey in Lake Champlain as part of a cooperative state and federal partnership to restore and enhance the fisheries of the lake.

Enhancing propagation of and endangered species

Of the 11 listed species, lake sturgeon will directly benefit as described in the *Lake Champlain Lake Sturgeon Recovery Plan* (MacKenzie 2016).

5. Detailed Explanation of Proposed Activities

See Appendix A: 2020 Missisquoi ANC Permit Application; Pages: 6-12 (Treatment Strategy and Methodology)

6. Are survey data available to indicate the size and/or extent of the impacted population for each species listed in section 3? No ___, Yes _X__.

Prior to commencing the proposed activities, a survey may be required to determine the extent and number of individuals of T&E species at the project location. The survey requires authorization from the Agency of Natural Resources (ANR) and shall be completed by an expert with experience/ qualifications acceptable to ANR.

Mussels
- *Black sandshell*
- *Pocketbook*
- *Pink heelsplitter*
- *Fluted shell*
- *Fragile papershell*
- *Cylindrical papershell*
- *Giant floater*

The presence of all (7) mussel species is discussed in the Final Supplemental Environmental Impact Statement (FSEIS) page 71 and reports on their conservation status is listed on the of State of Vermont's Natural Heritage Inventory. The densities and distribution of these mussels in the Missisquoi River are not known.

Fish

Lake sturgeon

The Vermont Fish and Wildlife Department provides an assessment of the status of lake sturgeon in the *Lake Champlain Lake Sturgeon Recovery Plan* (*Mackenzie 2016).*

Eastern sand darter

The Vermont Fish and Wildlife Department assessed the status and distribution of eastern sand darters in the *Channel Darter and Eastern Sand Darter Sampling Using Trawls and Seines T&E Permit ER-2017-14 2018 Annual Report (Pientka and Good 2019).*

Stonecats

The population of stonecats in the treated reach of the Missisquoi River was sampled using trawls, trapping, and electrofishing from 2010 – 2014. (Cox and Parrish 2011, Puchala 2015).

American brook lamprey

Larval lamprey surveys used to assess sea lamprey populations also serve to assess the population of American brook lamprey (ABL). American brook lamprey have been documented in four parts of the Missisquoi River Watershed; Youngman Brook, Missisquoi River proper between Swanton Dam and Highgate Falls, Kelly Brook, and Hungerford Brook (USFWS unpublished data). Youngman Brook is a tributary to the Dead Creek branch of the lower River, Kelly and Hungerford brooks are tributary to the Missisquoi between Swanton Dam and Highgate Falls. Larval surveys had previously failed to detect ABL in the lower river between Swanton Dam and the mouth (2002, 2003, 2007). American brook lamprey (ABL) were first documented in the Missisquoi River, below Swanton Dam, in the 2008 post-treatment mortality survey (Chipman 2009). Since the initial detection in 2008, ABL were detected in the larval survey below Swanton Dam in 2011(2 individuals) and again in the mortality survey following the 2012 treatment (1 individual). A larval survey of the proposed treatment area in 2019 did not detect ABL. We believe that if present, ABL exist in very low densities below Swanton Dam.

7. Provide a detailed explanation for the basis of the taking/impact.

For instance, if the basis is Scientific Purposes, demonstrate how the benefits of the proposed activities outweigh the impact(s) to the individuals and the populations.

If the basis is Incidental Take, explain:

A) Steps taken to avoid, minimize, and mitigate impact to listed species and/or critical habitat;
B) The benefits that would result if a permit is issued;
C) Why you believe the taking is necessary;
D) Why you believe the taking will not impair the conservation or recovery of T&E species;
E) Any alternative actions to the taking that you considered and the reasons that the alternative(s) were not selected.

Provide supporting documentation if applicable.

The information provided to answer the sub-parts of question 7 is either new, additional, or noteworthy relative to information submitted in our 2012 application that addressed each of these same species. That application was approved and issued as *2012 Missisquoi T&E Takings Permit #EH-2012-18* (Appendix B).

7A) The proposed treatment concentration has been lowered to 1.2 x the Minimum Lethal Concentration (MLC) for sea lamprey to minimize any potential impact on stonecats based on toxicity testing conducted by the Service. Other rivers in Vermont are routinely treated at 1.3 x MLC to minimize any potential impact to more tolerant Endangered and Threatened species. In the state of New York, and in Vermont streams where no sensitive Endangered and Threatened species are present, sea lamprey control treatments are conducted at concentrations up to 1.5 x MLC to ensure environmental variability in rivers is accounted for and addressed, thereby reducing the risk of exposing the environment to lampricide without achieving the desired result of eliminating sea lamprey.

The concentration of 1.2 x MLC carries a degree of risk in that environmental conditions may lead to areas of the river that do not receive an exposure of TFM that is lethal to sea lamprey. We have accepted that risk to provide additional protection to Vermont listed species sensitive to TFM.

7B) *See Appendix A: 2020 Missisquoi ANC Permit Application; Page 18 (Public Benefits)*

7C) *See Appendix A: 2020 Missisquoi ANC Permit Application; Pages 2-4 (Reasons to Control the Aquatic Nuisance)*

7D) Toxicity of lampricides to non-target species is described, for the purposes of the proposed treatment, relative to the Minimum Lethal dose required to kill 99% of sea lamprey (MLC), (Figure 1 below). Results from toxicity tests are reported as no observed effect concentration (NOEC) and the lowest observed effect concentration (LOEC). Standard operating procedures for acute toxicity testing (ASTM 2007; USEPA 1975) allow 10% mortality in the experimental control exposures to account for random mortalities not due to toxicity. Mortality that exceeds 10% is assumed to be a significant adverse effect. The highest lampricide concentration that exhibits less than 10% mortality is the NOEC. The next highest TFM concentration that test subjects are exposed to where mortality exceeds 10% is defined as the LOEC.

Mussels

The discussion on the toxicity of TFM to mussels in the FSEIS (pp. 126-130) concludes that mussels suffer little or no mortality during typical TFM treatments. After 100 stream lampricide treatments in the Champlain Basin, only 33 mussel mortalities have been recorded. No mussel mortalities have been recorded in the past 10 years. Research on mussel susceptibility to TFM is consistent with the low number of mussel mortalities observed following treatments (Table 1).

Table 1. NOEC values for selected mussel species are represented as a multiple of sea lamprey 9-hour MLC.

Species	TFM		Data Source
	NOEC	LOEC	
Black sandshell	1.7	2.1	Boogaard et al. 2013
Cylindrical papershell	2.6	3.2	NYSDEC and VTDFW 2007
	2.3	2.9	
Fluted shell	1.6	2.0	NYSDEC and VTDFW 2001
	1.6	2.0	
Pocketbook (adult)	1.5	1.9	Neuderfer 2001; NYSDEC and VTDFW 2001
	1.6	2.0	
	≥2.0	>2.0	
Pocketbook (juvenile)	1.5	1.9	Neuderfer 2001
Fragile papershell	1.5	1.8	Boogaard et al. 2004
Giant floater	1.6	2.0	Boogaard et al. 2004
Pink heelspliter	≥1.9	>1.9	Boogaard et al. 2004

The effects of TFM on mussel glochidia have long been of interest, but difficulty in culturing them has led to an inability to perform toxicity tests on that life stage until now. Boogaard et al. (2015) published a study that determined the acute toxicity of TFM to selected life stages of the snuffbox mussel (*Epioblasma triquetra*), a Great Lakes species and candidate for federal listing under the Endangered Species Act. TFM toxicity to free-floating glochidia and one-week-old juvenile snuffbox (collected one week after dropping from the infected fish host) life stages was tested for the first time. The study found no significant difference in survival among life stages at concentrations of up to 1.8 times what would be applied during a lampricide treatment. The host species for the glochidia, log perch, are more sensitive than the mussels themselves and would be the greater source of concern. While snuffbox is not a species that occurs in Lake Champlain, it does show for the first time that there is no evidence of additional sensitivity in the glochidia stage.

In summary, TFM treatments are expected to have negligible impacts, on mussel populations at concentrations of up to at least 1.5 x MLC. No mortality is the most often observed effect. Thus, the proposed 1.2 x MLC maximum target TFM concentration for the Missisquoi River would mitigate the risk to resident mussels, including the listed species. Also, all the listed Missisquoi River mussel species, except for the cylindrical papershell, have been documented to occur upstream of the Swanton Dam, as well as in the treatment area. The mussel community above the application point will not be exposed to TFM.

Fish

Lake sturgeon

Early life stages of lake sturgeon appear to be among the most sensitive of non-lamprey fishes to TFM. Boogaard et al. (2003) conducted a series of flow-through TFM toxicity tests on nine early life stages of lake sturgeon, from sac fry, through age 1+ (Table 2). Young-of-year lake sturgeon up to about 80 mm total length were found to be nearly as sensitive to TFM as sea lamprey, with NOEC's ranging from 0.4 to 0.8 x MLC, depending on size class. Their tolerance to TFM increased with size. Average NOEC's of three young-of-year size classes averaging 107, 157, 217 mm TL were equivalent to 1.0 x MLC, 1.0 x MLC, 1.2 x MLC, respectively; average NOEC for an age 1+ group averaging 261mm TL was equivalent to 1.5 x MLC.

Table 2**.** Toxicity of TFM and to four early life stages of lake sturgeon and comparison to observed sea lamprey MLC (Boogaard et al. 2003).

Average Length mm (range)	Test #	TFM NOEC Multiple X Sea Lamprey MLC
107.4 (85-125)	1	1.0
	2	1.0
	3	1.0
157.4 (131-181)	1	1.0
	2	1.0
	3	1.0
217.4 (183-255)	1	1.3
	2	1.2
	3	1.0
261.0 (219-301)	1	1.5
	2	1.6
	3	1.3

We will treat the Missisquoi River between Late September and Late November which will allow young-of-year sturgeon increased growth potential prior to Lampricide exposure.

The Vermont Department of Fish and Wildlife published its Lake Champlain Lake Sturgeon Recovery Plan in 2016 which lists its highest priority in Sturgeon Recovery as **"*A. Continue efforts to reduce sea lamprey numbers in Lake Champlain to reduce lamprey predation on sub-adult and adult lake sturgeon*"** (MacKenzie 2016). The plan reports that 62% of adult sturgeon collected in Vermont between 1998 and 2002 had fresh or healing sea lamprey wounds. The impacts of lamprey on sturgeon whereby they prevent sub-adults from maturing to spawning age and kill spawning age adults is the reason that the state of Vermont considers lamprey control of greater benefit than the cost of potential effects from lampricide. Reducing the effects of lampricide on young-of-the-year sturgeon was priority "**E.**"

Eastern sand darter

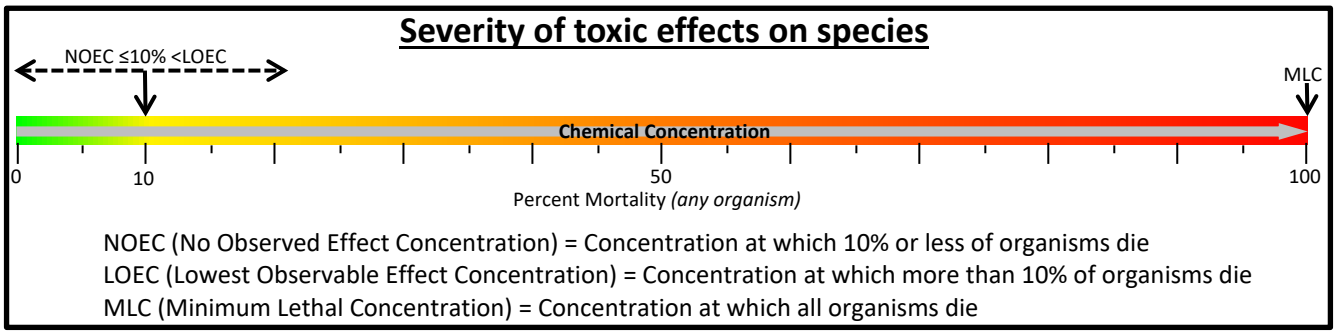
Eastern sand darters are relatively tolerant of TFM exposure at treatment concentrations, with a NOEC of 1.4 x MLC in a laboratory toxicity test (Neuderfer 2000). Based on these above findings, a treatment concentration of up to 1.2 x MLC should not affect the eastern sand darters and thus mitigates the risk to the population.

Stonecats

Twenty-two stonecat mortalities were observed during the 2008 treatment of the Missisquoi River below Swanton Dam, but that was an unfortunate result of an inadequate treatment apparatus (Chipman 2009). That insufficiency was rectified for the 2012 treatment of the Missisquoi where only one stonecat mortality was observed (Smith 2013). USFWS Lake Champlain Fish and Wildlife Resource Office conducted a series of 3 bioassays for stonecats with the lampricide TFM during the summer and fall of 2011 (Calloway 2012), which resulted in a mean LOEC of 1.4 X MLC. Based on our bioassay data and previous treatment experience, a 1.2 X MLC treatment concentration target should result in minimal stonecat mortality.

American brook lamprey

The impacts of TFM on ABL are discussed in pp. 136-140 of the FSEIS. ABL are known to be slightly more resistant to TFM than sea lamprey (King and Gabel 1985), but substantial losses of ABL larvae are unavoidable during TFM treatments. Given our proposed treatment target concentration of up to 1.2 X MLC, we expect American brook lamprey mortalities in portions of the treated river where they are present. It should be noted that experience with sampling larval lampreys in the basin finds that ABL are typically and most frequently found in clearer and cooler streams (e.g. Trout Brook, Sunderland Brook, and several NY Adirondack tributaries to Lake Champlain). Sea lamprey are found in a wider range of habitat conditions. The lower Missisquoi River downstream of Swanton Dam would not be classified as preferred habitat for ABL, but areas of the main stem between the Swanton and Highgate Falls dams and adjacent tributaries to that reach are more consistent with ABL habitat. This is likely why only 4 individuals have ever been documented in the mainstem Missisquoi below the Swanton dam.



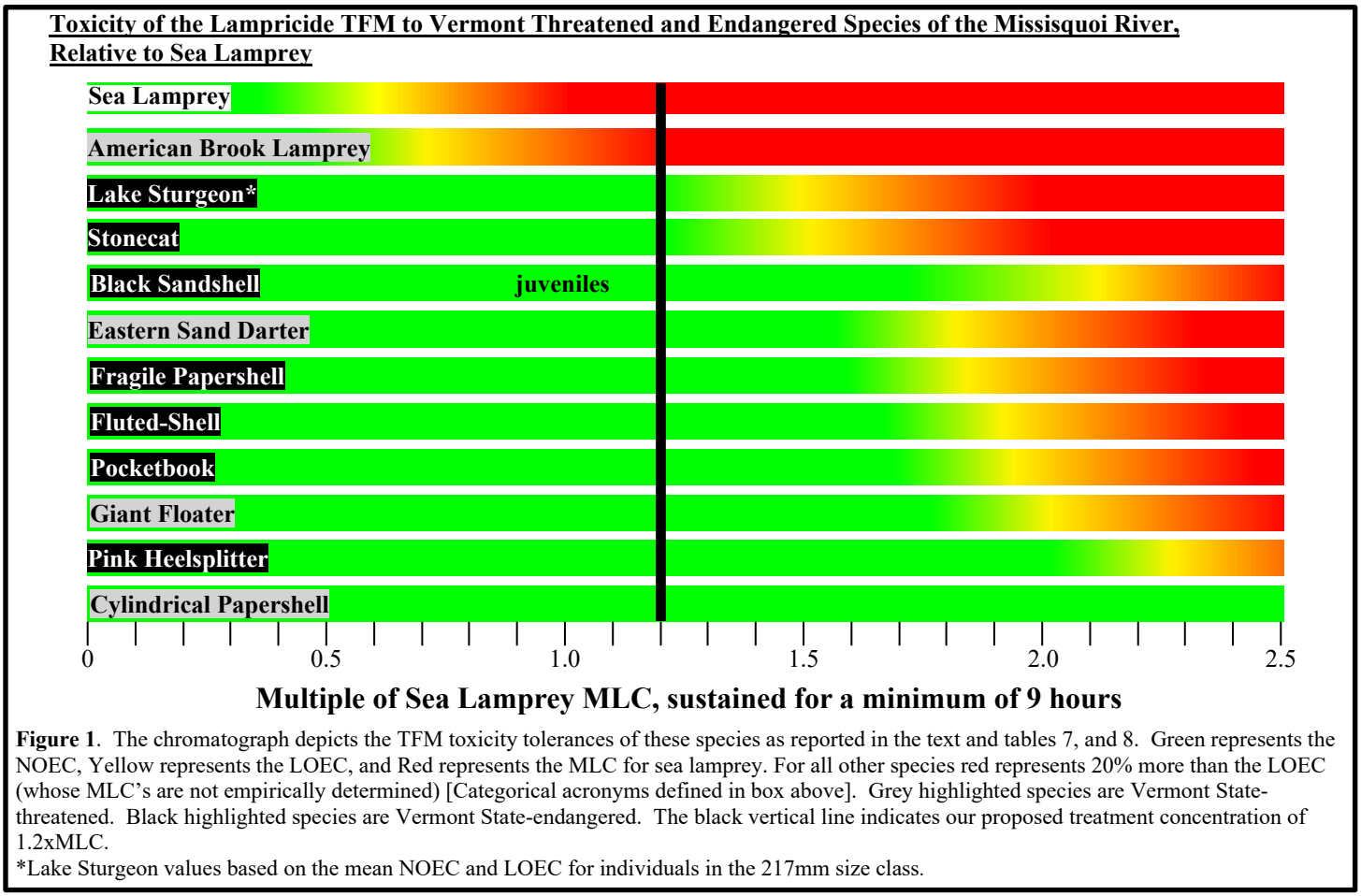


Figure 1. The chromatograph depicts the TFM toxicity tolerances of these species as reported in the text and tables 7, and 8. Green represents the NOEC, Yellow represents the LOEC, and Red represents the MLC for sea lamprey. For all other species red represents 20% more than the LOEC (whose MLC's are not empirically determined) [Categorical acronyms defined in box above]. Grey highlighted species are Vermont State-threatened. Black highlighted species are Vermont State-endangered. The black vertical line indicates our proposed treatment concentration of 1.2xMLC.
*Lake Sturgeon values based on the mean NOEC and LOEC for individuals in the 217mm size class.

7E) *See Appendix A: 2020 Missisquoi ANC Permit Application; Page 13 (There is no reasonable non-chemical alternative available).*

8. What is the time frame of proposed activities:

We seek this ANC permit to become effective in the fall of 2020 and remain effective through the fall of 2024. This would allow the Missisquoi River to be treated twice under this permit (2020 and 2024). The span of 2020-2024 would accommodate the potential need for a postponement of the first treatment due to environmental conditions while maintaining our 4-year cyclical schedule. We recognize that a postponement of the second treatment would necessitate submission of a new permit. If issues arise, we understand the permit can be reopened. We understand this does not guarantee permission to conduct two treatments; instead, it allows a second treatment in 2024 if all contingencies and conditions in the permit continue to be fulfilled. The applicant will notify the Agency of Natural Resources at least 6 months prior to a planned second treatment to allow time for any questions or concerns to be raised and addressed.

9. What are the qualifications & experience of person(s) conducting the proposed activities?

Professional and technical staff from the two agencies listed in #2 above are licensed pesticide applicators with special training and expertise in conducting lampricide treatments to control sea lamprey larvae while minimizing the effects on non-target species, including the Vermont state-listed endangered and threatened species listed above.

10. Which methods and equipment will you use?

If, for example, you seek authorization to translocate/transplant Threatened & Endangered Species, attach a translocation/transplanting plan identifying how specimens will be found and moved, where to, and how you propose to monitor the effectiveness of the translocation/transplanting.

See Appendix A: 2020 Missisquoi ANC Permit Application; Pages: 6-12 (Description of Proposed Control Activity)

11. Where is your project location? Be as specific as possible and identify the town(s) and county. If field-based activities are proposed, attach a detailed map of project site(s).

Missisquoi River in the town of Swanton downstream of the Swanton Dam. Detailed map included in *Appendix A: 2020 Missisquoi ANC Permit Application; Page 8 (Treatment Methodology).*

12. **What are the possible impacts of the proposed activities on the target species or habitat?**

Include details about the numbers of plants and/or animals that will be taken/impacted, and/or the extent and nature of habitat alteration or destruction and efforts to minimize impact.

Addressed in Question 7D

13. **What is your plan for conservation or mitigation of species or habitat impacted?**

Addressed in Question 7A

14. **Final disposition of the specimens you collect (if any)?**

All dead fish (excluding lamprey), amphibians, mussels and other large invertebrates encountered will be identified and enumerated, if possible. Organisms not identified in the field will be collected, if possible, and retained for identification. As noted above, dead lamprey larvae will not be counted during the post treatment mortality survey, but the first 30 encountered in each transect will be retained and identified.

15. **If your project is proposed for a time of year that is more likely to impact listed species than other**

times of year, please explain why a permit should be granted during your proposed time period.

The range of acceptable dates to perform treatments is set by the State of Vermont, to avoid conflict with the public whose use of the areas proposed for treatment decreases after Labor Day. We believe this date range also happens to be most advantageous for the survival of T&E species.

16. **Impacts to Migratory Birds:** Federal authorization is required for activities which might take birds (alive or dead, feathers, eggs and even nests). Federal migratory bird permits are issued by the US Fish & Wildlife Service Migratory Bird Office: 413-253-8643, https://www.fws.gov/birds/policies-and-regulations/permits.php.

My proposed project will impact migratory birds, feathers, eggs or nests: _X_ No, ____ Yes?

If yes: My migratory bird permit # is_____, it is valid until _____
(please include a copy with your application)

I don't have a migratory bird permit but will apply for one ____ Yes.

17. **Institutional Animal Care & Use Committee (IACUC) Protocol #** (if applicable)**:** NA

18. **Required attachments**

**See Below*

_X*_ **Permit fees:** Make checks payable to: "**VFWD T&E Permit Fund 20345"**
$50 for permits for scientific, educational and noncommercial cultural or ceremonial purposes, for enhancing the propagation of a listed species and for special purposes consistent with the federal Endangered Species Act.
$250 for each listed animal/plant taken up to $25,000 for zoological exhibition and incidental take.

_X__ **Map/Site Plan:** For field-based activities attach a map, of appropriate scale, identifying the location where field based activities will occur.

___ **Scientific Research**: Include a research proposal/description and IACUC review and approval application or report with any T&E permit application for scientific research.

___ **Translocation/Transplanting Plan**: If you seek authorization to translocate/transplant listed species, attach a plan identifying how specimens will be found and moved, where to and how you propose to monitor the effectiveness of the translocation/transplantation.

___ **Importation**: For permits authorizing the importation of live specimens of threatened or endangered species a Veterinary Health Inspection report is required certifying the disease-free status of the specimens to be imported.

* The USFWS was informed that application fees for T&E permits would not be required for activities initiated by ANR staff or for agents of ANR working cooperatively or at the direction of ANR staff. This applies in the case of lampricide applications which have been a cooperative endeavor between USFWS and VFWD. Therefore, the USFWS will not be required to pay fees of $50 for permits issued for scientific and education purposes, enhancing the propagation of a species, and special purposes consistent with the federal Endangered Species Act. The $250 fee for each listed animal/plant taken, up to $25,000, will not apply to takings specified in the permit.

18. **Certification by signature:** I hereby affirm, under penalty of perjury, that the information, as well as any exhibits, documentations, and maps, are truthful to the best of my knowledge, that I am not delinquent in any obligation to pay child support or that I am in good standing with respect to any unpaid judgment issued by the judicial bureau or district court for fines and penalties for a civil violation or criminal offense. I also understand that false statements made on this application are punishable pursuant to 10 V.S.A. 4267 of Vermont state law.

Signature:  **Date**: __March 10, 2020_____

Submit signed application via email to jon.kart@vermont.gov or mail c/o "Permit Specialist" Vermont Fish & Wildlife Department, 1 National Life Drive, Davis 2, Montpelier, VT 05620-3702.

Endangered and threatened species taking permits are issued under the authority of 10 VSA §5408. Permits are issued for the purposes of taking (including collecting, disturbing or possessing) individuals (or parts of) of species listed as Endangered or Threatened by the State of Vermont. Collection on lands posted according to 10 VSA §5201 or 13 VSA §3705 is unlawful without landowner permission.

References

ASTM 2007. Standard Guide for Conducting Acute Toxicity Tests on Test Materials with Fishes, Macroinvertebrates, and Amphibians. Designation: E729 – 96 In: 2007 Annual Book of ASTM Standards, American Society for Testing and Materials, West Conshohocken, PA. 10.1520/E0729-96R07.

Boogaard, M. A., T. D. Bills, and D. A. Johnson. 2003. Acute toxicity of TFM and a TFM/niclosamide mixture to selected species of fish, including lake sturgeon (*Acipenser fulvescens*) and mudpuppies (*Necturus maculosus*), in laboratory and field exposures. Journal of Great Lakes Research. 29 (Supplement 1):529–541.

Boogaard, M. A., C. S. Kolar, and D. L. Waller. 2004. Acute toxicity of 3-trifluoromethyl-4-nitrophenol (TFM) and a TFM-1% niclosamide mixture to the giant floater (*Pyganodon grandis*), fragile papershell (*Leptodea fragilis*), and the pink heelsplitter (*Potamilus alatus*) unionid mussels and sea lamprey (Petromyzon marinus) larvae. Completion report prepared for Lake Champlain Fish and Wildlife Management Cooperative.

Boogaard, T. D. Hubert, and B.D. Chipman 2013. Acute toxicity of 3-trifluoromethyl-4-nitrophenol (TFM) and a TFM:1% niclosamide mixture to the juvenile black sandshell mussel (*Ligumia recta*). For submission to the Lake Champlain Fish and Wildlife Management Cooperative. 5 pp.

Boogaard, M.A., T.J. Newton, T.D. Hubert, C.A. Kaye, and M.C. Barnhart. 2015. Evaluation of the short term 12 hour toxicity of 3-trifluoromethyl-4-nitrophenol (TFM) to multiple life stages of *Venustaconcha ellipsiformis* and Epioblasma triquetra and its host fish (*Percina caprodes*). Environ Toxicol Chem. 34:1634-1641. doi: 10.1002/etc.2959.

Calloway, M.T. 2012. Report on Stonecat Toxicity after exposure to TFM (lampricide). USFWS Lake Champlain Fisheries Resource Office Essex Junction, 05452.

Chipman, B.D. 2009. Chemical Treatment Summary: Missisquoi River, Vermont, 2008. Vermont Department of Fish and Wildlife 111 West Street Essex Junction, VT 05452 29 pp.

Cox, K.M. and D.L. Parrish. 2011. Summary of experimental application of the mini-Missouri trawl for sampling benthic fish populations in the Winooski, Lamoille and Missisquoi Rivers, July 11-14, 2011. Report to Vermont Agency of Natural Resources Secretary Deborah Markowitz. 11 pp.

King, E.L., and J.A. Gabel. 1985. Comparative toxicity of the lampreicide 3-trifluoromethyl-4-nitrophenol to Ammocoetes of Three Species of Lampreys. Great lakes Fishery Commission Technical Report No. 47 pp. 25

MacKenzie, C. 2016. Lake Champlain Sturgeon Recovery Plan. Vermont Fish and Wildlife Department. Agency of Natural Resources. 1 National Life Drive, Davis 2, Montpelier, VT 05620.

Neuderfer, G. 2000. Summary of eastern sand darter (*Ammocrypta pellucida*) laboratory toxicity test results on the Poultney River on September 9, 2000. New York State Department of Environmental Conservation, Avon, NY.

Neuderfer, G. N. 2001. Toxicity of the lampricide TFM (3-trifluoromethyl-4-nitrophenol) to juvenile and adult pocketbook mussels (*Lampsilis ovate*), black sandshell (*Ligumia recta)*, and the channel darter (*Percina copelandi)*. NYSDEC Administrative Report. Avon, NY. 34 pp.

NYSDEC and VTDFW 2001. Preliminary Results of TFM Toxicity Tests of the Fluted Shell (*Lasmigona costata*) and Pocketbook (*Lampsilis ovata*) Mussels. New York State Department of Environmental Conservation, Avon, NY. 10 pp.

NYSDEC and VTDFW 2007. Summary of TFM Toxicity Tests of the Cylindrical Papershell (*Anodontoides ferussacianus*) Mussel. New York State Department of Environmental Conservation, Avon, NY. 4 pp.

Pientka,B., and S. Good. 2019. Channel Darter and Eastern Sand Darter Sampling Using Trawls and Seines T&E Permit ER-2017-14. Vermont Department of Fish and Wildlife, Essex Junction, VT. 38 pp.

Puchala, E. 2015. The Status of Stonecats (*Noturus Flavus*) In The LaPlatte And Missisquoi Rivers, Vermont. University of Vermont Graduate College Dissertations and Theses. 83 pp.Smith, S.J. 2013. Lake Champlain sea lamprey control program, chemical treatment summary: Missisquoi River, VT 2012. USFWS Lake Champlain Fisheries Resource Office, Essex Junction, VT.

USEPA. 1975. Methods for acute toxicity tests with fish, macroinvertebrates, and amphibians. EPA-600/3-75-009. U.S. Environmental Protection Agency, Corvallis, OR. 61